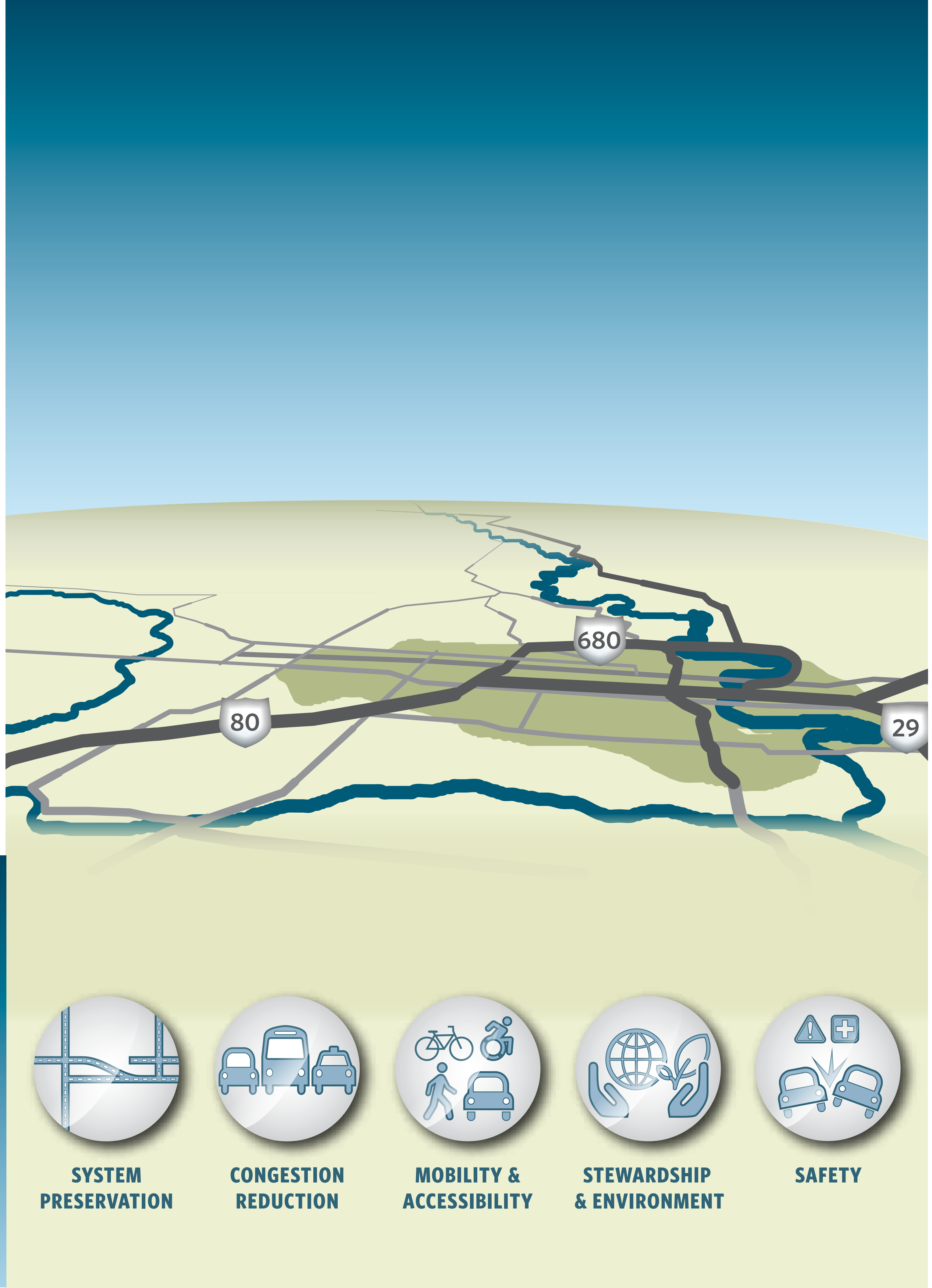

Metro Area Travel Improvement Study

Phase 1 - Existing and Future No-Build Conditions

November
2015

U.S. Department of Transportation
Federal Highway Administration

NDOR
Nebraska Department of Roads

MAPA

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Chapter 1 - Introduction

Study Purpose

The Metro Area Travel Improvement Study (MTIS) is a collaboration between the Nebraska Department of Roads (NDOR) and the Metropolitan Area Planning Agency (MAPA). MTIS is a comprehensive transportation study that recognizes future interstate and freeway system needs are intrinsically linked with arterial, local roads and transit system needs and investment decisions in the MAPA region. This approach provides the opportunity for identifying an optimum area-wide, multimodal transportation system where investment decisions are made understanding the comprehensive travel network and leveraging available strategies and options to efficiently meet the community needs. The purpose of the study is to:

- Develop a comprehensive, multimodal, multisystem plan
- Prioritize projects for short-term, mid-term, and long-term
- Consider funding constraints and TIP shortfalls

Study Goals and Objectives

The performance goals listed below, initially developed from the priorities identified at the study kick-off meeting, were discussed and vetted by workshop participants to ensure that they provided an accurate expression of transportation priorities for the region while supporting the study purpose.

- **System Preservation**: Achieve state-of-good-repair by prioritizing projects that address timely and cost-beneficial asset rehabilitation.
- **Congestion Reduction**: Reduce the growth of peak-period delay on freeways and improve system reliability and overall performance.
- **Mobility and Accessibility**: Reduce the growth of peak-period travel times for all modes, and increase transit access and ridership.
- **Stewardship and Environment**: Address air quality concerns, consider land use in all improvements, and incorporate economic, social, and environmental criteria in project selection and programming decisions.
- **Safety**: Reduce fatalities and serious injuries.

Study Approach

The study will utilize a phased approach. This report covers Phase 1. The study phases include:

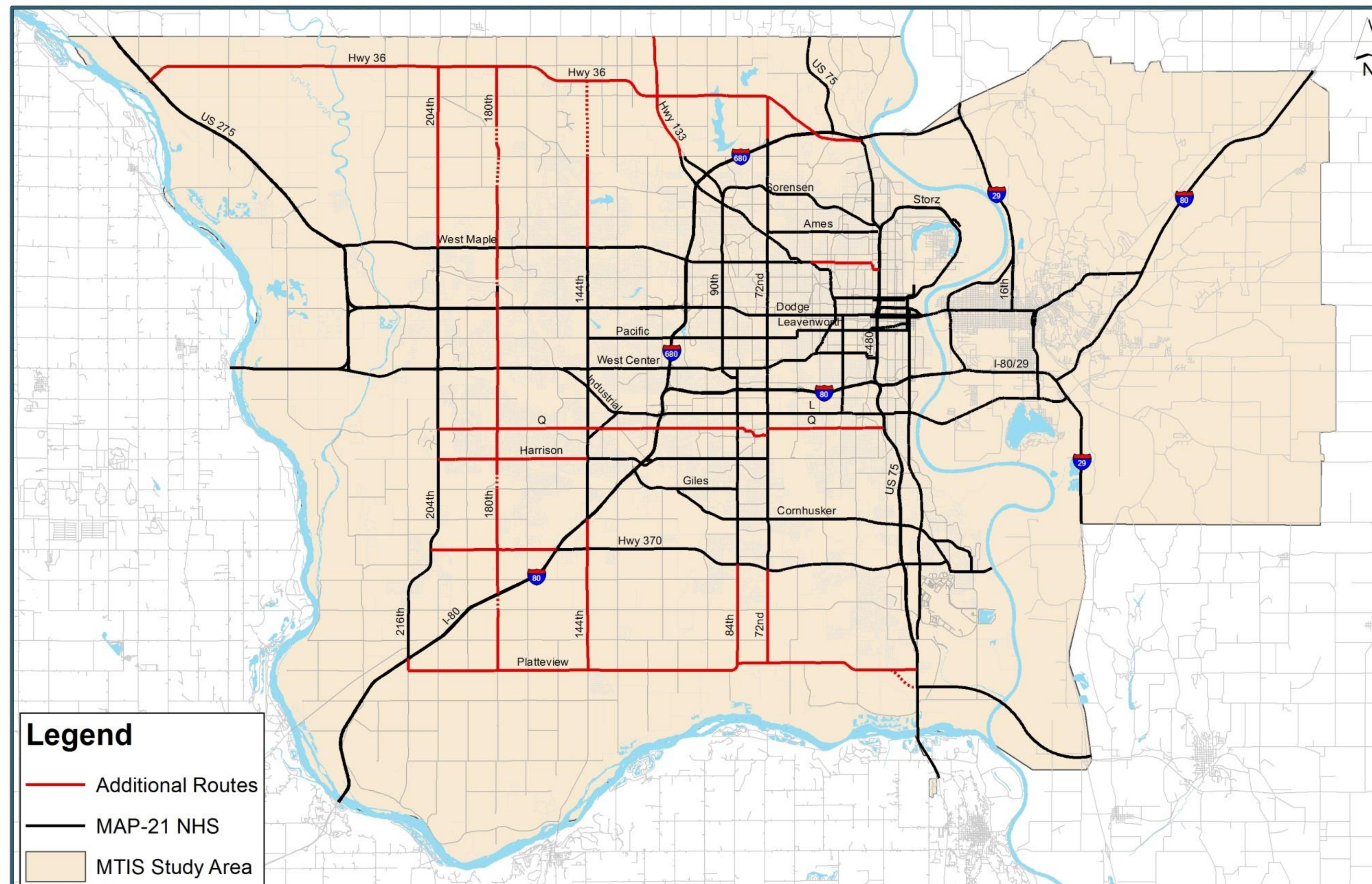
- **Phase 1**: Existing / Future No-Build Conditions Review
- **Phase 2**: Strategy / Alternative Development and Evaluation
- **Phase 3**: Alternative Design and Implementation Plan

Study Area

The first phase of the study has defined the study area boundary and roadways based on discussions with NDOR, MAPA and jurisdictional stakeholders. The MTIS study area is shown in **Figure 1.1** and includes the following elements:

- The study area boundary was based on MAPA's designated Transportation Management Area (TMA), which includes all of Douglas and Sarpy Counties in Nebraska, Western parts of Pottawattamie County in Iowa, and a small segment of Cass County along US 75 northwest of Plattsmouth in Nebraska. The study area was expanded slightly into the northwest corner of Mills County, Iowa between the Missouri River and I-29, to include the recently completed US 34 connection between I-29 and US 75
- All National Highway System (NHS) routes are included in the study area. Additional non-NHS routes that were considered priority corridors by NDOR & MAPA were included as well.
- The freeway system in Iowa will not be evaluated in MTIS, as the Council Bluffs Interstate system is currently undergoing a multi-year reconstruction and expansion that will address long-term mobility and safety needs. Those Council Bluffs Interstate projects included in the current Transportation Improvement Program (TIP) will be part of the "existing-plus-committed" (E+C) future regional system assumed to be in place for the baseline conditions analysis.

Figure 1.1. Study Area and Roadways



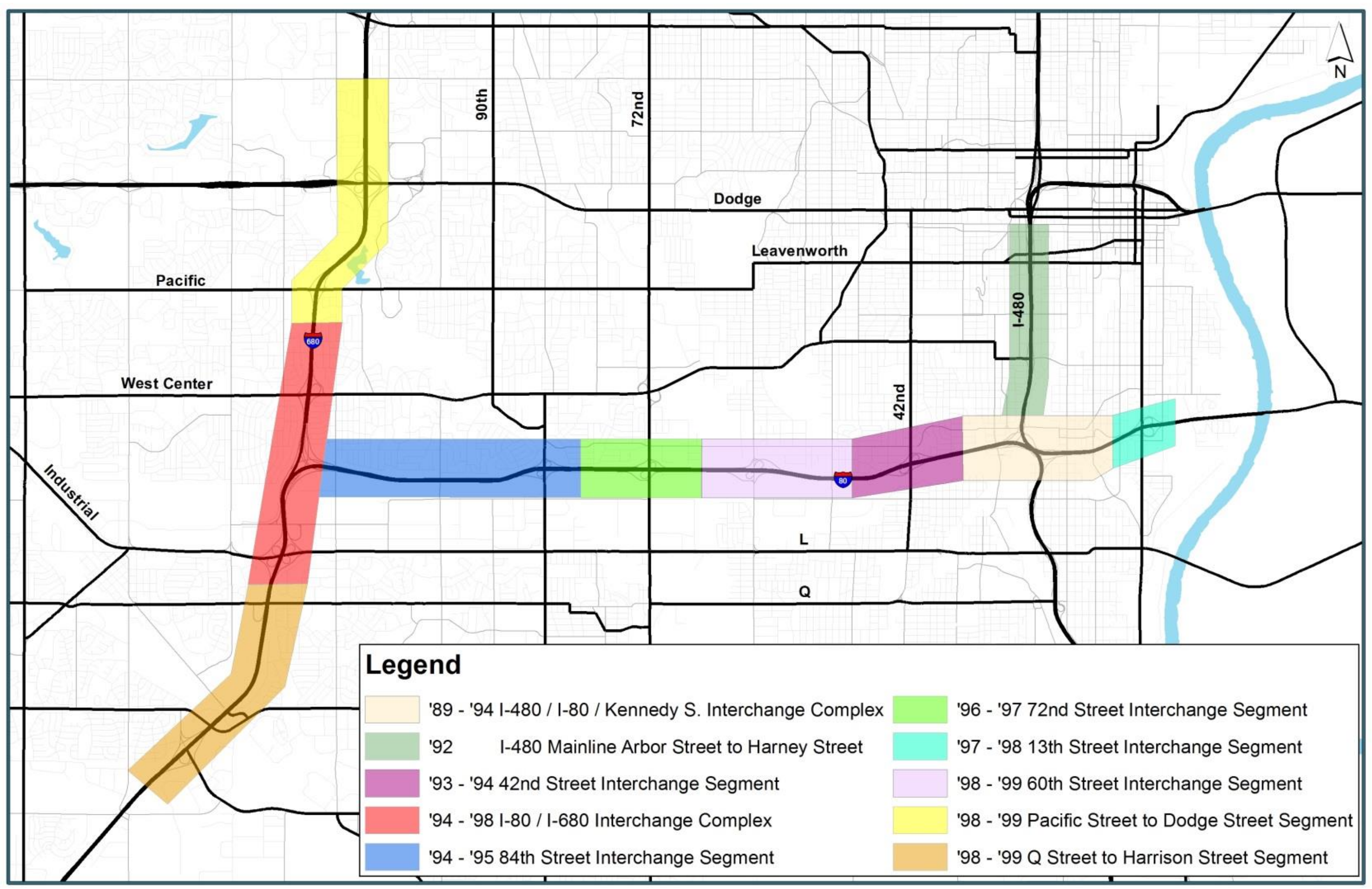
Study Background

Previous Freeway Master Plan / Reconstruction

The previous freeway master plan for the Omaha metropolitan area was completed in 1985. The objective of the study was to develop a rehabilitation plan which corrected the existing geometric and operational deficiencies and accommodated future traffic requirements in the "year 2000 and beyond". The plan also included a construction phasing plan for rehabilitation within the framework of the long-range plan. Reconstruction projects recommended by the master plan have been completed over the last 20+ years and are shown in **Figure 1.2**.

The preferred ultimate plan from 1985 is nearing the end of its useful life. NDOR recently removed a series of bottlenecks on the freeway system in 2014 that were originally constructed as part of the 1985 freeway master plan. These recent projects addressed localized congestion issues but will not address system-wide congestion issues expected in the future. MTIS aims to provide NDOR with a new freeway master plan for the Omaha metropolitan area.

Figure 1.2. NDOR Interstate Reconstruction Omaha Projects (1989 - 1999)



LRTP Process

As part of its role as the Omaha - Council Bluffs metropolitan area's Metropolitan Planning Organization (MPO), MAPA receives federal funding for transportation projects and programs. MAPA is required to update its Long Range Transportation Plan (LRTP) every 5 years. The LRTP is a document that identifies:

- A regional transportation vision for the community
- Current and future transportation system needs
- A reasonably-fundable list of projects, program, and strategies to implement over the next 20+ years.

The region is currently completing its 2040 LRTP, which will be adopted later this year. The 2040 LRTP is considered an interim document, that builds off of the products and vision provided by the 2035. The technical analyses completed as a part of the MTIS will help drive development of successor metropolitan transportation plans including a 2050 LRTP. The 2050 LRTP will align with the horizon year of MAPA's Heartland 2050 plan that developed future land use scenarios for input into the MAPA travel demand model.

Study Participants / Stakeholders

Multiple government agency committees have been established to help guide the MTIS Consultant Team. These include:

- **Executive Committee**: Members include representatives from NDOR, MAPA, the City of Omaha and FHWA. This committee is responsible for high-level decisions regarding study scope, study schedule and study recommendations.
- **Management Committee**: Members include representatives from NDOR and MAPA. This committee is responsible for day-to-day management of the study. Monthly progress meetings are being conducted with this committee to review study progress and provide direction to the Consultant Team.
- **Technical / Stakeholder Committee**: Members include representatives from various jurisdictional agencies within the study area. In Phase 1, this committee met quarterly and provided technical input to the study, including much of the data that was gathered during Phase 1. In future phases of MTIS, this committee will provide stakeholder input, including feedback on study methods, findings, and recommendations.

Executive Committee

Executive Committee members are shown below in **Table 1.1**.

Table 1.1. Executive Committee Members

Committee Member	Organization
Kyle Schneweis	NDOR Director
Khalil Jaber	NDOR Deputy Engineering
Moe Jamshidi	NDOR Deputy Operations
Tim Weander	NDOR District 2
Jim Knott	NDOR Roadway Design
Dan Waddle	NDOR Traffic
Robert Stubbe	Omaha Public Works
Greg Youell	MAPA
Michael Felschow	MAPA
Mike Owen	NDOR Planning & Project Development
Terry Gibson	NDOR Roadway Design
Jeff Johnston	NDOR Roadway Design
Brian Johnson	NDOR Roadway Design
Justin Luther	FHWA

Management Committee

Management Committee members are shown below in **Table 1.2**.

Table 1.2. Management Committee Members

Committee Member	Organization
Tim Weander	NDOR District 2
Terry Gibson	NDOR Roadway Design
Brian Johnson	NDOR Roadway Design
Jeff Johnston	NDOR Roadway Design
Dan Waddle	NDOR Traffic
Greg Youell	MAPA
Michael Felschow	MAPA
Michael Helgerson	MAPA
Josh Corrigan	MAPA

Technical / Stakeholder Committee

Technical / Stakeholder Committee participants are shown below in **Table 1.3**. Note that the table includes any person that attended at least one Technical / Stakeholder Committee meeting during Phase 1.

Table 1.3. Technical / Stakeholder Committee Meeting Participants

Participant	Organization
Terry Gibson	NDOR Roadway Design
Tim Weander	NDOR District 2
Jeff Johnston	NDOR Roadway Design
Brian Johnson	NDOR Roadway Design
Dan Waddle	NDOR Traffic
Alan Swanson	NDOR Traffic
Noel Salac	NDOR Planning & Project Development
Brad Zumwalt	NDOR Planning & Project Development
Brian Jelinek	NDOR Roadway Design
David Schoenmaker	NDOR Planning & Project Development
Mike Owen	NDOR Planning & Project Development
Randy ElDorado	NDOR Planning & Project Development
Ryan Huff	NDOR Rail & Public Transportation
Greg Youell	MAPA
Michael Felschow	MAPA
Michael Helgerson	MAPA
Megan Walker	MAPA
Courtney Fuhrer	MAPA
Ashley Myers	MAPA
Nick Weander	MAPA
Evan Schweitz	Metro
Lauren Cencic	Metro

Participant	Organization
Cody Wilbers	FHWA
Justin Luther	FHWA
Nick Finch	FHWA
Tracy Troutner	FHWA
Eric Wilke	Iowa DOT
Steven Labedz	Iowa DOT
John Rexilius	City of Bellevue
David Vermillion	City of Council Bluffs
Greg Reeder	City of Council Bluffs
John Kottmann	City of La Vista
Derek Miller	City of Omaha
Murthy Koti	City of Omaha
Todd Pfitzer	City of Omaha
Chad Weaver	Omaha City Planning
Jeff Thompson	City of Papillion
Marty Leming	City of Papillion
Dan Kutilek	Douglas County
Bill Herr	Sarpy County
Denny Wilson	Sarpy County
Michael Kosa	Sarpy County
Pat Dowse	Sarpy County

Chapter 2 - Coordination with Other Studies and Projects

Several on-going and past regionally-significant studies have relevance to MTIS. The Consultant Team reviewed the progress and scope of each of these studies to determine how they could assist with data needs, and which studies would provide coordination opportunities moving forward. Several studies were identified as opportunities to coordinate shared goals, objectives and system performance analysis. A summary of on-going studies is provided in **Table 2.1**, and a summary of past relevant studies is provided in **Table 2.2**.

Table 2.1. Summary of On-Going Relevant Regional Studies / Programs

	Study	Study Status	Data Relevance / Coordination for MTIS
Ongoing Studies	Sarpy County Comprehensive Plan	In Process. Scheduled to be complete Fall 2015	Project to update the Sarpy County Comprehensive Plan, Zoning Ordinance, and Zoning Map.
	Platteview Road Corridor Study	First interim report completed May 2014. Short term projects developed.	Answer questions such as: • Future cross-section for Platteview Rd? • How would it affect volumes along I-80/I-29? • What is the implementation plan? • Is it fundable?
	Central Omaha Transit AA	In Process. Locally-preferred concepts selected. Evaluating Bus Rapid Transit (BRT) concept. Modern Streetcar concept financial analysis is underway and preliminary design work will begin in 2016.	Ridership forecasts for Central Omaha with Locally-Preferred Alternative. Funding plan.
	Heartland 2050	Currently implementing the vision	Study developed regional growth scenarios - applicable to MTIS & MAPA Regional Model.
	Metro! Rideshare / Air Quality / CMAQ	Ongoing MAPA TDM and Air Quality outreach programs.	Scientific telephone survey conducted for the Air Quality portion. Travel data are collected for metro area residents.
	MAPA Transportation Improvement Program (TIP), 2013-2018	2013 version complete. Occasionally amended, updated annually (Draft 2014 version complete).	All programmed regional transportation projects that have funding sources identified through 2018 are included in TIP.

Table 2.2. Summary of Past / Completed Relevant Regional Studies / Programs

	Study	Study Status	Data Relevance / Coordination for MTIS
Past / Completed Studies	Heartland Connections Bicycle-Pedestrian Plan	Completed (2015)	Data include bike / pedestrian short and long term recommendations, bicycle level of service, and goals / strategies.
	Heartland Connections (Regional Transit Vision)	Completed (2013)	Data include travel market analysis, transit service plans, on-board ridership survey and a financial analysis.
	External-to External O-D Survey	Completed (2013)	Travel pattern data at the MAPA study area cordon: regional through trips and External-Internal trip patterns. Data delivered from TTI is model-ready.
	City of Omaha Traffic Signal System Master Plan	Completed (2013)	Includes recommended system upgrades over a 10-year period, estimated costs, and other key recommendations
	Long Range Transportation Plan 2035	Completed (2010). 2040 Draft LRTP completed in 2015.	Includes goals, objectives and "measures of success" for regional transportation system. Potential starting point for MTIS. Funding assumptions likely form the basis of our business as usual funding scenario.
	Beltway Study	Completed (2010)	Regional alternatives / scenarios / land use options to consider for inclusion in MTIS.
	Transportation Funding Study	Completed (2004)	Financial analysis of "business as usual" in 2004, looks at funding gaps, and review of options for expanding roadway funding. Review funding elements and compare to 2035 LRTP for inclusion in MTIS baseline.
	West Douglas County Trails Plan	Completed (2004)	Trails plan map. Likely will be superseded by Heartland Connections Bicycle-Pedestrian Plan.
	Northwest Douglas County Arterial Streets Study	Completed (2003)	Cross-section plans / alignments for corridors north of Omaha (120th/132nd/144th/180th/State/Rainbow Rd). All projects included in LRTP.
	Omaha Master Plan - Transportation Element	Completed (2012). MAPA staff has mentioned potential re-evaluation of project selection with new performance measures.	TMP includes some performance measure approaches to consider for inclusion in MTIS. Follow progress of any updates to TMP. Not a multi-jurisdictional plan.
	Omaha Master Plan - Environmental Element	Completed (2010)	City of Omaha document that provides some goals / objectives that relate to transportation. Not a multi-jurisdictional plan.
	Kennedy Freeway Planning Study	Completed (2002)	Cross-section needs for the Kennedy Freeway through 2030.
	Council Bluffs Interstate System Improvement Program	Design Completed. Ongoing construction.	Cross-section and plans for Council Bluffs interstate system.
	Nebraska Strategic Highway Safety Plan	Completed for 2012-2016 cycle.	Strategic plan for meeting statewide traffic safety goals. Includes safety goals, objectives, strategies and performance measures.
	Statewide LRTP / Vision 2032	Completed (2012)	Provides NDOR's system planning vision, goals, objectives and performance measures. Statewide summary data on travel, freight and transit.
	Omaha Area Freeway Leisch Study	Completed (1985)	Study recommended projects have been completed over last 20+ years.

Chapter 3 - Data Collection

Data Types

In Phase 1 the Consultant Team coordinated with MAPA, NDOR, and other participating agencies to obtain a comprehensive set of transportation data to support all phases of MTIS. As it is a large study area with multiple jurisdictions supplying data, it was necessary to track the compilation of the data, while evaluating and summarizing how the transportation data received could be used for the study. This was a wide-ranging effort that procured various types of relevant transportation data from a multitude of government agencies. The data types that were requested, compiled, and reviewed included:

- Traffic counts (daily and hourly)
- Speed data
- Signal timing data
- As-Built plans
- Transit ridership data
- Crash data
- GIS data
- Bridge condition
- Pavement condition
- Relevant studies / reports
- Regional origin-destination data
- Household survey data

Data Sources

Agency Data

Various agencies provided different their available types from the list above. Agencies that provided data include: NDOR, Iowa Department of Transportation (Iowa DOT), MAPA, Douglas County, Sarpy County, Metro Transit, City of Omaha, City of Council Bluffs, City of Bellevue, City of La Vista, and City of Papillion.

MAPA Travel Demand Model

The recently-updated MAPA travel demand model is a traditional trip-based, four step regional model. The model simulates the interaction between land development and the transportation system, and estimates the travel patterns associated with various land use and transportation network scenarios for the year 2040. The model is validated to the year 2010. Recent updates have added key enhancements to mode choice and time-of-day modeling.

Miovision

Miovision is a vendor that provides video-based traffic count data and was used to fill gaps in missing count data in the MTIS study area. Miovision provided weekday peak period traffic counts at 19 locations that were identified during Phase 1.

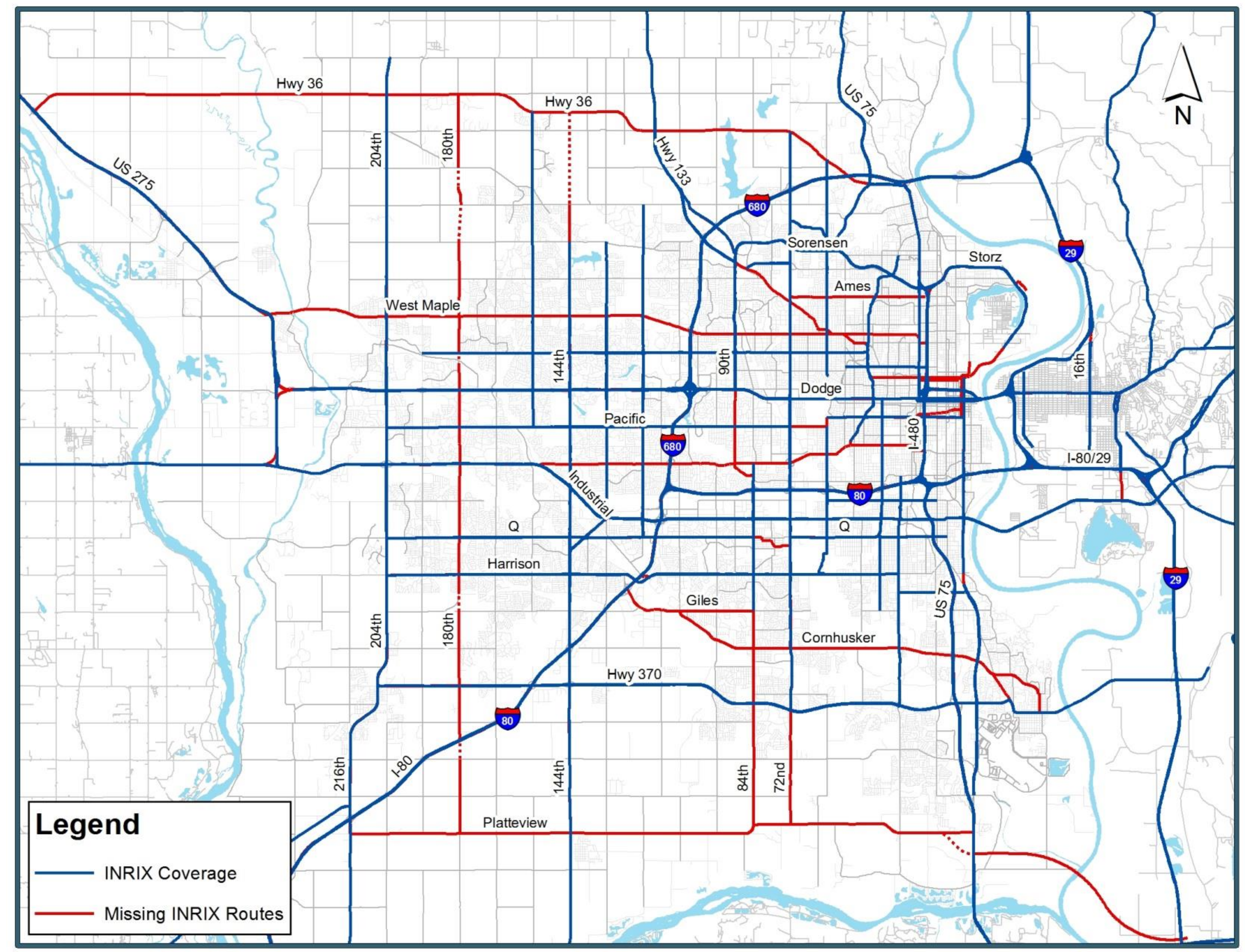
AirSage

To supplement the analysis capabilities of MAPA's regional travel demand model, the Consultant Team used AirSage data. AirSage is a vendor that provides origin-destination data based on an anonymous aggregation and tracking of wireless signals from a sample of mobile phone companies in the region. The AirSage product was statistically adjusted and expanded to represent the travel of all residents in the region. The origin-destination data provided by AirSage was for weekdays in March 2014, and was in a format that reflected the Traffic Analysis Zones (TAZs) of the MAPA region.

INRIX

INRIX is a vendor that provides travel speed and travel time data derived from multiple sources including commercial vehicle Automatic Vehicle Locator System (AVLS) technology, smart phone mapping applications, in-vehicle navigation systems and GPS navigation systems. The study used licensed INRIX data purchased by the NDOR and Iowa DOT. The data were organized and analyzed using a shapefile of Traffic Message Channels (TMCs). As of April 2015, there are several study area roadways that are not covered by INRIX which are highlighted in **Figure 3.1**.

Figure 3.1. INRIX Coverage (April 2015)



ETC Institute

A household transportation survey was conducted in the Omaha-Council Bluffs Metropolitan Statistical Area (MSA) during December 2014. The survey was conducted by ETC Institute on topics including perceptions and importance of current transportation issues, potential solutions, and funding approaches.

Metro Area Travel Improvement Study

Chapter 4 - Study Performance Measures and Targets

By linking performance goals with planning and programming decisions, performance-based planning can be applied to generate a list of new cost-beneficial projects for consideration while addressing unmet needs. Performance measures serve a critical role in performance-based planning due to their usefulness for: evaluating system needs; evaluating investment scenarios; selecting and prioritizing projects; performance tracking and reporting; and real-time information management and dissemination.

Specifically, it is important MTIS utilizes performance measures that:

- Are supported by existing resources.
- Are important to decision-makers and stakeholders.
- Are influenced by agency policies.
- Support project prioritization.
- Support predictive capability.

Phase 1 of MTIS has focused on analyzing how the transportation system performs today, and how it would perform in the Year 2040 if no other projects are constructed beyond the current TIP. This has allowed the Consultant Team to establish performance targets that are:

- Useful for prioritizing and selecting projects.
- Feasible with respect to data sources.
- Aspirational / challenging for the region, would make significant improvements in system performance, yet are targets that could be reasonably attained.

The selected performance measures and targets are broken into the five goal areas below. Additional information regarding the selected performance measures can be found in the chapters listed with each goal area.

- **System Preservation**: (**Table 4.1 and Chapter 6**) Achieve state-of-good-repair by prioritizing projects that address timely and cost-beneficial asset rehabilitation.
- **Congestion Reduction**: (**Table 4.2 and Chapters 8 & 12**) Reduce the growth of peak-period delay on freeways and improve system reliability and overall performance.
- **Mobility and Accessibility**: (**Table 4.3 and Chapters 10 & 12**) Reduce the growth of peak-period travel times for all modes, and increase transit access and ridership.
- **Stewardship and Environment**: (**Table 4.4 and Chapter 12**) Address air quality concerns, consider land use in all improvements, and incorporate economic, social, and environmental criteria in project selection and programming decisions.
- **Safety**: (**Table 4.5 and Chapter 9**) Reduce fatalities and serious injuries.

The baseline analysis results of these performance measures for existing condition and Year 2040 No-Build Conditions are provided in the tables that follow. Note that baseline results could not be computed for certain performance measures. This occurred if no data existed to compute a baseline condition or if the performance measure target could not be expressed quantitatively.

Table 4.1. System Preservation Performance Measures & Targets

Performance Measure	Performance Measure Target	Existing Conditions Baseline	Future No-Build Conditions Baseline
Pavement: Nebraska Serviceability Index (NSI)	84% of highway system miles at least good or very good (NSI ≥ 70)	Interstate 88.9% Freeway 99.3% State Highway 53.1% Local Roads 76.6% *Overall 74.1%*	*Overall 0% (Year 2040)*
Pavement: International Roughness Index (IRI)	84% of NHS-enhanced miles at a ride quality of at least “good” or “very good” (IRI ≤ 2.48 mm/m or 157.13 in/mile)	Interstate 97.9% Freeway 98% State Highway 46.9% Local Roads N/A *Overall 72.3%*	*Overall 0% (Year 2040)*
Bridge: National Bridge Index (NBI)	95% of Bridges NBI ≥ 6 and 0 functionally obsolete or structurally deficient bridges	76% of Bridges NBI ≥ 6 4% Structurally Deficient Bridges (by deck area)	44% of Bridges NBI ≥ 6 30% Structurally Deficient Bridges (by deck area) (year 2040)
Transit: State-of-Good-Repair	All assets in state-of-good-repair (no assets in Worn or Marginal condition)	62% of current assets in Worn or Marginal condition	All current assets in Worn or Marginal Condition

Table 4.2. Congestion Reduction Performance Measures & Targets

Performance Measure	Performance Measure Target	Existing Conditions Baseline	Future No-Build Conditions Baseline
System Reliability (Trucks Included)	Address reliability issues along five (5) segments with highest RI_{80}	Urban Arterials: 1.11 Rural Arterials: 1.07 Urban Freeways: 1.20 Rural Freeways: 1.03	N/A
Vehicle Miles Traveled (VMT)	2040 VMT per Household grows by 5% or less compared to 2010 levels	16.1M Daily VMT 55.1 Daily VMT / Household	24.3M Daily VMT 62.4 Daily VMT / Household
Vehicle Hours Traveled (VHT)	2040 Scenario reduces VHT growth by 25% compared to 2040 No-Build	401,300 Daily VHT 1.37 Daily VHT / Household	753,900 Daily VHT 1.94 Daily VHT / Household
Delay	2040 Scenario reduces delay growth by 25% compared to 2040 No-Build	16,300 Daily Hours Delay	109,000 Daily Hours Delay
LOS / Congested Miles of Freeway (Mainline)	2040 Congested Miles of Freeway same or lower than 2010 levels	6.8 miles at LOS E or F	23.5 miles at LOS E or F
Miles of Congested Non-Freeway Segments	2040 Scenario reduces number of congested miles of Non-Freeway by 33% compared to 2040 No-Build levels	34.5 miles at LOS E / F	126.8 miles at LOS E / F

Table 4.3. Mobility & Accessibility Performance Measures & Targets

Performance Measure	Performance Measure Target	Existing Conditions Baseline	Future No-Build Conditions Baseline
Regional Mode Share	Achieve 10% transit, bike, walk mode share for all trips by 2040	0.6% transit mode share 1.9% walk mode share 0.2% bike mode share **2.7% non-motorized**	1.0% transit mode share 1.9% walk mode share 0.2% bike mode share **3.1% non-motorized**
Access to Jobs	Scenario increases average auto and transit access levels 10% above 2040 No-Build levels	Auto: 47.6% jobs within 15 minutes Transit: 7.0% jobs within 60 minutes	Auto: 36.9% jobs within 15 minutes Transit: 8.6% jobs within 60 minutes
Access (Proximity) to Transit	Maintain housing and jobs proximity levels at ¼ mile walk distance at 2010 levels	Jobs: 45.0% within ¼ mile Houses: 32.3% within ¼ mile	Jobs: 39.7% within ¼ mile Houses: 27.9% within ¼ mile
Environmental Justice (EJ) Access to Jobs	Provide equal or higher levels of EJ access to jobs via auto and transit than 2010 levels	Auto: 47.5% jobs within 15 min for EJ HH Transit: 13.6% jobs within 60 minutes for EJ HH	Auto: 53.4% jobs within 15 min for EJ HH Transit: 19.6% jobs within 60 min for EJ HH
EJ Access (Proximity) to Transit	Provide transit services within ½ mile to 90% of EJ households.	Within ¼ mile of local transit: 74.1% Within ½ mile of local transit: 89.3%	Within ¼ mile of local transit: 74.1% Within ½ mile of local transit: 89.3%
Bike and Pedestrian Accessibility / Proximity	Increase the percentage of jobs and households within ½ mile of bike facilities by 10% by 2040.	Jobs within ½ mile of bike facilities: 61.5% Households within ½ mile of bike facilities:56.2%	Jobs within ½ mile of bike facilities: 57.2% Households within ½ mile of bike facilities:50.2%
Transit Passenger Trips	Use Mode Share Performance Measure	11,685	29,395

Table 4.4. Stewardship & Environment Performance Measures and Targets

Performance Measure	Performance Measure Target	Existing Conditions Baseline	Future No-Build Conditions Baseline
Criteria Pollutant Emissions	Reduce NOx and VOCs by 10% compared to 2040 No-Build.	CO - 197,093 lbs/day NOx - 60,407 lbs/day SO2 - 699 lbs/day VOCs - 8,311 lbs/day PM10 - 1,832 lbs/day PM2.5 - 1,691 lbs/day	CO - 43,872 lbs/day NOx - 6,768 lbs/day SO2 - 130 lbs/day VOCs - 611 lbs/day PM10 - 207 lbs/day PM2.5 - 188 lbs/day
Economic Development	No Baseline Assessment		
Sustainability Score	No Baseline Assessment		
Existence of Ped/Bike Elements	No Baseline Assessment		
Transit Accommodation	No Baseline Assessment		

Table 4.5. Safety Performance Measures and Targets

Performance Measure	Performance Measure Target	Existing Conditions Baseline	Future No-Build Conditions Baseline
Annual Number of Fatal and Injury Crashes Benefit/Cost Ratio	Reduce Vehicle/Vehicle Annual Fatal and Injury Crash Frequency among "need" areas identified, for the study area, utilizing existing traffic (2009-2011 Average Annual Observed), after applying improvement Countermeasures. Apply measures to achieve an overall effectiveness goal of 30% reduction.	339.6 Total Annual Fatal and Injury Crashes in existing year (2009-2011 Average Annual Observed), for all "need" sites within the study.	N/A
	Reduce Vehicle/Pedestrian Annual Fatal and Injury Crash Frequency among corridors and areas identified as "needs", utilizing existing traffic (2012) after applying improvement Countermeasures. Apply measures to achieve an overall effectiveness goal of 50% reduction.	86.3 Average Annual Fatal and Injury Crashes (2009-2011 Average Annual Observed) along identified vehicle/pedestrian crash corridors and defined areas.	N/A
	Reduce Vehicle/Vehicle Annual Fatalities and Injuries (individual count) within study area for Existing Traffic (2012). Run Prediction Model on system wide improvement scenarios and compare to no-build.	10.8 Total Annual (2012) Fatalities and 1386.7 Injuries.	N/A
	Reduce Annual Fatal and Injury Crashes within the study area for Design Year Traffic (2040) - Alternative Scenarios vs. No-Build. Numbers to be used as benchmarks with which to compare alternative strategies.	N/A	1492.2 Total Annual Fatal and Injury Crashes for the entire study area in the design year (2040) in the No Build condition
	Reduce Annual Fatalities and Injuries (individual count) within the study area for Design Year Traffic (2040) - Alternative Scenarios vs. No-Build. Numbers to be used as benchmarks with which to compare alternative strategies.	N/A	15.4 Total Annual Fatalities and 1967.7 Injuries, for entire study area in the design year (2040) in the No Build condition.
	Reduce Total Fatalities and Injuries within study area over the Design Life of the Study (Existing (2012) to 2040). Illustrates the life cycle escalation of fatalities and injuries. Timing of improvements will directly affect this value.	369.2 Total Fatalities and 47,251.6 Injuries for the entire study area from existing (2012) to design year (2040) in a no build condition.	

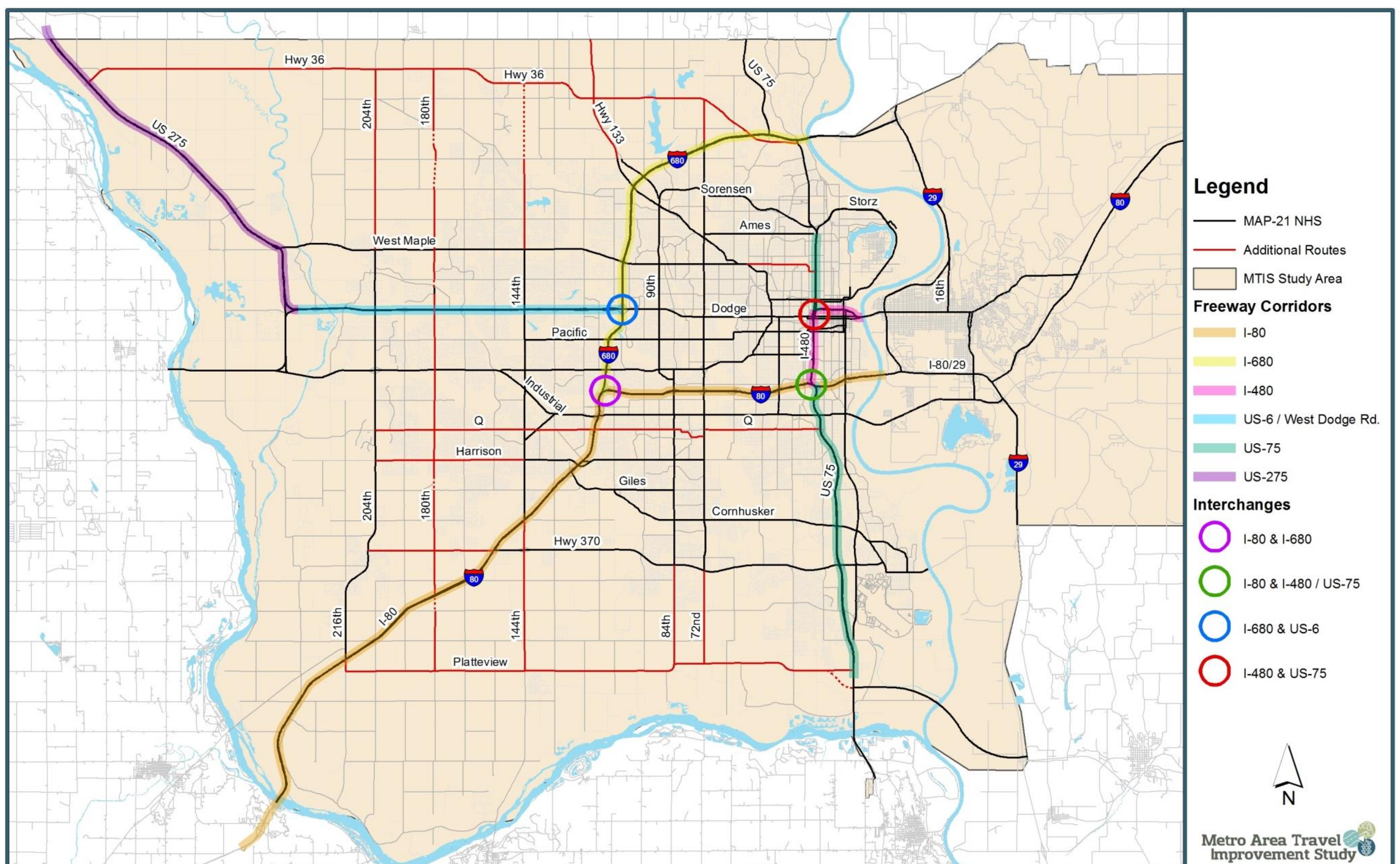
Chapter 5 - Freeway System Geometry and Operational Features

Existing

The Consultant Team conducted a detailed evaluation of existing conditions of the study area freeway system geometry and operational features. The freeway assessment corridors are shown in **Figure 5.1** and include:

- Interstates 80, 480, and 680
- US Highways 6, 75, and 275
- Collector-Distributor (CD) Roads I-80 at L Street and I-680 at Center Street
- System Interchanges: I-80 & I-680, I-80 & I-480 / US 75, I-680 & US-6, and I-480 & US 75

Figure 5.1. Freeway Assessment Corridors



Methodology

The 2011 AASHTO *Policy on Geometric Design of Highways and Streets* (Green Book) was the basis for the evaluation criteria. Alignment, cross section and sight distance were evaluated in comparison with policies and guidelines for urban freeways, as noted in the Policy. For the purposes of analysis the quality of the geometry was evaluated using the design speed limits for each of the corridors in the study area. The evaluations were performed based on available as-built plans, supplemented by reference to Google Earth aerial photography. Ratings of Good, Fair, and Poor (exceeds, meets, and does not meet design criteria, respectively) have been assigned based on the established criteria.

Horizontal Alignment

Mainline horizontal alignment ratings are based on the adherence of the horizontal alignment to current AASHTO and NDOR design policy assuming a design speed of 70 mph for all mainlines and maximum superelevation policy (e_{max}) = 0.06. Ratings were assigned using the centerline or control line geometry, unless the two directions of travel are on independent alignment, in which case each direction was evaluated separately. The following ratings, which vary by design speed, apply:

- Good: Radius of Curve is ≥ 2040 ft. (Design Speed is 70 mph)
- Fair: Radius of Curve is ≥ 1330 ft. and < 2040 ft. (Design Speed is 60 to 69 mph)
- Poor: Radius of curve is < 1330 ft. (Design Speed is < 60 mph)

Vertical Alignment

As-built construction plans were referenced in the evaluation of vertical alignment. Two separate analyses were performed, with the lowest rating for a given highway section recorded on the summary exhibits.

The first analysis was a simple comparison of mainline centerline grades with maximum recommended values per AASHTO. For evaluation purposes, the entire study area was considered in rolling terrain. A typical 70 mph design speed uses the following criteria for mainline grade:

- Good: ≤ 4.0%
- Fair: 4.01% to 5.00%
- Poor: > 5.00%

In addition, the operational effects of long and/or steep grades were investigated. The AASHTO Policy for combinations of grade and length of grade is based on avoiding designs that produce significant speed reductions by trucks with high weight to horsepower (WT/HP) ratios. The AASHTO Policy recommends the use of a 10 mph speed reduction for typical heavy trucks (WT/HP of 200) as a desirable maximum. The AASHTO Policy includes curves that combine length and grade to enable this analysis. For combinations of upgrades the Highway Capacity Software (HCS) includes a simple module that enables testing of vertical alignment effects on speed. The following criteria were applied:

- Good: Speed Reduction for a 200 WT/HP vehicle as given by grade and length < 10 mph
- Fair: Speed Reduction for a 200 WT/HP vehicle as given by grade and length 10 - 15 mph
- Poor: Speed Reduction for a 200 WT/HP vehicle as given by grade and length > 15 mph

Vertical alignment also includes sag and crest vertical curvature. Design for these geometric features is based on the design requirements for stopping sight distance. Ratings for the quality of vertical curve design are thus included in the evaluation of stopping sight distance.

Stopping Sight Distance (SSD)

AASHTO design values for stopping sight distance form the basis for vertical and horizontal curve criteria and ratings. Both vertical and horizontal stopping sight distance were reviewed using as-built plans. Research on risk analysis suggests that marginal deficiencies in available SSD may not pose serious problems.

AASHTO SSD policy is based on an assumed eye height of 3.5 ft. and assumed object height of 2.0 ft. The minimum stopping sight distance for 70 mph design speed is 730 ft.; and for 60 mph the SSD is 570 ft. The following criteria were established for stopping sight distance evaluations applied to mainline curvature:

Crest Vertical Curve SSD

Crest vertical curvature is described by the value 'K' which is the value of curve length divided by the algebraic difference in grades that are intersecting and requiring the vertical curve. Stated differently:

*L (length of crest curve in ft.) = K*A*

The AASHTO Policy provides values for K based on the design speed. Using these values the following criteria apply to crest vertical curvature at 70 mph:

- Good: K ≥ 247 (> 730 ft. of SSD)
- Fair: K ≥ 151 and < 247 (570 to 730 ft. of SSD)
- Poor: K < 151 (< 570 ft. of SSD)

Sag Vertical Curve SSD

When a vehicle traverses a sag vertical curve at night, the portion of highway visible ahead is dependent on the position of the headlights and the direction of the light beam. Sag vertical curvature is also described by the value 'K' which is the value of curve length divided by the algebraic difference in grades that are intersecting and requiring the vertical curve. Stated differently:

*L (length of sag curve in ft.) = K*A*

The AASHTO Policy provides values for K based on the design speed. Sag vertical curve stopping sight distance can be mitigated using roadside lighting. Using these values the following criteria apply to sag vertical curvature at 70 mph:

- Good: K ≥ 181 (> 730 ft. of SSD)
- Fair: K ≥ 136 and < 181 (570 to 730 ft. of SSD)
  or K < 135 (< 570 ft. of SSD) with adequate roadside lighting
- Poor: K < 136 (< 570 ft. of SSD)

Horizontal Curve SSD

Horizontal sight restrictions that limit stopping sight distance are created by the combination of horizontal curvature and presence of an object in the inside of a curve. For freeway mainline alignment this is typically associated with median barrier. The combination of the barrier and vertical alignment may create a sight obstruction. This is evaluated using design guidance from AASHTO which expresses the horizontal offset as measured from the middle of the lane (driver eye location) to middle of the lane ahead, with the sight line tangential to the obstruction. The offset for any given design speed varies with the horizontal curvature. The available offset (which would include half the inside lane width and full shoulder width if any) can be translated to an 'effective' design speed, i.e., a speed associated with the sight distance provided. For example, the necessary offset associated with a 70 mph design speed and minimum curvature of 2050 ft. for that speed is 22 ft.

Horizontal stopping sight distance criteria for median and outside obstructions such as retaining walls were also evaluated. Available offsets are translated to effective speeds, and the following criteria applied are consistent with the ratings for vertical curvature:

- Good: ≥ 70 mph (> 730 ft. of SSD)
- Fair: 60 mph to 69 mph (570 to 730 ft. of SSD)
- Poor: < 60 mph (< 570 ft. of SSD)

Cross Section Elements

As-built plans and Google Earth reviews were used to rate cross section elements, including lane width, shoulder width and roadside slope (where barrier does not exist). Evaluation criteria are based on a combination of the following elements:

- Lane Widths
- Shoulder Widths (both left and right)
- Median Width
- Roadside Design (steepness of slope and height of fill)
- Roadside Barrier Design

A composite rating was assigned to the cross section (freeway mainline and C-D Roads) based on the criteria shown in **Table 5.1**.

Table 5.1. Evaluation Criteria for Cross Sectional Elements

Good (Each of features must meet criterion)	• Lane Width of 12 feet • Right Shoulder Width at least 10 ft. • Left Shoulder Width at least 3.5-ft. paved (4-lane sections) or at least • Left Shoulder Width at least 10-ft. paved (for 6-lane and 8-lane sections) • Foreslopes designed to 6:1 for 0 to 5 ft. of fill; and 4:1 or flatter for greater than 5 ft. fill*
Fair (Each of features must at least meet criterion)	• Lane Width of 12 feet • Right Shoulder Widths at least 10 feet • Left Shoulder Width of 2 to 3.5 feet (for all freeway sections) • Foreslopes designed to 4 :1 for 0 to 15 feet of fill ; and 3:1 for greater than 15 feet of fill* • The absence of shoulders on long bridges (over 200 ft.) are given a fair rating due to cost considerations.
Poor (Rating assigned if any of the features has noted deficiency)	• Lane Width less than 12 feet • Right Shoulder Width less than 10 feet • No left shoulder • Unprotected foreslope 3:1 or steeper*

** Side slope evaluation requires a field review, and is therefore not included in this analysis*

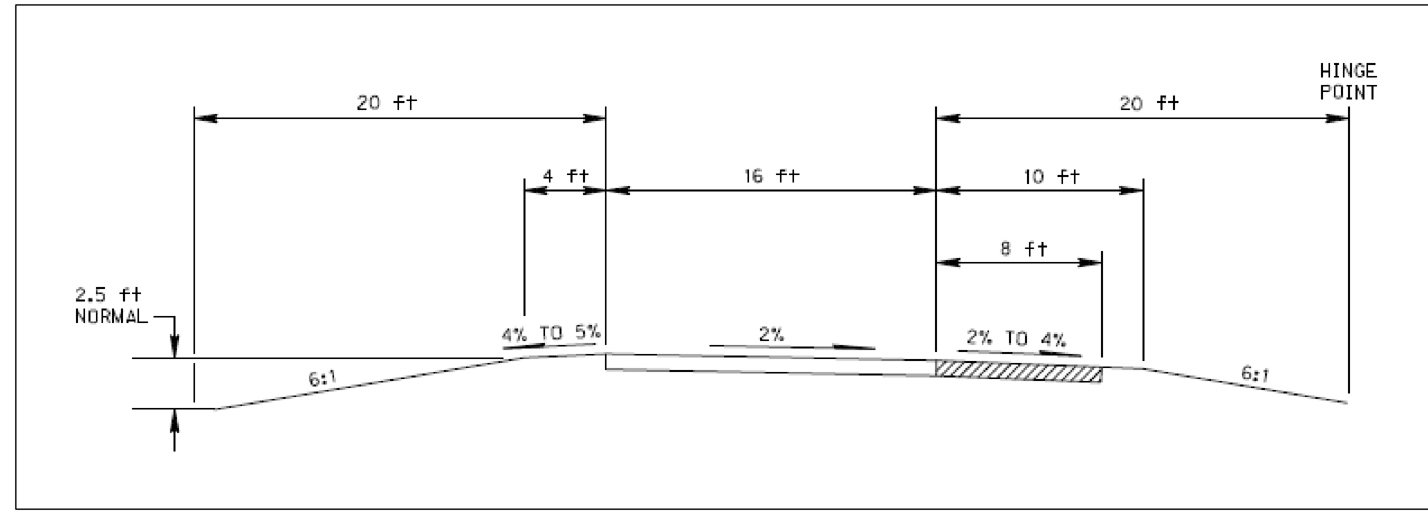
A similar composite rating was assigned to the interchange ramps located within the study area's four major system interchanges. The composite cross section criteria for these ramps are as shown in **Table 5.2**.

Table 5.2. Evaluation Criteria for Ramp Cross Sectional Elements

Good (Each of features must meet criterion)	• Pavement Width is provided in accordance with Criteria per AASHTO policy • Right Shoulder Width at least 8 ft. • Left Shoulder Width at least 3.5-ft. paved • Left Shoulder Width at least 10-ft. paved (for 6-lane and 8-lane sections)
Fair (Each of features must at least meet criterion)	• Pavement Width is provided in accordance with Criteria per AASHTO policy • Right Shoulder Widths at least 6 feet • Left Shoulder Width of 2 to 3.5 feet (for all freeway sections)
Poor (Rating assigned if any of the features has noted deficiency)	• Pavement Width in accordance with criteria is not provided • Right Shoulder Width less than 6 feet • No left shoulder

Figure 5.2 shows the required minimums for Interstate Interchange Ramps from the State Board of Public Roads and Classifications and Standards. Cross Section ratings for the Interchange ramps were assigned as either meeting all of the minimums shown in **Figure 5.2** from traveled way width and shoulder width ("good") or not ("poor").

Figure 5.2. Interstate Interchange Ramp Cross Section



Decision Sight Distance (DSD)

The concept of decision sight distance addresses the desirability of providing additional time for driver decision-making. Decision sight distance, an increment of sight distance above stopping sight distance, should be provided in advance of exits, major forks and lane drops. At these locations, drivers perceive, decide a course of action, and navigate. Decision sight distance criteria are shown below. The AASHTO criteria apply to mainline alignment at specific locations if one of the following conditions apply:

- Condition 1
  - A: Mainline approach to an interchange entrance where there is a continuous auxiliary lane to the next downstream interchange exit.
  - B: Mainline approach to an interchange exit where there is a continuous auxiliary lane from the previous interchange entrance.
- Condition 2: Mainline thru lane becomes "exit only" at an interchange or a mainline thru lane direction split
- Condition 3: Mainline approach to an interchange entrance merge ramp

The following criteria apply to DSD:

- Good: DSD ≥ 1450 ft.
- Fair: DSD < 1450 ft.
- Poor: DSD is not a requirement per AASHTO and NDOR policies, therefore lack of DSD should not be characterized as a 'poor condition'.

Ramp Terminal Design

The quality of the design of each ramp is based on two elements: the ramp taper angle in the vicinity of the point of physical merge or diverge, and the length of acceleration or deceleration taper available to the driver. Recommended AASHTO design values form the basis for the criteria and are summarized in **Table 5.3**.

Table 5.3. Evaluation Criteria for Ramp Terminal Design

	Exit Ramp	Entrance Ramp
Good	4° Diverge or equivalent length for parallel lane design	50:1 taper* or greater
Fair	4° to 5° Diverge or equivalent length for parallel lane design	40:1 to 50:1 taper*
Poor	Greater than 5° Diverge	Less than 40:1 taper*

** Taper measured from physical merge or diverge to beginning of taper*

Evaluation criteria for the length of deceleration lanes and tapers for exits are summarized below.

- Good: Deceleration Length is provided in accordance with Criteria per AASHTO policy
- Fair: Not applicable
- Poor: Adequate deceleration length is not provided

Evaluation criteria for the length of acceleration lanes and tapers for entrances are summarized below.

- Good: Acceleration Length is provided in accordance with Criteria per AASHTO policy
- Fair: Not applicable
- Poor: Adequate acceleration length is not provided

Lane and Route Continuity

The term "continuity" refers to the desirable characteristic of providing a certain minimum number of continuous through lanes along a marked interstate route. In all cases, at least two lanes should be provided. On higher volume freeways, three or four continuous lanes may be necessary. Continuity implies that drivers following the route and using those lanes need not lane change or exit to remain on the route. This is generally accomplished by adding and dropping lanes only on the right, and through special system interchange designs.

The existing system was reviewed to establish the effective number of basic lanes and auxiliary lanes, which were then used to confirm or note the presence of lane continuity at each diverge.

- Good: Section has lane/route continuity
- Fair: Not applicable
- Poor: Section lacks lane/route continuity

Lane Balance at Exits and Entrances

Provision for lane balance recognizes the need to facilitate access / egress to the freeway while minimizing disruption to through traffic by creating unnecessary lane changing. Evaluation criteria are summarized below.

- Good: Ramp terminal is designed in accordance with lane balance criteria per AASHTO Policy
- Fair: Not applicable
- Poor: Lane balance criteria are not met by existing ramp terminal design

Spacing and Sequencing of Ramps

The close proximity of successive exit and entrance ramps can have significant safety and capacity effects. Note that the AASHTO Policy cites only absolute minimum values. Adequate and even desirable ramp spacing provide much better operational quality. Evaluation criteria are summarized below.

- Good: Spacing meets or exceeds “absolute minimum” criteria per AASHTO Policy
- Fair: Not applicable
- Poor: Spacing is less than "absolute minimum"

The Highway Capacity Manual (HCM) illustrates that the operational impacts of ramp-freeway junctions are localized within a defined ramp influence area. For most ramps, this area includes the ramp and the outer two lanes of the mainline. Due to this influence on operations, for this analysis, “parclo” interchanges with successive on ramps are treated as separate entrance locations, regardless of the ramp type (parallel or taper).

Freeway Guide Signing

Signing is an important aspect of freeway operations. The Manual on Uniform Traffic Control Devices (MUTCD) provides guidelines for proper design. Applying these guidelines can be challenging for urban freeways with multiple closely spaced interchanges.

Signing for each interchange was reviewed to assess its adherence to the MUTCD and also its complexity and hence the relative ease or difficulty of an unfamiliar driver in comprehending the signs. Each interchange approach and each assembly of signs along the mainline were rated. Note that only sign design and messages were rated. Rating criteria are summarized in **Table 5.4**.

Table 5.4. Evaluation Criteria for Freeway Guide Signing

Good	• 2 advance and 1 gore sign • Gore sign overhead mounted at tip • Special “ exit only ,” panels used at lane drops • No more than 5 message units per sign
Fair	• 1 advance and 1 gore sign • Gore sign overhead mounted at tip • Minor message inconsistency between signs for same exit • Minor location problem
Poor	• Gore sign not located overhead • Improper lane drop signing • No advance signs • More than 6 message units per sign

Evaluation of Freeway Conditions

A comprehensive evaluation of the existing freeway geometric and operational conditions was made for each of the freeways within the study area based on the described methodology. Detailed engineering drawings of each corridor have been created to summarize the ratings for each evaluation criteria. In general, the assessment of the existing freeway system within the study area indicates that the horizontal and vertical geometry of the freeway system is in generally good condition. The evaluation drawings identified several segments which have “poor” ratings across multiple categories.

The following material can be found in a companion technical memorandum *Freeway System Assessment* (August 2015):

- An overall rating summary for each corridor organized by mile reference post
- Freeway corridor plan sheets (evaluation drawings)

Horizontal Alignment

The horizontal alignment consists of long tangential sections and large radii curves in the majority of the study area. Less than 4% of the study area received a rating of "fair" and no portion of the study area received a rating of "poor" for freeway horizontal alignment. **Table 5.5** summarizes the horizontal alignment evaluations by corridor.

Table 5.5. Rating Summary for Horizontal Alignment

Corridor	Good	Fair	Poor
I-80	98.2%	1.8%	-
I-480	80.7%	19.3%	-
I-680	100.0%	-	-
US 6	100.0%	-	-
US 75	97.8%	2.2%	-
US 275	92.2%	7.8%	-
Total	*96.9%*	*3.1%*	-

Vertical Alignment

The vertical alignment in the MAPA region is generally flat, and the changes in grade are very minor. Over 96% of the freeway system received a rating of "good". **Table 5.6** summarizes the vertical alignment evaluations by corridor. Areas identified as having "poor" vertical alignments include:

- Eastbound I-480 mainline undercrossing northbound US 75 at the I-480 & US 75 interchange.

Table 5.6. Rating Summary for Vertical Alignment

Corridor	Good	Fair	Poor
I-80	100.0%	-	-
I-480	94.6%	-	5.4%
I-680	100.0%	-	-
US 6	73.9%	26.1%	-
US 75	99.0%	1.0%	-
US 275	100.0%	-	-
Total	*96.1%*	*3.6%*	*0.3%*

Critical Length of Grade

Sustained grades are not common within the MAPA region. There were no areas identified as having sub-standard critical length of grade as shown in **Table 5.7**.

Table 5.7. Rating Summary for Critical Length of Grade

Corridor	Good	Fair	Poor
I-80	100.0%	-	-
I-480	100.0%	-	-
I-680	100.0%	-	-
US 6	100.0%	-	-
US 75	100.0%	-	-
US 275	100.0%	-	-
Total	*100.0%*	-	-

Stopping Sight Distance - Vertical Curves

The vertical alignment in the majority of the study area does not appear to restrict the vertical SSD based off the as-built drawings. **Table 5.8** summarizes the evaluation of SSD of vertical curves by corridor. Areas identified as having "poor" vertical curve stopping sight distance include:

- Northbound I-480 west of Martha Street/Ed Creighton Avenue crossing S 28th Avenue
- Eastbound I-480 west of the Missouri River at N 8th Street

Table 5.8. Rating Summary for SSD on Vertical Curves

Corridor	Good	Fair	Poor
I-80	95.7%	4.3%	-
I-480	83.4%	15.9%	0.7%
I-680	100.0%	-	-
US 6	93.7%	6.3%	-
US 75	99.0%	1.0%	-
US 275	100.0%	-	-
Total	*96.7%*	*3.3%*	*0.04%*

Stopping Sight Distance - Horizontal Curves

Horizontal SSD is dependent largely on roadside features that may obstruct the drivers view. Retaining walls and bridge piers are typical obstructions that were documented with the available as-built drawings. **Table 5.9** indicates that 99% of the freeway corridors received a "good" rating. Areas identified as having "poor" horizontal curve stopping sight distance include:

- Eastbound I-80 at South 20th Street due to median barrier location
- Westbound I-80 at South 13th Street due to median barrier location
- US 275 at West Dodge Road due to the overpass abutment

Table 5.9. Rating Summary for SSD on Horizontal Curves

Corridor	Good	Fair	Poor
I-80	99.5%	-	0.32%
I-480	100.0%	-	-
I-680	100.0%	-	-
US 6	100.0%	-	-
US 75	100.0%	-	-
US 275	94.9%	-	5.1%
Total	*99.0%*	-	*1.0%*

Cross Section Elements

Cross section element ratings vary by direction of travel. In most cases, both directions consist of adequate lane and shoulder width. **Table 5.10** indicates 84.4% of the freeway corridors received a "good" rating. Side slopes would need to be verified by a field review, and are therefore not included in this analysis. Some trees and drainage features impede into the clear zone, however do not provide any more of a driver obstruction than a protective barrier would. Areas identified as having "poor" cross sections include:

- US 6 from 156th Street to N 120th Street (inside shoulder width)
- US 75 through the Chandler Road interchange (inside shoulder width)
- US 75 through the L Street interchange (inside shoulder width)
- US 275 at West Maple Road (outside shoulder width)

Table 5.10. Rating Summary for Cross Section Elements

Corridor	Good	Fair	Poor
I-80	100.0%	-	-
I-480	78.6%	23.2%	-
I-680	40.5%	59.5%	-
US 6	78.8%	1.7%	19.5%
US 75	91.3%	-	8.7%
US 275	92.0%	-	8.0%
Total	*84.4%*	*10.5%*	*5.1%*

Decision Sight Distance (DSD)

Decision Sight Distance requires additional reaction time for complex maneuvers. These decision points generally occur before ramps. Because this additional distance is not an AASHTO or NDOR requirement, there are no locations with a "poor" rating.

Ramp Terminal Design

The angle that a ramp enters or exits a freeway has a direct effect on the efficiency and the safety of the connection. In the study area, the exit ramps have generally better ratings than the entrance ramps. **Table 5.11** indicates that nearly 97% of the study area ramp terminal designs are "good". Areas identified as having "poor" ramp terminal design include:

- I-480 - Eastbound Exit to South 20th Street
- I-680 - Eastbound Entrance Ramp from Blair High Road
- US 6 - Westbound entrance ramp from 156th Street
- US 75 - Northbound Entrance Ramp from Fort Crook Road
- US 75 - Southbound Entrance Ramp from Q Street

Table 5.11. Rating Summary for Ramp Terminal Design

Corridor	Good	Fair	Poor
I-80	98.4%	1.6%	-
I-480	95.7%	-	4.3%
I-680	97.2%	-	2.8%
US 6	95.9%	2.0%	2.0%
US 75	93.8%	2.1%	4.2%
US 275	100.0%	-	-
Total	*96.6%*	*1.3%*	*2.1%*

Lane and Route Continuity

Lane and route continuity enables drivers to remain on a given freeway route without changing lanes. Simplifying this task reduces accident potential by minimizing lane changes. Left hand exits are a major contributor to "poor" route continuity. **Table 5.12** summarizes the lane and route continuity evaluations by corridor. Areas identified as having "poor" lane and route continuity include:

- Westbound US 6 exit near N 204th Street

Table 5.12. Rating Summary for Lane and Route Continuity

Corridor	Good	Poor
I-80	100.0%	-
I-480	100.0%	-
I-680	100.0%	-
US 6	99.5%	0.5%
US 75	100.0%	-
US 275	100.0%	-
Total	*99.9%*	*0.1%*

Lane Balance at Exits and Entrances

Lane balance minimizes lane changes and erratic movements at ramp terminals. Drivers in the outside lanes should not be forced to exit and should have the option to continue on the freeway. **Table 5.13** summarizes the lane balance evaluations by corridor. Areas identified as having "poor" lane balance include:

- Eastbound I-480 at exit to 14th Street
- Westbound I-480 at exit to Dodge Street
- Southbound I-680 at exit to West Maple Road
- Northbound I-680 at exit to Fort Street
- Westbound US6 at exit to N 132nd Street
- Southbound US 75 at exit to Chandler Road
- Southbound US 75 at exit to Q Street
- Northbound US 75 at exit to Storz Expressway

Table 5.13. Rating Summary for Lane Balance

Corridor	Number of Locations Not Meeting Criteria
I-80	0
I-480	2
I-680	2
US 6	1
US 75	3
US 275	0
Total	*8*

Spacing and Sequencing of Ramps

Inadequate spacing of ramps creates conflicts within the overlapping areas of merging and diverging traffic. This is especially apparent in the weaving sections between successive entrance and exit ramps. **Table 5.14** summarizes the ratings for ramp sequencing and spacing. Areas identified as having “poor” ramp spacing and sequencing include:

- I-80 - 4 Locations, all Entrance-Entrance configurations
- I-480 - 5 Locations (including Entrance-Exit, Entrance to Entrance, and Exit to Exit configurations)
- I-680 - 1 Location (Entrance to Entrance Configuration)
- US 6 - 8 Locations, all weaving configurations
- US 75 - 7 Locations (4 weaves, one Exit-Exit and 2 Entrance-Entrance)
- US 275 1 Location (weave configuration)

Table 5.14. Rating Summary for Ramp Spacing and Sequencing

Corridor	Good	Poor
I-80	98.8%	1.2%
I-480	83.0%	17.0%
I-680	99.3%	0.7%
US 6	91.8%	8.2%
US 75	95.1%	4.9%
US 275	99.0%	1.0%
Total	*96.7%*	*3.3%*

Freeway Guide Signing

The existing corridor guide signing generally meets the guidelines set forth by the MUTCD. This is evidence by the fact that this evaluation revealed no highway segments with a “poor” rating as shown in **Table 5.15**. However, about 44% of the total routes analyzed rated “fair,” indicating there are some areas needing improvement. Areas with “fair” ratings may benefit from additional signing improvements. Those areas, and other considerations noted include:

- Along US 275, all but one exit does not have gore signs overhead and all exits have only a single advance guide sign.
- I-80 has approximately 20 miles of guide signing rated “Fair”. Some locations lack overhead gore signs and others have less than ideal lane drop signage.
- Some sign messages exceed six information units. Given the multiple destinations and closely spaced interchanges on some corridors, it may be difficult to improve this condition.
- In addition to displaying yellow “exit only” panels on advanced guide signs, consider using them at the interchange gores where “trap” lane drops occur.
- Exit only signing and striping are sometimes inconsistent. Dotted white lane markings should be used in conjunction with yellow “exit only” panels (MUTCD E11-1).

Table 5.15. Rating Summary for Freeway Guide Signing

Corridor	Good	Fair	Poor
I-80	60.8%	39.2%	-
I-480	50.0%	50.0%	-
I-680	52.9%	47.1%	-
US 6	58.3%	41.7%	-
US 75	85.8%	14.2%	-
US 275	-	100.0%	-
Total	*55.6%*	*44.4%*	-

System Interchanges

In additional to the corridors discussed above, four system interchanges were evaluated using the applicable design criteria. These interchanges are:

- I-680 and US 6
- I-80 and I-680
- I-80 and I-480 / US 75
- I-480 and US 75

Each ramp of interchange was rated in the following categories:

- Horizontal and Vertical Alignment
- Critical Length of Grade
- Crest Vertical Curve Stopping Sight Distance
- Horizontal Curve Stopping Sight Distance
- Cross Section Elements
- Decision Sight Distance
- Bridge Condition (where applicable)

Results of the geometric and operational conditions for the system interchanges can be found in a companion technical memorandum *Freeway System Assessment* (August 2015).

Chapter 6 - Physical Conditions

This chapter summarizes the existing and future no-build conditions for pavement, bridge, and transit assets in the MTIS study area. Note that a significant portion of Iowa pavement and bridges will be replaced in the near future as part of the Council Bluffs Interstate System Reconstruction Project.

Existing

Pavement

Existing pavement conditions is based on an assessment of pavement inventory data obtained from NDOR and Iowa DOT. All interstate, freeway, state highway, and major local roads within the study area were included in the analysis. **Table 6.1** provides an inventory of pavement segments considered in the analysis by total segment miles and lane-miles. Note that all segment miles and lane miles were calculated for each direction of travel (e.g. Platteview Road between 72nd Street and 84th Street is equivalent to 2 segment miles and 2 lane miles while Q Street between 144th Street and 156th Street is equivalent to 2 segment miles and 4 lane miles).

Table 6.1. Study Area Pavement Inventory

Functional Class	Nebraska Portion		Iowa Portion		Total	
	Segment Miles	Lane Miles	Segment Miles	Lane Miles	Segment Miles	Lane-Miles
Interstate	90.9	275.7	80.0	167.4	170.9	443.1
Freeway	79.3	174.8	0.0	0.0	79.3	174.8
State Highway	268.4	543.6	29.5	69.0	297.9	612.6
Local Roads	326.0	515.0	1.8	3.6	327.8	518.6
Total	*764.6*	*1509.1*	*111.3*	*240.0*	*875.9*	*1749.1*

Pavement condition indices calculated as a combination of surface and structural distresses (i.e., rutting and faulting) were applied as primary pavement performance measures for the MTIS study area as follows:

- The Nebraska Serviceability Index (NSI) was applied for pavements within the Nebraska region; and
- The Pavement Condition Index (PCI) was used for pavements within the Iowa region.

Both NSI and PCI are measured on a 0-100 scale with higher values indicating better pavement condition. In addition to NSI/PCI, the International Roughness Index (IRI) was applied as required under MAP-21 as a measure of pavement surface quality. Higher IRI values indicate higher pavement roughness and thus reduced ride quality.

The pavement inspection data used to support these measures was collected by NDOR and Iowa DOT. NSI/PCI and IRI were collected for all interstate, national, and state roadways included in the analysis. For local roadways, NDOR conducted a visual inspection of pavement surface conditions based on the Pavement Surface and Evaluation Rating (PASER) scale with the corresponding State of Repair category (**Table 6.2**) used to convert the PASER ratings to NSI. Performance targets with respect to NSI/PCI and IRI measures as developed during Phase 1 are presented in **Table 6.3**.

Table 6.2. NSI, PCI, IRI, and PASER State of Repair Classifications

Classifications	NSI	PCI	IRI (mm/m)	PASER
Excellent	90 -100	85 - 100	0 - 0.85	9-10
Good	70 - 89	70 - 84	0.86 - 2.48	7-8
Fair	50 - 69	50 - 69	2.49 - 3.33	5-6
Poor	30 - 49	30 - 49	3.34 - 4.21	3-4
Very Poor	0 - 29	0 - 29	4.22	1-2

Table 6.3. NSI, PCI, and IRI Performance Targets

Performance Measure	Performance Target
NSI	84% of highway system miles in “good” or better condition (NSI>=70)
PCI	84% of highway system miles in “good” or better condition (PCI>=70)
IRI	84% of NHS-enhanced miles at a ride quality of at least "good" or "very good" (IRI<=2.48mm/m or 157.13 in/mi)

Source: NDOR Performance Measures, Oct 2012

Table 6.4 provides a summary of existing pavement condition by functional class for study area roadways with respect to the NSI / PCI and IRI. The pavement condition of MTIS study roadways by functional class based on the State of Repair classifications shown in **Table 6.4** is provided in **Figure 6.1**. Notable findings from this analysis include that:

- Pavement segments in the Nebraska portion of the study area are generally in better condition than those in the Iowa portion of the study area; and
- Interstates and freeways are the functional classes of roadways within the study area that currently meet the performance target of 84% “good” or better condition. State highway and local roads currently do not meet the performance target.

Table 6.4. Current Pavement Condition Summary

Functional Class	Nebraska Portion		Iowa Portion		Total
	Average NSI	Average IRI (mm/m)	Average PCI	Average IRI (mm/m)	Average IRI (mm/m)
Interstate	90	1.54	77	1.49	1.52
Freeway	92.4	1.39	-	-	1.39
State Highway	70.6	2.5	48	3.05	2.56
Local Roads	7.39	-	80	-	-

A map of the current pavement conditions within the study are is shown on the following page in **Figure 6.2**.

Figure 6.1. Current Pavement Conditions by Functional Class

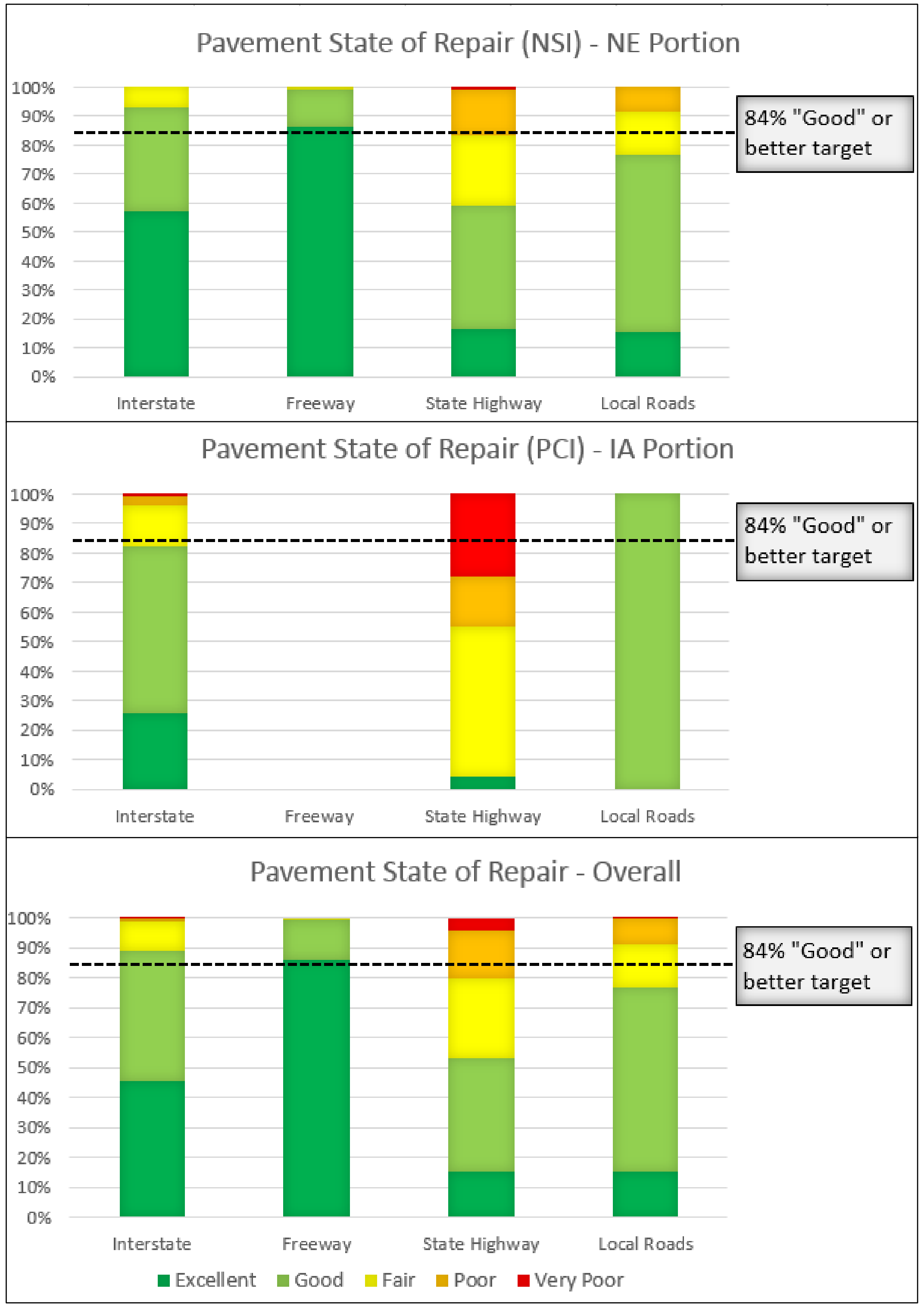
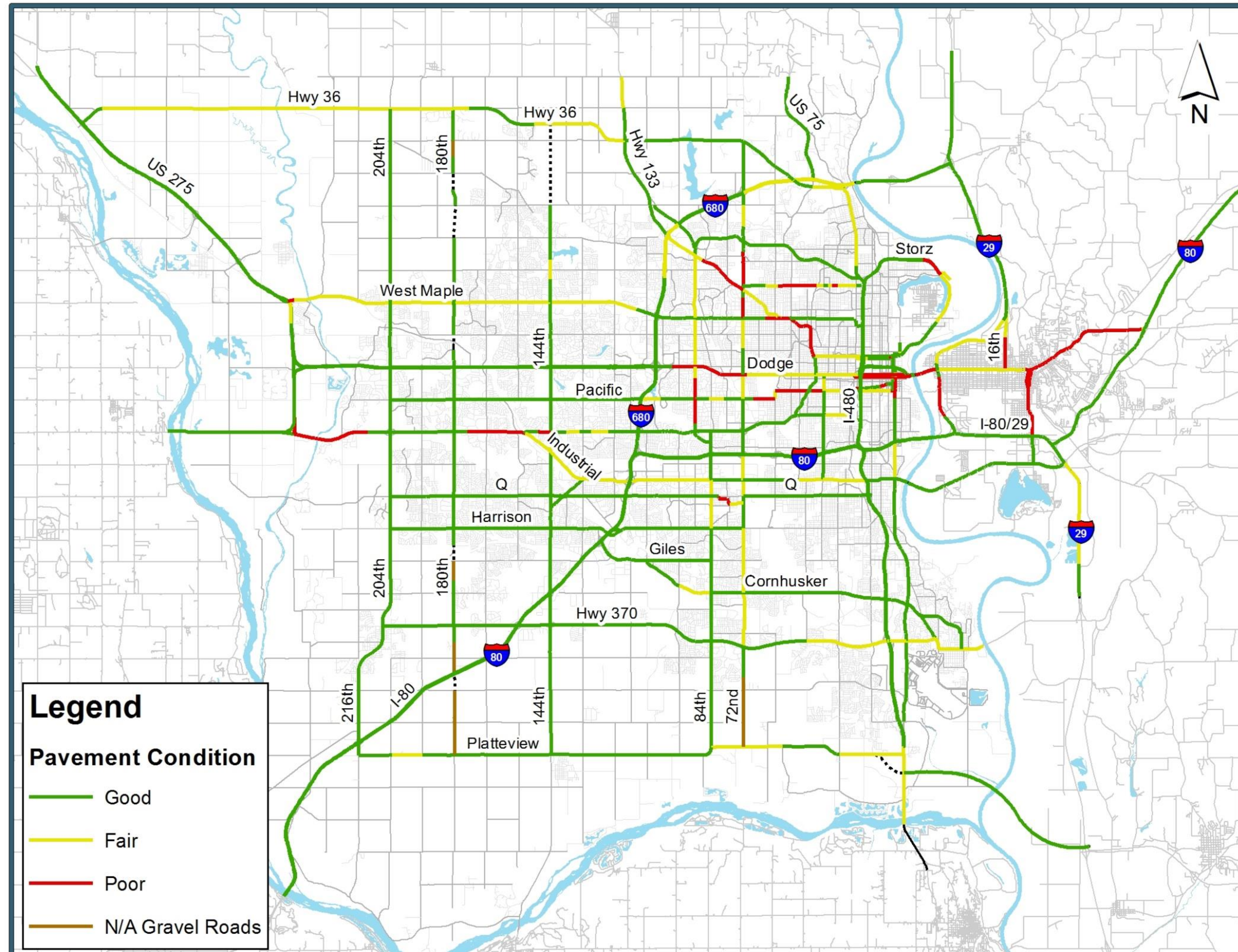


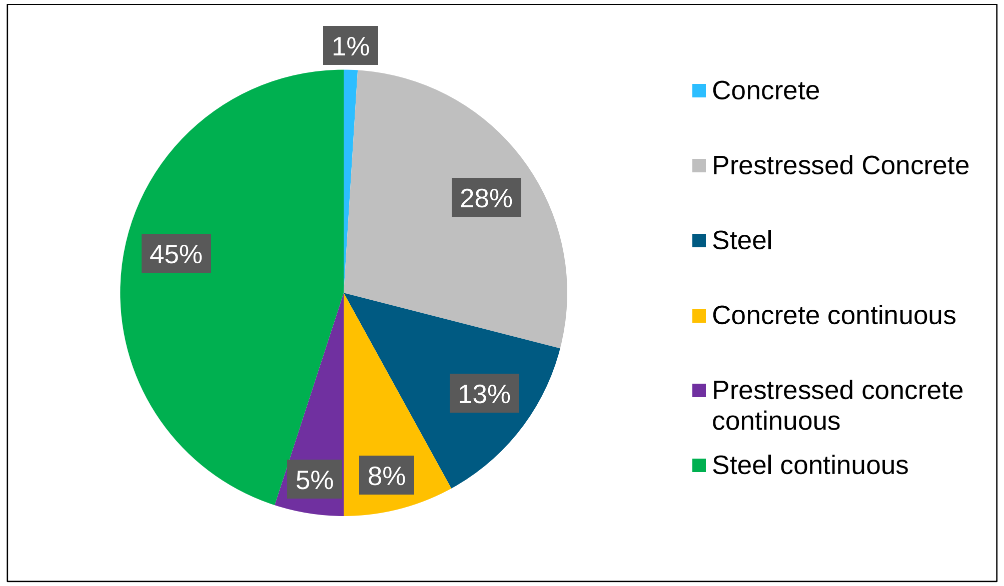
Figure 6.2. Current Pavement Conditions Map



Bridge

Similar to the pavement analysis, the bridge analysis was based on an assessment of bridge inventory data obtained from NDOR and Iowa DOT. A total of 393 bridges located within the MTIS study area were included in the analysis. **Figure 6.3** shows the distribution of study area bridges by type.

Figure 6.3. Bridges by Material Type



Two types of bridge deficiency as defined by FHWA were considered in the analysis:

- **Structural Deficiency**: Bridge deck/superstructure/substructure in "poor" state of repair based on condition rating (as shown in **Table 6.5**); very low load carrying capacity; waterway inadequacy.
- **Functional Obsolescence**: Insufficient due to geometric/ capacity constraints (e.g., width, underclearance, roadway alignment, etc.).

Table 6.5. Bridge State of Repair Classification by Component Condition Rating

Deck/Superstructure/Substructure Condition Rating (CR)	State of Repair Classification
CR ≤ 4	Poor
CR = 5	Fair
CR ≥ 6	Good

Consistent with MAP-21, the "Percentage of Structurally Deficient Deck Area" for NHS and non-NHS bridges was applied as the primary performance measure for this study to assess existing conditions and forecasted future conditions. Functional obsolescence was used as a secondary measure to evaluate existing conditions.

Data used to support these measures were obtained for years 2008 to 2012 from the National Bridge Inventory (NBI) database and NDOR's PONTIS database. The data included deck, superstructure, and substructure condition ratings based on the latest biannual inspection as well as general bridge attribute information including deck geometry, material type, year constructed/reconstructed, bridge geographical and functional classification, and sufficiency rating.

The analysis of the current bridge conditions found that 76% of bridges in the MTIS study area are in good condition, 20% in fair condition, and the remaining 4% are in poor condition (see **Figure 6.4**). The majority of bridges in the Iowa region are in fair condition (63%), while the majority of bridges in Nebraska are in good condition (85%).

As calculated based on the original construction or reconstruction year, MTIS study area bridges are on average 23 years old. The average age of bridges in the Nebraska portion is 23 years old, while the average age of bridges in the Iowa portion is 45 years old. **Figure 6.5** shows the age distribution of study area bridges.

Figure 6.4. Current Bridge Condition by Percent Deck Area

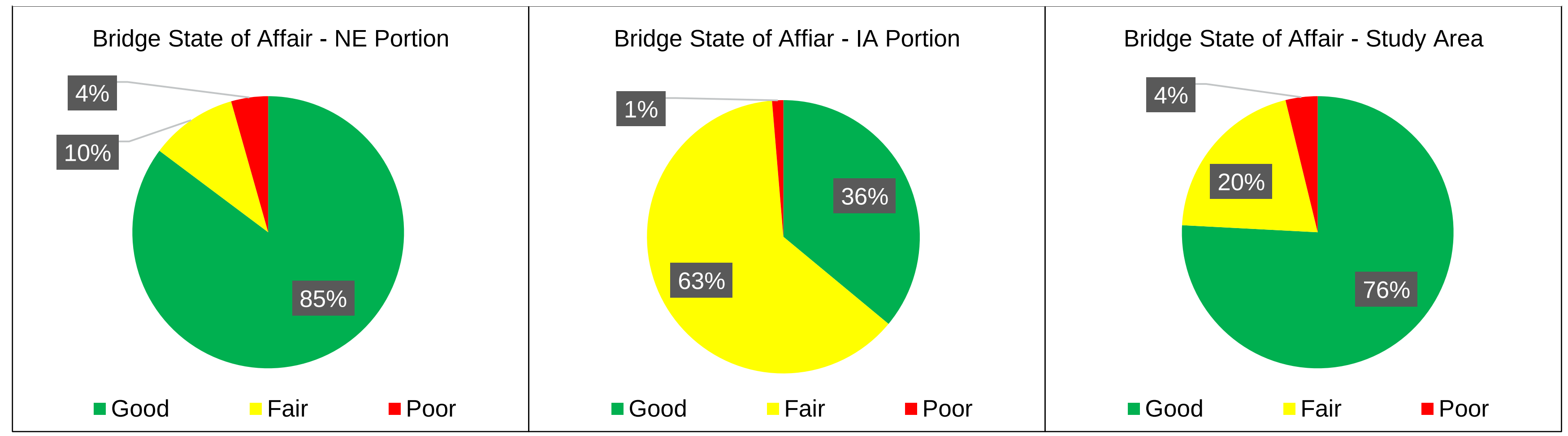
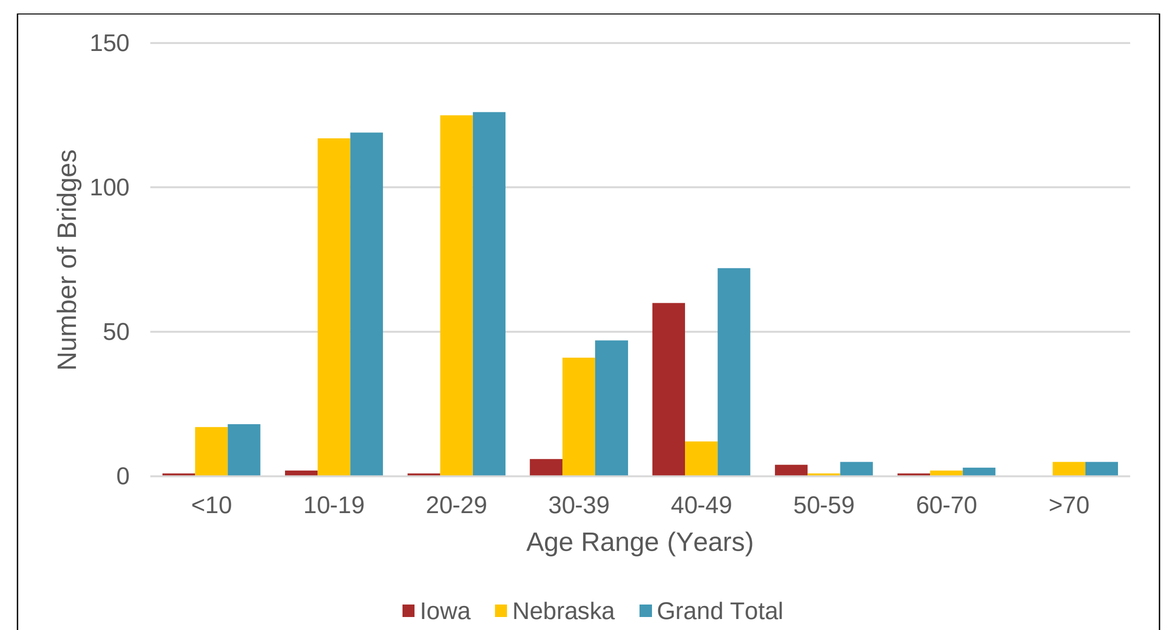


Figure 6.5. Age Distribution of MTIS Study Area Bridges



In order to assess the current overall condition of each bridge, the condition ratings of their main components (deck, superstructure, and substructure) were analyzed. In Iowa, the majority of the bridge component ratings lie in the range of 5 to 7, while in Nebraska the components are in better condition, with the majority of ratings at 6 to 8 (see **Figure 6.6**). Current bridge conditions within the study are shown in **Figure 6.7**.

Figure 6.6. Distribution of Current Bridge Component Condition Ratings

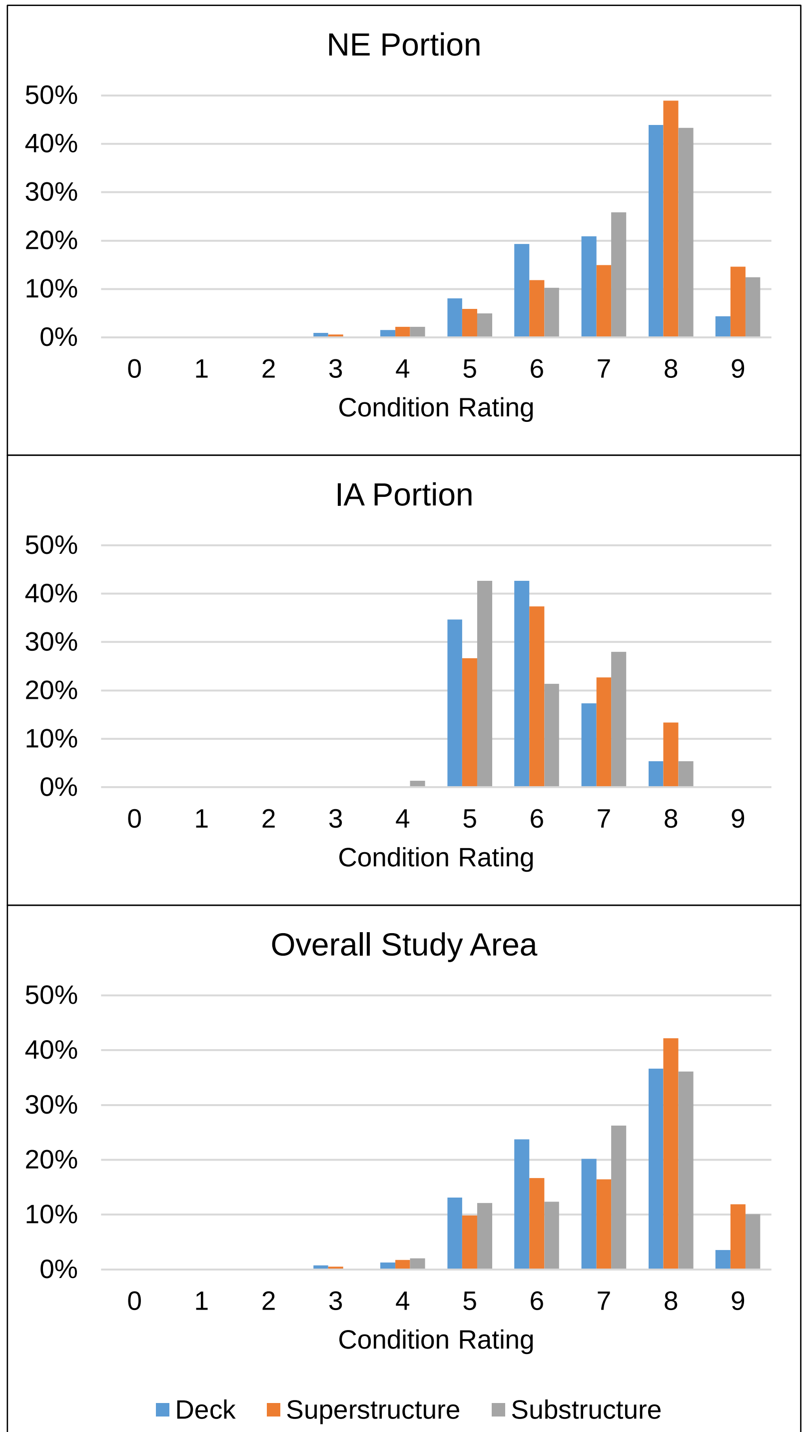
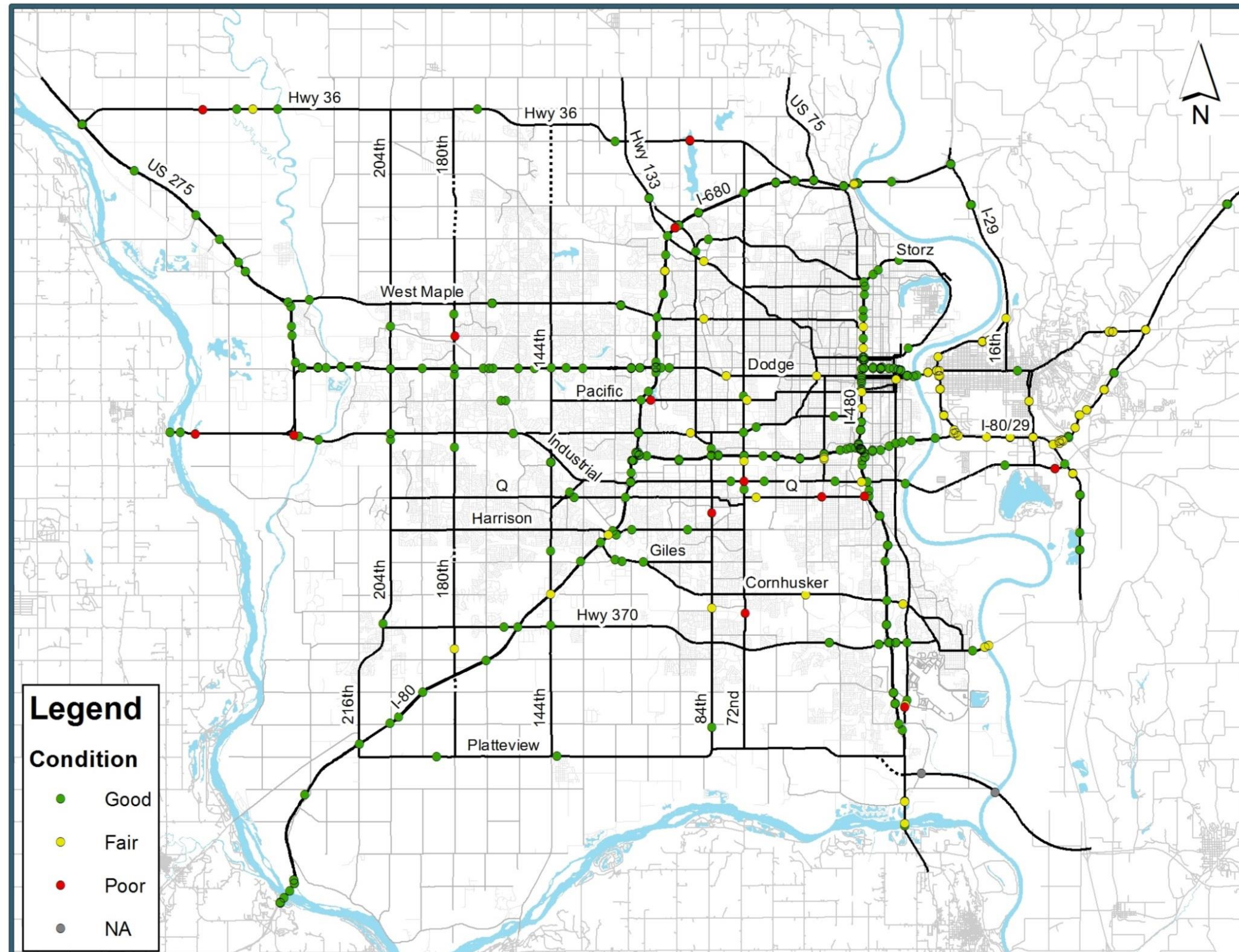


Figure 6.7. Current Bridge Conditions Map



Transit Infrastructure

Metro (Transit) is responsible for the operation of fixed route bus and paratransit service within the City of Omaha and Douglas County in Nebraska. Metro (Transit) also has turn-key contracts to provide bus service within five municipal jurisdictions, including: Ralston, La Vista, Bellevue, and Papillion in Nebraska and Council Bluffs in Iowa.

Table 6.6 summarizes the replacement value of Metro's assets, which totals just under $117 million. All values in this table are based on 2014 dollars. Facilities, such as garages, maintenance equipment, and office furniture make up the largest portion of Metro's assets at just over $54 million. Vehicle assets, both revenue and non-revenue vehicles, follow closely behind at just over $48 million.

Table 6.6. Metro (Transit) Asset Inventory

Asset Category	Value ($2014)
Facilities	$54,151,587
Stations	$9,866,463
Systems	$4,754,450
Vehicles	$48,223,078
Total	*$116,995,578*

The TERM Lite model, designed for state and local transit agencies, was used to conduct the current condition assessment. The model estimates the total level of reinvestment needed to reach and maintain a state of good repair (SGR). The current condition of public transit assets was also estimated based on the provided inventory.

The SGR backlog for public transit is estimated based on deferred rehabilitation and replacement needs. Based on the provided inventory, Metro's current SGR backlog is estimated to be valued at $30.6 million, or about 26 percent of the asset base. This SGR backlog represents all assets that are beyond their useful life and should be replaced.

The Federal Transit Authority (FTA) five point rating scale for asset condition is shown in **Table 6.7**. It is important to note that a rating of Marginal (2) or Worn (1) indicates that an asset is past its useful life. A condition rating of 2.5 indicates the need to replace an asset, meaning it has reached the end of its useful life.

Table 6.7. FTA Asset Condition Rating Scale

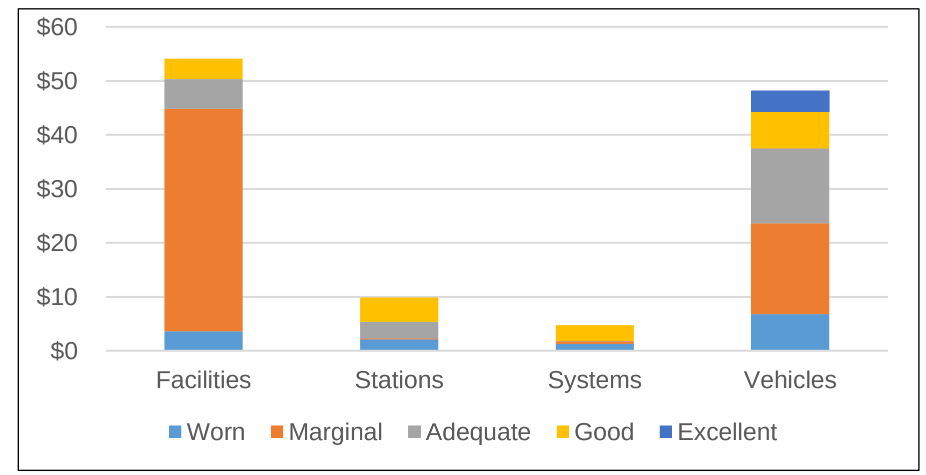
Condition	FTA Rating	Description
Excellent	5	• New assets • No visible defects
Good	4	• Asset showing minimal signs of wear • Some (slightly) defective or deteriorated component(s)
Adequate	3	• Asset has reached mid-life (3.5) • Some defective or deteriorated component(s)
Marginal	2	• Asset reaching end of useful life (2.75 to 2.5) • Increasing number of defective or deteriorating component(s) and increasing maintenance needs
Worn	1	• Asset has past useful life and is in need of immediate repair or replacement • May have critically damaged component(s)

The Metro (Transit) current condition estimates are based on individual asset ages and replacement values and are summarized in **Table 6.8** and **Figure 6.8**. According to TERM Lite's estimates, Metro has 62 percent of its total asset value in the marginal or worn categories. This is well above Metro's current SGR backlog of 26 percent. These assets must be prioritized for replacement within Metro's current funding constraint.

Table 6.8. Metro (Transit) Current Asset Condition Estimate by Asset Type ($2014 million)

Asset Category	Worn	Marginal	Adequate	Good	Excellent
Facilities	$3.6	$41.2	$5.5	$3.8	$0.0
Stations	$2.1	$0.2	$3.0	$4.5	$0.0
Systems	$1.3	$0.5	$0.1	$2.9	$0.0
Vehicles	$6.8	$16.8	$13.9	$6.8	$3.9
Total	*$13.8*	*$58.7*	*$22.5*	*$18.0*	*$3.9*

Figure 6.8. Metro (Transit) Current Asset Condition Estimate by Asset Type ($2014 million)



The average current condition estimate for the bus fleet is 3.2, with an average age of 7.8 years. While the average condition rating is above 2.5, many buses are in the current SGR backlog and require replacement. Buses currently constitute $20.8 million (68 percent) of the current $30.6 million backlog. The van fleet has an average current condition of 2.7, with an average age of 5.4 years. The rating for paratransit vans indicates that a majority of the fleet is nearing the end of its useful life. It is clear that Metro (Transit) requires significant investment in updating its vehicle fleet in order to maintain a SGR for transit services in the MTIS study area.

Figure 6.9 and **Figure 6.10** below illustrate Metro's current SGR for transit assets within the MTIS study area.

Figure 6.9. Metro (Transit) Current State of Good Repair Backlog by Asset Type ($2014 thousands)

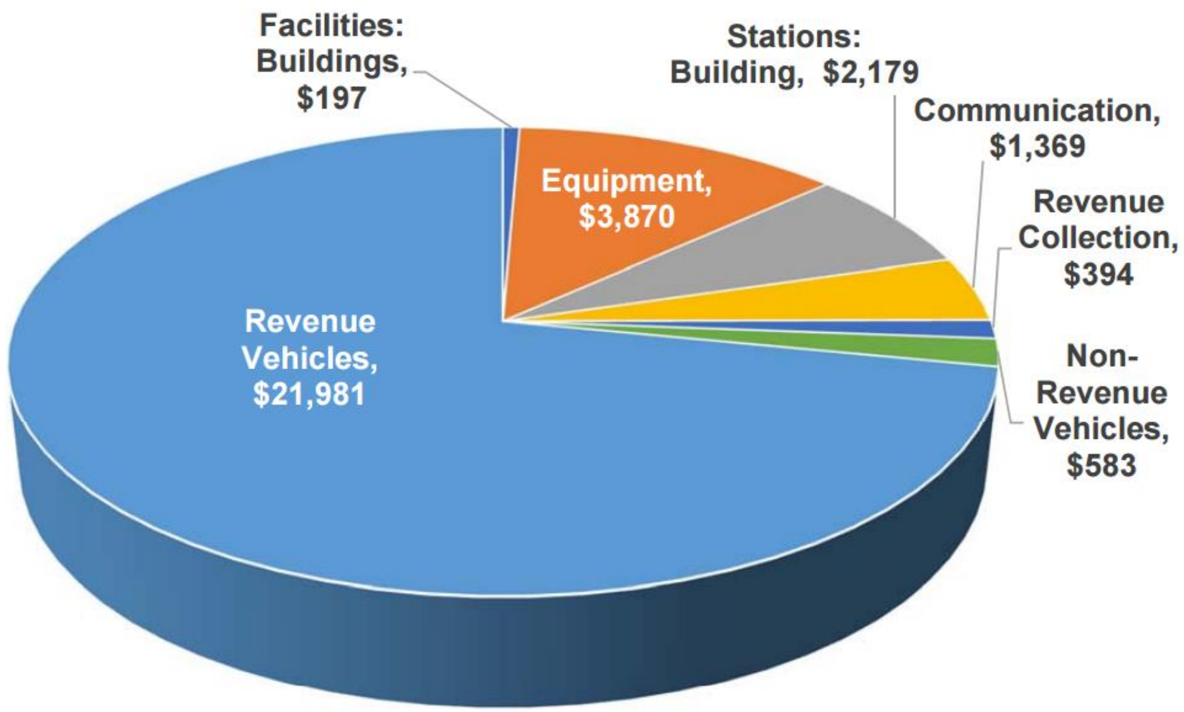
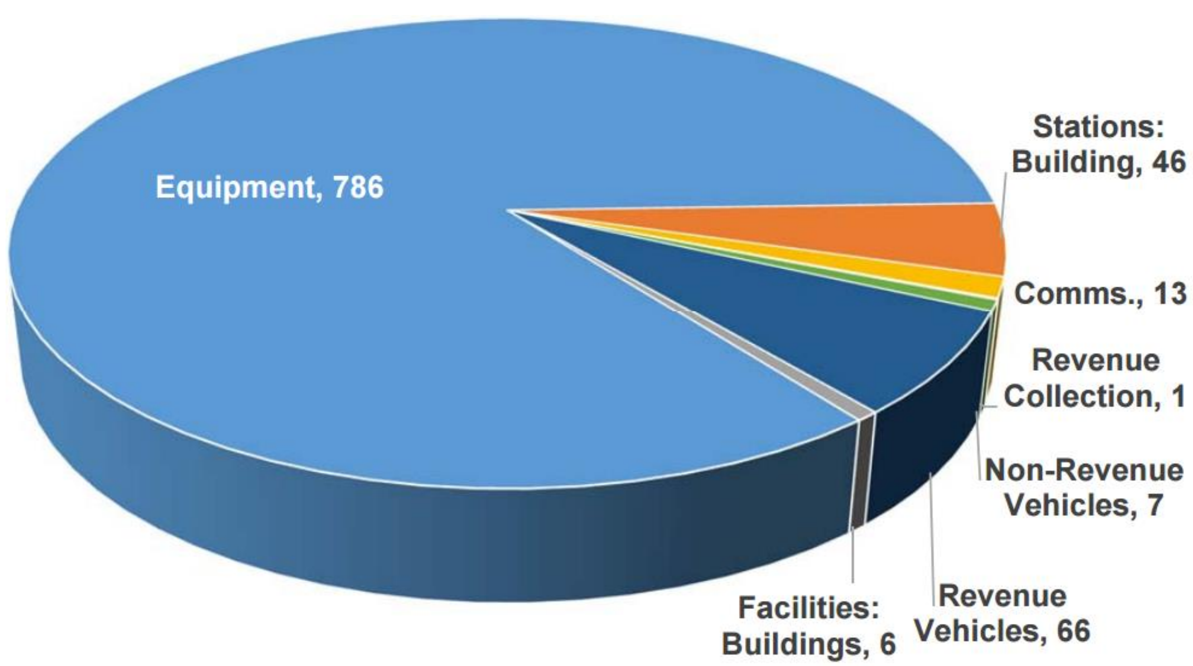


Figure 6.10. Metro (Transit) Current State of Good Repair Backlog by Asset Type: Number of Records



Future No-Build

Pavement

Pavement deteriorates over time due to traffic loads, severe weather, and other factors. Without preventative maintenance or rehabilitation, pavement will eventually deteriorate to a point where it is no longer serviceable and requires reconstruction. Pavement deterioration models are used to predict the remaining service life of pavement assets and they help determine when the pavement will require treatment to maintain SGR. The models aid in the selection activities (preservation, rehabilitation, and reconstruction) and aid in determining timeframes for these activities to minimize life-cycle costs.

Pavement deterioration models developed by NDOR as part of the 2011 Pavement Optimization Program were applied for MTIS to forecast future pavement condition and determine the time at which pavement assets would become deficient assuming no further preservation or rehabilitation treatments are applied. **Figure 6.11** shows how each functional classification's percentage of lane-miles in "good" or better condition is expected to change over time based on the deterioration models. Findings from this analysis include:

- Interstate and Freeway pavement segments in the Nebraska portion of the study area will not meet the 84% "good" or better performance target after 2021 and 2023, respectively. Nebraska State Highway and Local Roads will never meet the performance target unless pavement treatments are applied.
- By year 2033, no study area roadways are expected to have pavement in "good" or better condition unless pavement treatments are applied.

Bridge

Historical inspection data were used to develop bridge deterioration models in order to predict the time at which each bridge is expected to become structurally deficient. The bridge deterioration models were developed based on time non-homogenous Markov chains whereby deterioration rates vary over time based on asset age and condition. The most likely condition rating at every point in time is used to build the average performance curve starting from the age and condition rating at the time of the most recent bridge inspection.

Using the developed deterioration curves, the condition of the bridges were forecasted over the planning horizon (2040), and the time until structural deficiency was determined for all bridges assuming no preservation, rehabilitation, or replacement is applied. Without preservation, the bridges in Nebraska are expected to reach structural deficiency in 45 years, while the bridges in Iowa are expected to reach structural deficiency in 21 years.

By 2040, study area bridges are expected to deteriorate from the current level of 4.03% structurally deficient deck area to 30% structurally deficient deck area without further investment in bridge preservation and rehabilitation (see **Figure 6.12**). During the same time, the percentage of bridge deck area in "good" condition is expected to decrease from 75% to 44%.

More than 80% of bridges in the Iowa portion of the study area are expected to become structurally deficient by 2040 (see **Figure 6.13**). The percentage of structurally deficient bridges in Iowa is expected to remain at approximately 1% through 2020, but will suddenly increase to 40% in 2025, and increase to almost 80% in 2040. This sudden increase is expected as roughly half of the bridges in the Iowa portion of the study area that are currently in fair condition are expected to deteriorate to "poor" condition in the next few years. Structurally deficient bridges in the Nebraska portion of the study area are expected to increase at a much slower rate as more than 84% of the bridges are currently in "good" condition.

Figure 6.11. Percent of Lane Mile is Good or Better Pavement Condition by Year

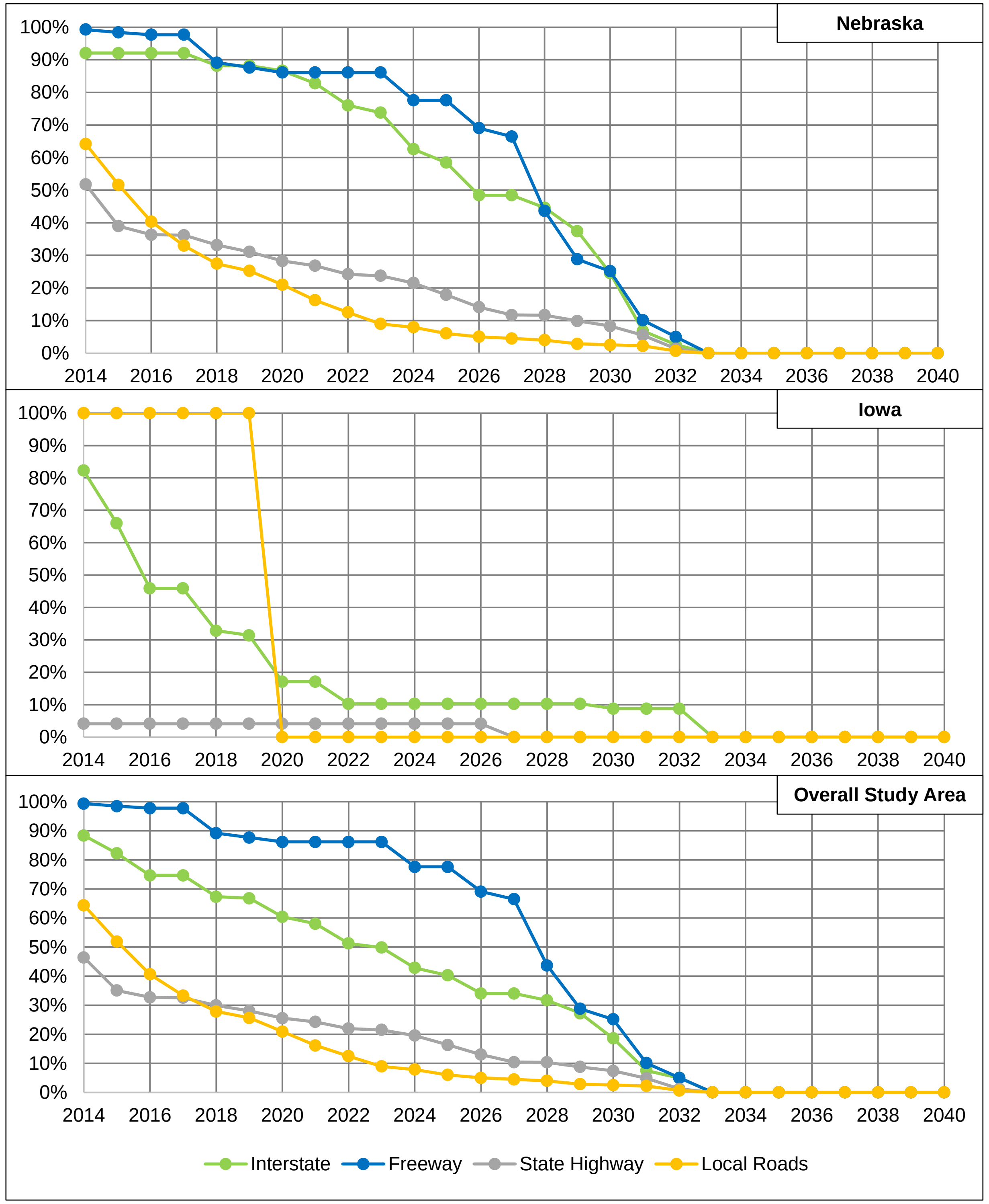


Figure 6.12. Forecasted No-Build Condition of MTIS Bridges

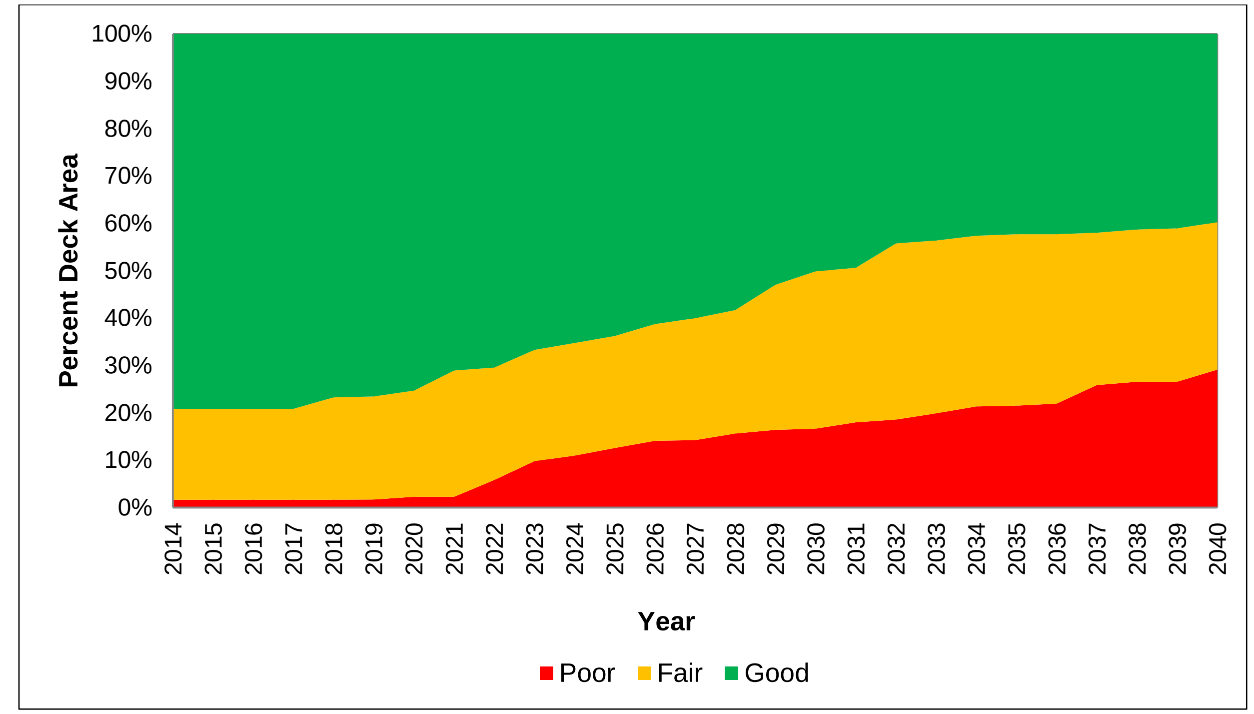
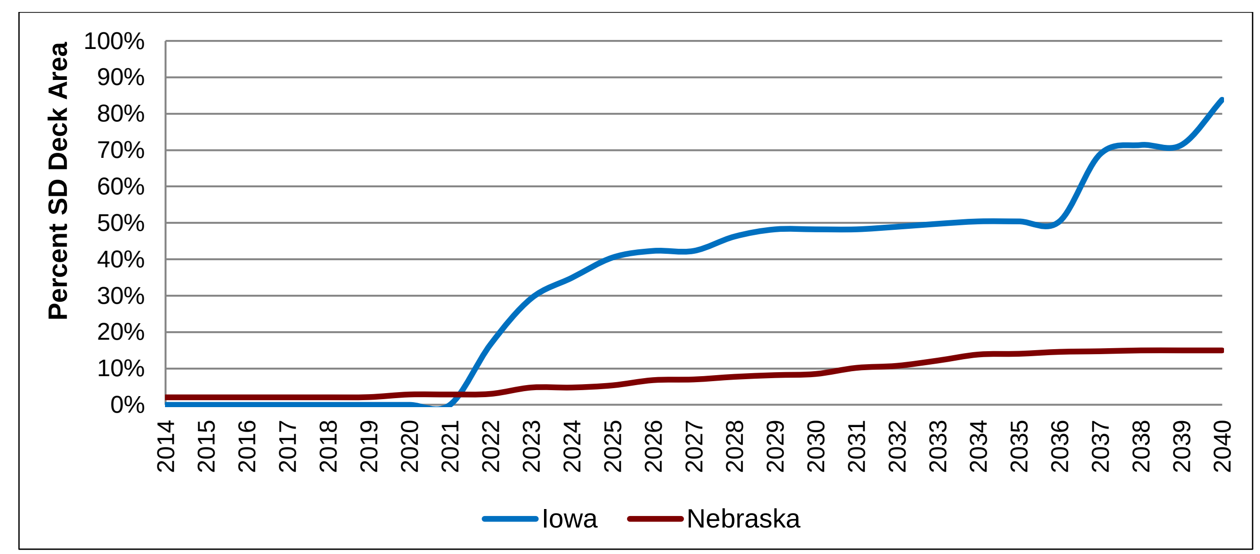


Figure 6.13. Forecasted Bridge Condition for the Iowa and Nebraska Portions of the MTIS Study Area



Transit Infrastructure

A future no-build scenario was not performed for transit infrastructure because transit investments are focused on rolling stock rather than civil infrastructure. Since rolling stock has a much shorter useful life, and cannot be maintained in useful condition over decades as civil infrastructure can, a no-build scenario is not feasible or realistic. Over the investment horizon of this study, multiple investments in new rolling stock are essential and unavoidable.

Chapter 7 - Traffic Volumes

Existing

Segment ADTs

Average Daily Traffic (ADT) volumes were obtained from MAPA for the years 2000 to 2012 (reported every two years). The ADTs represent estimated traffic flows from a variety of data sources that MAPA uses to prepare the Metro Area Traffic Flow maps. Volumes from 2008, 2010, and 2012 were checked for inconsistencies and individual counts were removed if too much variability was observed. Overall traffic change for the 2008 to 2012 period was assessed, and little regional or sub-area change was observed. To get the most complete regional traffic coverage possible, 2008, 2010, and 2012 counts were averaged to represent a base year count at each location. Base Year ADT volumes are shown in **Figure 7.3**.

Peak Hour Volumes

Traffic counts collected in Phase 1 included segment volumes and turning movement volumes from various count days and in various count periods / formats. Additional data were collected to fill in missing gaps and to revisit counts that were collected prior to 2010. This raw count data was utilized to develop freeway and non-freeway AM and PM peak hour volumes for existing conditions.

Freeway System

System-wide AM and PM peak hours were developed to represent the worst case total volumes along the freeway system. It is recognized that the worst case peak hour varies somewhat between different parts of the freeway system, particularly when comparing the fringes of the study area to central core areas. To successfully complete the analysis, it was important to establish a consistent analysis time and smooth (balance) any inconsistencies between adjacent traffic counts for both current AM and PM peak hours on the freeway system. At ramp terminal intersections the worst-case analysis time traffic volumes were utilized to account for the varying peak hours throughout the MTIS study area. Therefore in most instances the freeway ramp volumes will not exactly match the ramp terminal turning movement volumes. The peak hour base year volumes used for freeway traffic analysis are included in the **Appendix**.

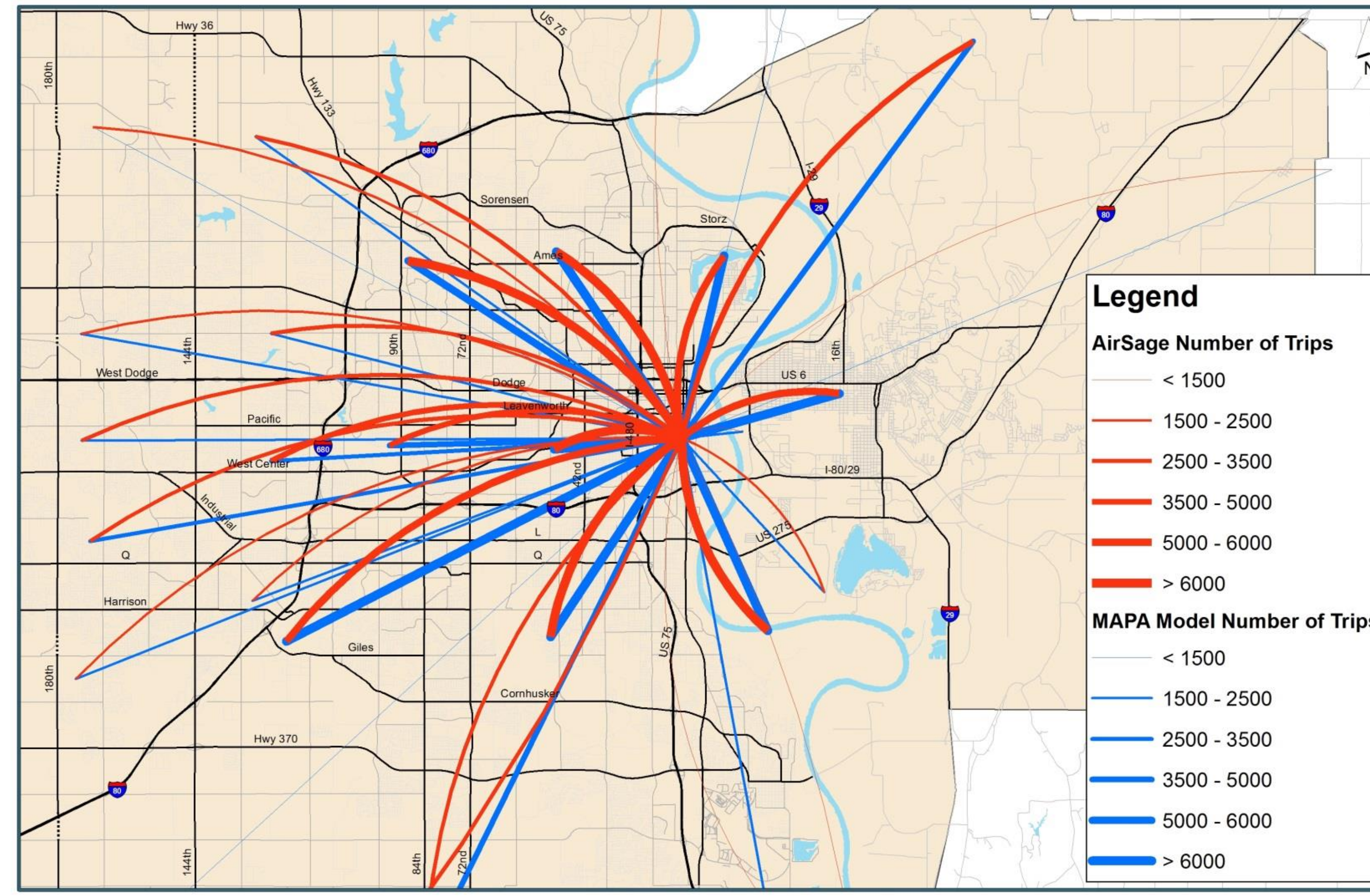
Non-Freeway System

AM and PM peak hour volumes at each non-freeway intersection were derived. Note that one system-wide AM and PM peak hour was not used for each intersection, similar to how the ramp terminal volume sets were developed. The worst-case AM and PM peak hour turning movements were determined by calculating the maximum inbound volume at each intersection for the AM and PM peak periods. Due to the large distance and multiple access points between non-freeway study area intersections, volumes were not balanced between intersections. Base year peak hour turning movements for all non-freeway intersections can be found in the **Appendix**.

Regional Trip Patterns

Trip patterns identified in the AirSage data were compared to base year trip patterns estimated by the MAPA travel demand model. Specifically, trip lengths in the model were compared to the AirSage data, and compared to data collected by the National Household Transportation Survey (NHTS) add-on survey that was completed in the MTIS study area in 2009. The results of that comparison led to the decision to incorporate changes to the parameters in the gravity model function that affect how long trips were in the model. These relatively minor changes were incorporated, and generally led to better model performance. **Figure 7.1** illustrates the regional trip patterns to the downtown area.

Figure 7.1. AirSage vs. MAPA Travel Demand Model Desire Lines (To Downtown Area)



More substantial changes to the MAPA travel demand model are recommended for Phase 2 of MTIS, including the incorporation of an income-component to the gravity model to better match home-based work trip productions (household side) to home-based work attractions (employment side).

Future No-Build

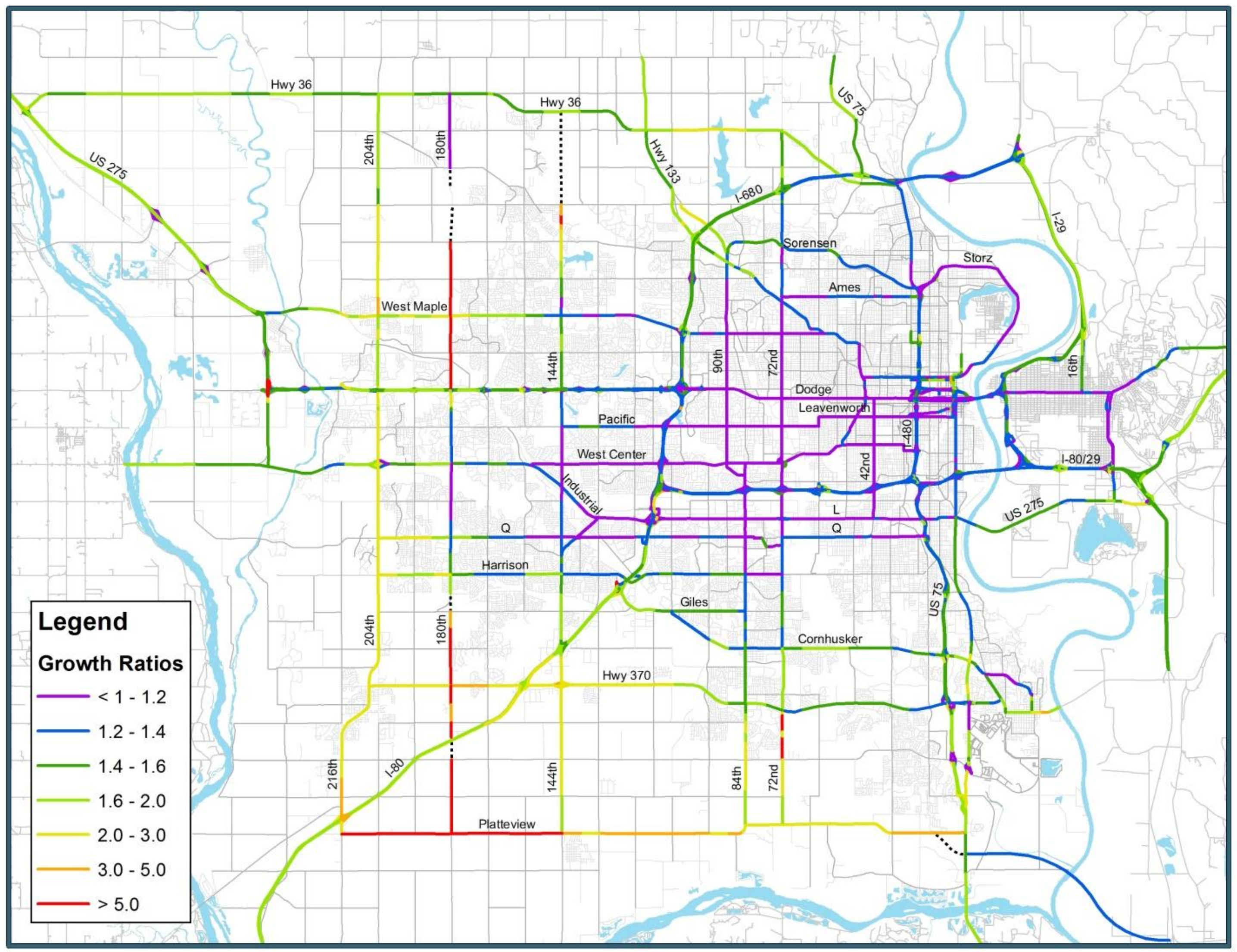
Segment ADTs

Forecasts of 2040 segment ADTs were developed using the existing segment ADTs in combination with MAPA 2040 existing plus committed (E+C) travel demand model output. A post-processing approach was used, whereby the level of base year model variation compared to observed base year traffic counts were applied to 2040 model output to provide a 2040 ADT forecast at each location. This process included review and adjustment of the post-processed forecasts for any areas of unreasonable or inconsistent growth rates. Forecasted 2040 E+C ADT volumes are shown in **Figure 7.3**.

Peak Hour Volumes

Growth ratios from 2010 to 2040 were developed by dividing 2040 forecasted ADTs by existing ADTs where applicable. Raw model growth ratios were calculated at locations that were not covered by the base year ADTs or locations that were believed to have unreasonable or highly variable base year ADTs. These growth ratios are displayed in **Figure 7.2**. Note that large growth ratios do not necessarily indicate large volumes. At many locations along the fringes of the study area where high growth ratios are indicated, current volumes are less than 1,000 vehicles per day. Thus, these locations could have a forecasted 2040 ADT of 5,000 vehicles per day, which can be accommodated on a two-lane roadway, but reflect a growth ratio greater than 5.0.

Figure 7.2. 2010 to 2040 Growth Ratios



Freeway System

The balanced set of base year volumes used for the existing traffic operations analysis were grown by the forecasted 2010 to 2040 traffic growth ratios. Ramp terminal turning movements were grown to match cross street and ramp forecasted volumes. The balanced set of peak hour 2040 E+C volumes used for future no-build freeway traffic analysis is included in the **Appendix**.

Non-Freeway System

Existing AM and PM peak hour volumes at each non-freeway intersection were multiplied by the growth ratios on each intersection leg to develop 2040 peak hour turning movements. For example, the north bound left movement was assumed to grow by the average of the south and west leg growth ratios. The 2040 E+C peak hour turning movements for future no-build non-freeway intersection traffic analysis can be found in the **Appendix**.

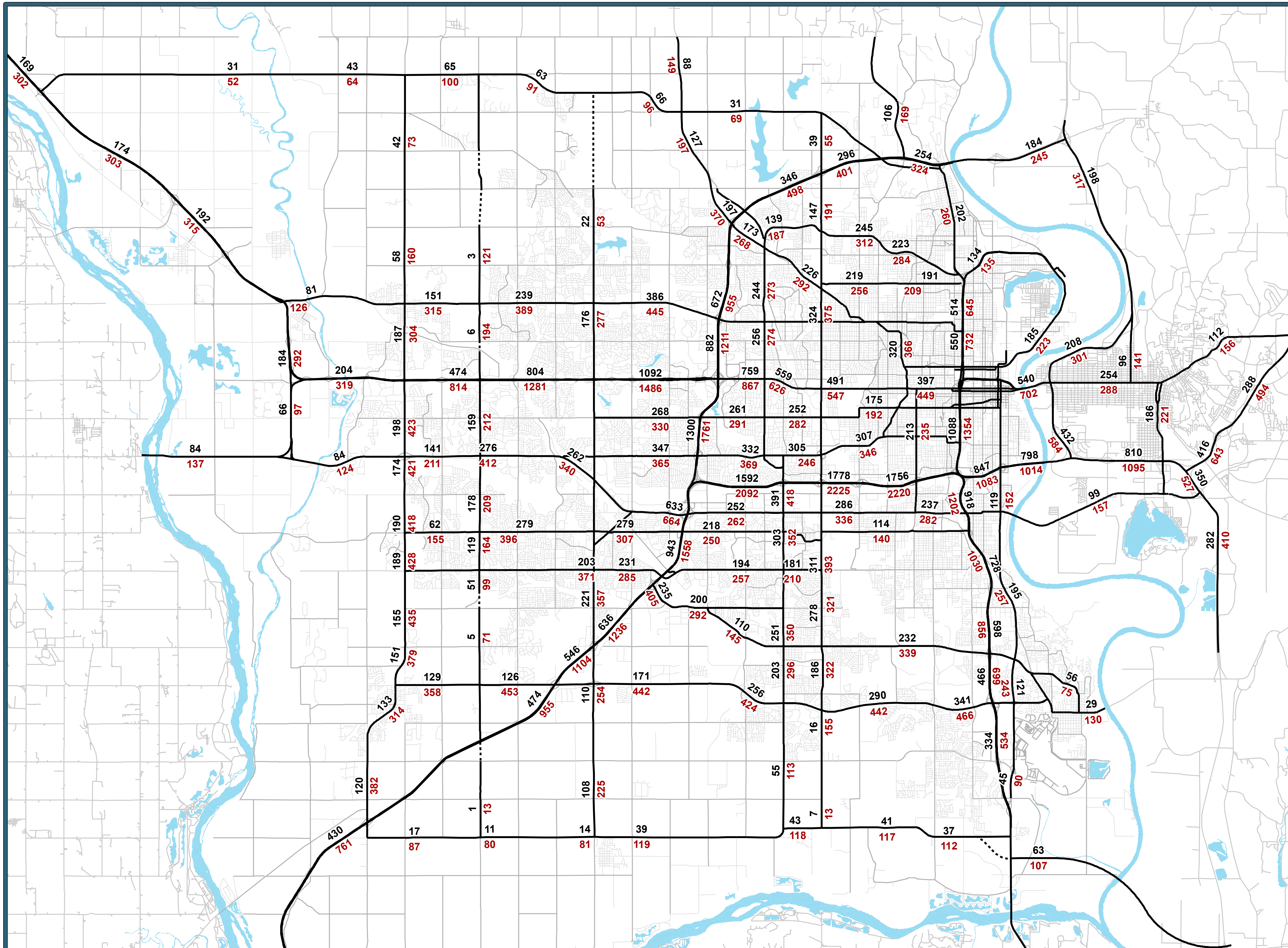


Figure 7.3: Existing and Future (2040) Segment ADTs

Legend

XXXX Base Year ADT (2010)

XXXX Future ADT (2040)

Study Roadways

Future Routes

Note: ADTs are expressed in hundreds of vehicles per day

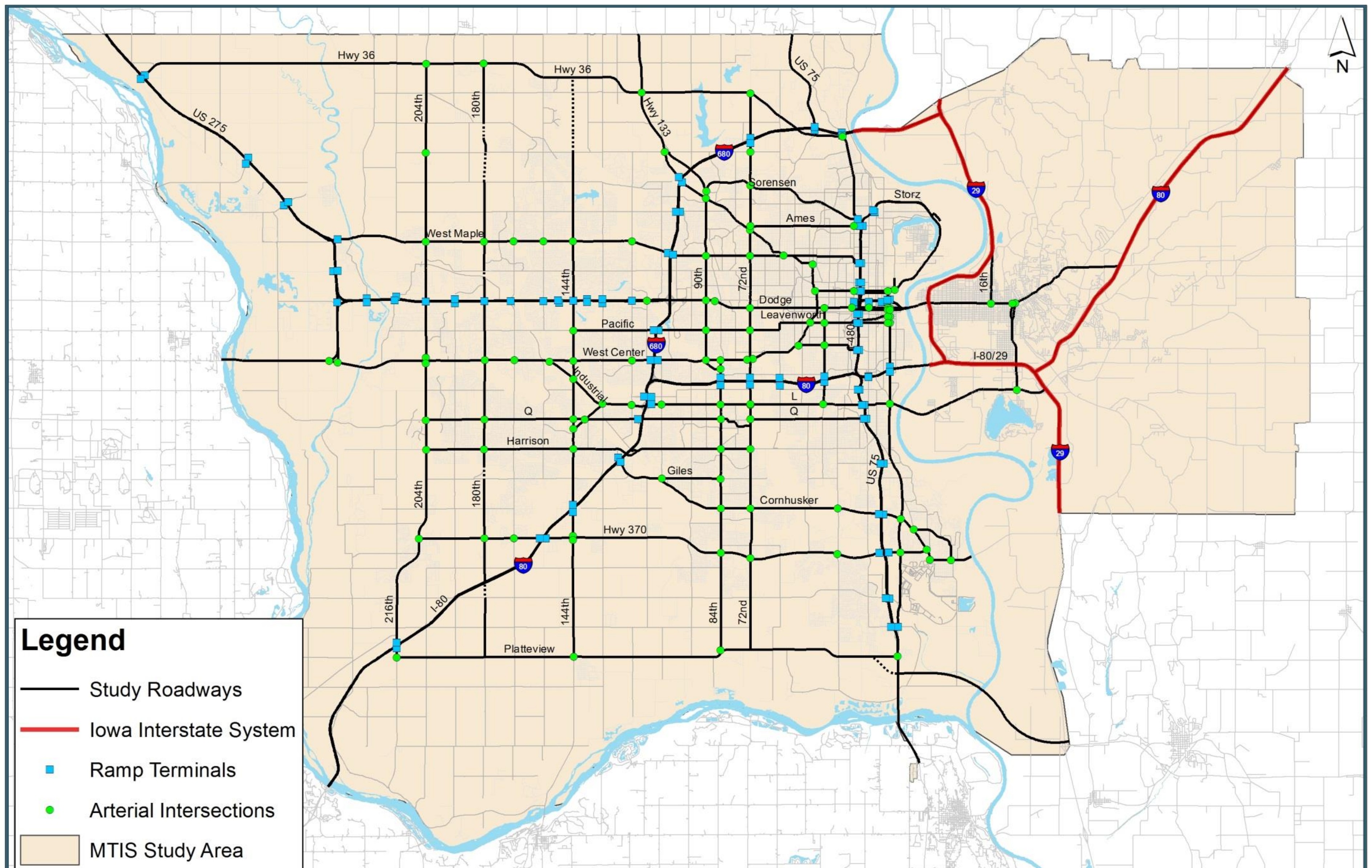
N

Metro Area Travel Improvement Study

Chapter 8 - Traffic Operations

This chapter summarizes the multi-level operations assessment for the existing and Future No-Build 2040 E+C scenarios at all study area roadways and intersections shown in **Figure 8.1**. Note that the Iowa Interstate System was excluded from the operations assessment since the majority of the system is currently being reconstructed or is slated for reconstruction in the coming years.

Figure 8.1. Study Area Roadways and Intersections for Traffic Operations Analysis



Existing

Freeway and Ramp Terminal Operations

As directed by the Management Committee, current freeway construction projects and projects that are programmed to be completed by 2016 were included in the existing operations analysis. Updated freeway geometries reflecting these complete or near-term projects at the following locations were included:

- I-680 NB - South of Center to North of Pacific
- I-80 EB - Giles to 96th
- I-80 EB/WB - I-480 Interchange to I-29 Interchange (in Iowa)
- I-80 WB - I-480 Interchange to 60th St

While the traffic counts used for the analyses were collected prior to the construction of the freeway projects listed above, the Consultant Team does not believe that traffic volumes will change significantly once the improvements are in place. Including these projects for the existing conditions analysis is the most appropriate representation of near-term freeway system operations.

Level of Service

Level of Service (LOS) analyses for the existing conditions were performed for freeway segments (basic, weave, and ramp) and ramp terminal intersections using procedures from the *Highway Capacity Manual 2010 Edition* (HCM 2010). Highway Capacity Software 2010 (HCS 2010) version 6.50, a computerized analytical tool based on HCM 2010, was utilized for the freeway segment and ramp terminal intersection operational analysis.

Basic Freeway Level of Service

LOS analyses for the basic freeway elements were performed following Chapter 11 procedures of HCM 2010. By definition, basic freeway segments are segments of the freeway that are outside of the influence area of ramps or weaving sections. Only freeway segments outside of the influence area of ramp junctions and weaving sections were evaluated as basic freeway segments. LOS for basic freeway segments is evaluated based on the average density of traffic (passenger cars per mile per lane) within the segment.

Weave Segment Level of Service

Weave segments were analyzed based on Chapter 12 procedures of HCM 2010. Weaving areas generally occur when an entrance ramp is closely followed by an exit ramp connected by an auxiliary lane. For locations with weaving traffic, ramp-to-ramp flows were estimated based on MAPA travel demand model percentages.

Ramp (Merge/Diverge) Segment Level of Service

Freeway merge and diverge segments were analyzed based on Chapter 13 procedures of HCM 2010. By definition, the LOS for a typical freeway merge or diverge segment is based on the average density of vehicles in the influence area (defined by the HCM as 1,500 feet upstream of a diverge section or downstream of a merge section).

Signalized Intersection Level of Service

Signalized ramp terminal intersections were analyzed based on Chapter 18 procedures of HCM 2010. LOS for signalized intersections is evaluated based on average control delay per vehicle (in seconds per vehicle).

Unsignalized Intersection Level of Service

Unsignalized ramp terminal intersections were analyzed based on Chapter 19 procedures of HCM 2010. LOS for unsignalized intersections is evaluated based on average control delay per vehicle (in seconds per vehicle). Results of the unsignalized intersection analysis were reported as the worst-case stop-controlled approach. This means that a majority of the volume at an intersection can be operating efficiently while a low volume stop controlled approach is not, resulting in a poor LOS evaluation for the intersection.

Results

Performance measure targets have been established for the MTIS study area. The threshold for acceptable HCM operations is LOS 'D' or better. The existing conditions analysis found that the majority of freeway facilities are generally operating at LOS 'D' or better during the peak hours. Freeway segments and ramp terminal intersections that are estimated to operate at LOS 'E' or worse are summarized in **Table 8.1** through **Table 8.5** for each type of LOS analysis.

LOS for all freeway segments and ramp terminal intersections can be found in the **Appendix**. A summary map showing the worst case peak hour LOS is included in **Figure 8.2**.

Table 8.1. Existing Basic Freeway LOS 'E' and 'F' Locations

Location	AM	PM
Dodge EB - 156th to 150th	E	-
* I-680 SB to I-80 EB	E	-
US-75 NB - Chandler to Q	E	-
US-75 NB - Under L	F	-

** System Ramp*

Table 8.2. Existing Ramp (Merge/Diverge) LOS 'E' and 'F' Locations

Location	AM	PM
US-75 NB - Chandler On Ramp	E	-
US-75 NB - Q Off Ramp	E	-
US-75 SB - Cornhusker Off Ramp	-	E
I-480 NB - Leavenworth Off Ramp	E	-

Table 8.3. Existing Weave LOS 'E' and 'F' Locations

Location	AM	PM
Dodge EB - 144th to 137th	E	-
Dodge EB - 132nd to 120th	E	-
Dodge EB - I-680 NB to Regency	E	-
Dodge WB - Westroads to I-680	-	E
Dodge WB - 120th to 132nd	-	F
Dodge WB - 132nd to 137th	-	E
Dodge WB - 137th to 144th	-	E
Dodge WB - 144th to 150th	-	E
* Dodge WB - I-680 NB/SB to Dodge	E	-
I-680 NB - Pacific to Dodge	F	F
I-680 NB - Dodge to Maple	-	F
I-680 SB - Maple to Dodge	F	-
I-680 SB - Dodge to Pacific	F	F
I-80 EB - 84th to 72nd	E	-
I-80 WB - 60th to 72nd	-	E
I-80 WB - 72nd to 84th	-	E

** System Ramp*

Note: Weaves reporting LOS'F' are based on calculated V/C > 1.

Table 8.4. Existing Signalized LOS 'E' and 'F' Ramp Terminals

Location	AM	PM
120th & West Dodge	-	F
I-680 & Pacific (East Terminal)	-	E
I-680 & Fort (West Terminal)	F	-
I-680 & Fort (East Terminal)	-	E
I-680 & Blair High (Southeast Terminal)	-	E
I-80 & Hwy 370 (West Terminal)	-	E
I-80 & L (East Terminal)	E	-

Table 8.5. Existing Unsignalized LOS 'E' and 'F' Ramp Terminals

Location	AM	PM
31st & I-680 (North Terminal)	E	F
192nd & West Dodge (South Terminal)	F	E
US-75 & L (East Terminal)	-	F
US-75, Fort Crook, Fairview (East Terminal)	F	-

Note: Worst stop-controlled approach LOS.

Non-Freeway Segment and Intersection Operations

Two capacity-based analyses were conducted for the non-freeway system.

- Daily volume to capacity (V/C) ratios were generated for non-freeway study area roadways.
- Peak hour analysis was conducted using Intersection Capacity Utilization (ICU) methodology at intersections of study area roadways and an additional 20 intersections identified by the Management Committee.

Intersection Capacity Utilization

ICU estimates the percentage of intersection traffic capacity that is being served, based on input traffic volumes and signal cycle length. Percentages below 100% indicate reserve intersection capacity while percentages over 100% indicate traffic over intersection capacity. This type of analysis differs from HCM methodology which calculates average control delay per vehicle. It may be possible to achieve an acceptable HCM LOS by using signal coordination and timings that favor higher volume movements when ICU indicates a failing LOS.

Results

The non-freeway existing conditions traffic analysis results are summarized below.

- 10% of non-freeway study roadways are approaching capacity or are over capacity (V/C > 0.9)
- 21 of the 112 study intersections are over capacity (LOS ‘F’) during their respective peak hours. ICU LOS ‘F’ intersections during the AM and PM peak periods were coded in Synchro 8 software and compared to the HCM LOS ‘D’ threshold stated in the freeway operations section. Non-freeway intersections that are estimated to operate at worse at LOS ‘E’ or worse are summarized in **Table 8.6**. Note that Supplemental Synchro 8 software analysis was conducted at intersections where the ICU methodology reported LOS ‘F’ for No-Build 2040 E+C conditions. These intersections (59) were also analyzed in the base year even if they were not at ICU LOS ‘F’. Note that the worst-case peak hour LOS was analyzed in Synchro 8.

LOS for all non-freeway intersections can be found in the **Appendix**. A summary map showing V/C ratios and the worst case peak hour LOS is included in **Figure 8.2**.

Table 8.6. Existing Non-Freeway Study Intersection LOS ‘E’ and ‘F’ Locations

Location	AM/PM
72nd & Pacific	E
72nd & Q	E
84th & L	F
84th & Q	E
90th & Maple	F
90th & West Dodge	F
132nd & L- Industrial	F

Note: Worst Peak Hour Synchro LOS

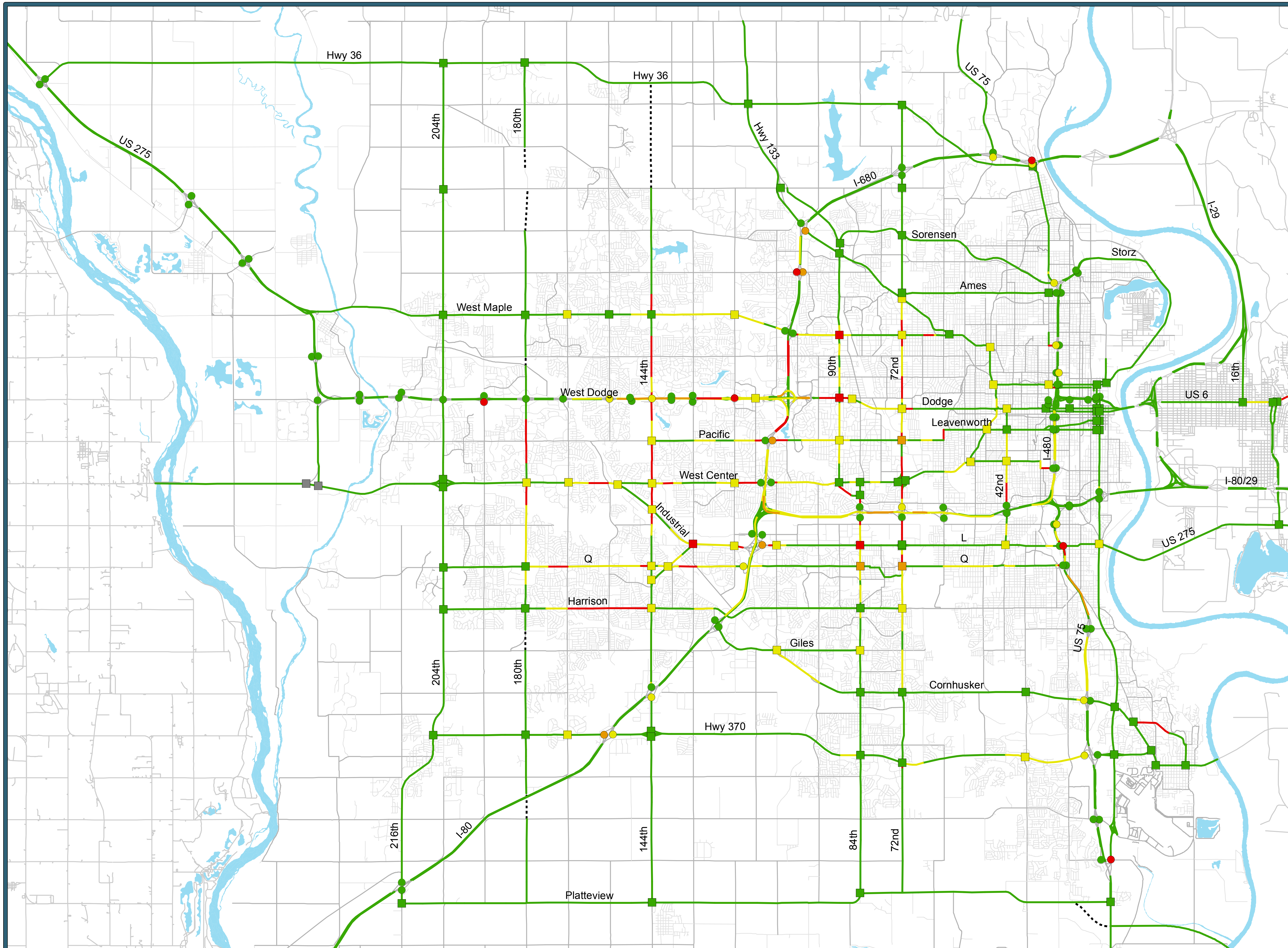


Figure 8.2: Existing Traffic Operations

Legend

HCM Intersection LOS

- A-C
- D
- E
- F

ICU / Synchro LOS

- A-C
- D
- E
- F
- N/A

HCM Freeway LOS

- A-C
- D
- E
- F

Non-Freeway V/C Ratios

- < 0.800
- 0.800 - 1.000
- > 1.000

Worst-case peak hour LOS based on:
- HCM analysis at ramp terminal intersections and freeway system
- ICU / Synchro analysis at non freeway study area intersections
- Daily V/C ratios on non-freeway study area roadways

N

Metro Area Travel Improvement Study

Future No-Build

Freeway and Ramp Terminal Operations

As directed by the Management Committee, future freeway construction projects that will be top priority over the next 10 years were included in the Future No-Build 2040 E+C traffic operations analysis. Only one future project was identified to be included in the no-build analysis (US-75 NB from Chandler Road to F Street).

Results

The Future No-Build 2040 E+C analysis found that a number of freeway facilities do not meet the threshold of LOS 'D' or better during peak hours. Freeway segments and ramp terminal intersections that are estimated to operate at LOS 'E' or worse are summarized in **Table 8.7** through **Table 8.11**.

LOS for all freeway segments and ramp terminal intersections can be found in the **Appendix**. A summary map showing the worst case peak hour LOS is included in **Figure 8.3**.

Table 8.7. Future No-Build 2040 E+C Basic Freeway LOS 'E' and 'F' Locations

Location	AM	PM
Dodge EB - 168th to 156th	F	-
Dodge EB - 156th to 150th	F	E
Dodge EB - 120th to 114th	F	-
Dodge EB (Expwy) - 120th to 114th	E	E
Dodge EB to I-680 SB	-	F
Dodge WB - 156th to 168th	-	F
Dodge WB (Expwy) - 114th to 120th	-	F
I-480 NB - Martha to Leavenworth	F	-
I-480 SB - 30th to Harney	-	E
I-480 SB - Leavenworth to Martha	-	E
* I-680 NB from I-80 EB	E	E
* I-680 NB from I-80 WB	E	E
I-680 NB - South of Center	E	E
* I-680 NB to Dodge WB	E	-
I-680 NB - Btw Fort Ramps	-	E
I-680 NB - Fort to Blair High	-	F
I-680 SB - Blair High to Fort	F	-
I-680 SB - South of Center	F	F
* I-680 SB to I-80 EB	F	F
I-80 EB - E of I-680 SB Merge	E	-
I-80 EB - IL I-680 CD to 84th	F	E
I-80 EB - Btw 84th On Ramps	E	-
I-80 EB - Btw 72nd On Ramps	E	E
I-80 EB - Btw 60th On Ramps	E	E
I-80 EB - 60th to 42nd	E	E
I-80 WB - Giles to 144th	-	E
I-80 WB - L CD to Giles	-	F
I-80 WB - West of I-680 Merge	-	F
I-80 WB - 84th to ILQ CD	-	E
I-80 WB - Btw 84th On Ramps	-	E
I-80 WB - Btw 72nd On Ramps	-	E
I-80 WB - Btw 60th On Ramps	-	E
US-75 NB - Between L Ramps	E	-
US-75 NB - Cornhusker to Chandler	F	-
US-75 NB - Hwy 370 to Cornhusker	E	-
US-75 SB - South of F	-	E
US-75 SB - Between L Ramps	-	E
US-75 SB - Q to Chandler	-	E
US-75 SB - Chandler to Cornhusker	-	F
US-75 SB - Cornhusker to Hwy 370	-	E

** System Ramp*

Table 8.8. Future No-Build 2040 E+C Ramp (Merge/Diverge) LOS 'E' and 'F' Locations

Location	AM	PM
Dodge EB - 168th On Ramp	F	E
Dodge EB - 156th On Ramp	F	-
Dodge EB - 156th Off Ramp	F	-
* Dodge WB - 204th Off Ramp	-	F
Dodge WB - 168th Off Ramp	-	F
Dodge WB - 156th On Ramp	-	F
I-480 NB - Martha On Ramp	F	-
I-480 NB - Leavenworth Off Ramp	F	-
I-480 NB - Harney Off Ramp	F	-
I-480 SB - Martha Off Ramp	-	E
I-680 NB - Fort On Ramp	-	F
I-680 NB - Blair High Off Ramp	-	F
I-680 SB - Blair High On Ramp	F	-
I-680 NB - Fort Off Ramp	F	-
I-80 EB - 84th Off Ramp	F	F
I-80 EB - 42nd Off Ramp	E	E
I-80 WB - 144th Off Ramp	-	E
I-80 WB - Giles Off Ramp	-	F
I-80 WB - L CD On Ramp	-	F
I-80 WB - 60th Off Ramp	-	F
US-75 NB - Chandler Off Ramp	F	-
US-75 NB - Cornhusker On Ramp	F	-
US-75 NB - Cornhusker Off Ramp	E	-
US-75 NB - Hwy 370 On Ramp	E	-
US-75 SB - Chandler On Ramp	-	F
US-75 SB - Cornhusker Off Ramp	-	F
US-75 SB - Hwy 370 Off Ramp	-	E

** Ramp is over capacity*

Table 8.9. Future No-Build 2040 E+C Weave LOS 'E' and 'F' Locations

Location	AM	PM
Dodge EB - 180th to 168th	E	-
Dodge EB - 150th to 144th	F	-
Dodge EB - 144th to 137th	F	E
Dodge EB - 137th to 132nd	F	E
Dodge EB - 132nd to 120th	F	E
Dodge EB - 114th to I-680 Split	E	F
Dodge EB - I-680 NB to Regency	E	-
Dodge WB - 150th to 156th	-	F
Dodge WB - 144th to 150th	-	F
Dodge WB - 137th to 144th	-	F
Dodge WB - 132nd to 137th	-	F
Dodge WB - Dodge to 132nd	-	F
* Dodge WB - I-680 NB/SB to Dodge	F	-
Dodge WB - Westroads to I-680	-	E
I-480 NB - I-80 EB to Martha	E	-
I-480 SB - Martha to I-80 EB/WB	-	F
I-680 NB - Maple to Fort	-	E
I-680 NB - Dodge to Maple	-	F
I-680 NB - Pacific to Dodge	F	F
I-680 NB - Center to Pacific	E	E
* I-680 NB - IL CD to Center	E	E
I-680 SB - Fort to Maple	F	-
I-680 SB - Maple to Dodge	F	-
I-680 SB - Dodge to Pacific	F	F
I-680 SB - Pacific to Center & ILQ	F	F
I-680 SB - Center to I-80 EB (CD)	F	E
I-80 EB - IL to I-680 (CD)	E	E
I-80 EB - 84th to 72nd	F	E
I-80 EB - 72nd to 60th	E	E
I-80 WB - 72nd to 84th	E	F
I-80 WB - 60th to 72nd	E	F
North Fwy NB - I-480 to Hamilton	-	F
US-75 SB - I-80 WB to F	-	E
US-75 SB - F to L	-	E
US-75 SB - L to Q	-	E

** System Ramp*

Note: Weaves reporting LOS 'F' are based on calculated V/C > 1.

Table 8.10. Future No-Build 2040 E+C Signalized LOS 'E' and 'F' Ramp Terminals

Location	AM	PM
204th & West Dodge	F	F
180th & West Dodge	-	E
144th & West Dodge	E	-
120th & West Dodge	-	F
216th (Gretna) & I-80 (N)	F	-
216th (Gretna) & I-80 (S)	F	-
I-80 & Hwy 370 (E)	F	F
I-80 & Hwy 370 (W)	F	F
144th and I-80 (N)	E	F
I-80 & 126th (Giles) (N)	-	E
I-80 & Q (W)	-	E
72nd & I-80 (N)	E	-
I-680 & Blair High (SE)	-	F
I-680 & Fort (E)	-	E
I-680 & Fort (W)	F	-
I-680 & Pacific (E)	-	E
US-75 & Cornhusker (E)	-	E
US-75 & Cornhusker (W)	-	F
US-75 & Hwy 370 (W)	E	E

Table 8.11. Future No-Build 2040 E+C Unsignalized LOS 'E' and 'F' Ramp Terminals

Location	AM	PM
14th & Chicago	-	F
192nd & West Dodge (S)	F	F
30th & I-680 (N)	F	F
30th & I-680 (S)	F	-
Mormon Bridge & I-680 (N)	-	F
Mormon Bridge & I-680 (S)	-	F
US-75 & L (E)	F	F
US-75, Fort Crook, Fairview (E)	F	F
US-75 & Fairview (W)	F	F
North Fwy & Lake (W)	-	F
North Fwy & Hamilton (E)	-	F
North Fwy & Hamilton (W)	-	E

Note: Worst stop-controlled approach LOS.

Non-Freeway Segment and Intersection Operations

Results

The non-freeway Future No-Build 2040 E+C conditions traffic analysis results are summarized below.

- 35% of non-freeway study roadways approaching capacity or over capacity (V/C > 0.9)
- 59 of the 112 studied intersections are over capacity (LOS 'F') during their AM or PM peak hours. LOS 'F' intersections during the AM and PM peak periods we coded in Synchro 8 software. Non-freeway intersections that are estimated to operate at LOS 'E' or worse in the Future No-Build 2040 E+C scenario are summarized in **Table 8.12**.

LOS for all non-freeway intersections can be found in the **Appendix**. A summary map showing V/C ratios and the worst case peak hour LOS is included in **Figure 8.3**.

Table 8.12. Future No-Build 2040 E+C Non-Freeway Study Intersection LOS 'E' and 'F' Locations

Location	AM/PM
204th & Harrison	F
204th & Q	F
204th & State	F
204th & West Center (N)	E
204th & West Center (S)	F
180th & Harrison	F
180th & Hwy 370	F
180th & W Center	E
168th & Hwy 370	F
168th & West Center	F
168th & West Maple	E
144th & Harrison	F
144th & Industrial	E
144th & Millard Ave	F
144th & Pacific	E
144th & Q	E
144th & West Center	E
144th & West Maple	E
132nd & L- Industrial	F
120th & L	E
120th & West Center	E
120th & West Maple	E
114th & West Dodge	E
108th & Giles	F
108th & L	E
90th & Maple	F
90th & Pacific	E
90th & West Dodge	F
84th & Giles	E
84th & L	F
84th & Hwy 370	F
84th & Q	F
72nd & Ames	E
72nd & Dodge	E
72nd & Harrison	F
72nd & Maple	F
72nd & Military Ave	E
72nd & Hwy 370	F
72nd & Pacific	F
72nd & Q	F
36th & Hwy 370	F
US-6, Hwy 31 & Hwy 370	F
Blair High & State	F
Fort Crook & Cornhusker	E
Industrial & W Center	F
Lincoln & Mission Ave	E
Saddle Creek & Cuming	F
Saddle Creek & Leavenworth	E

Note: Worst Peak Hour Synchro LOS

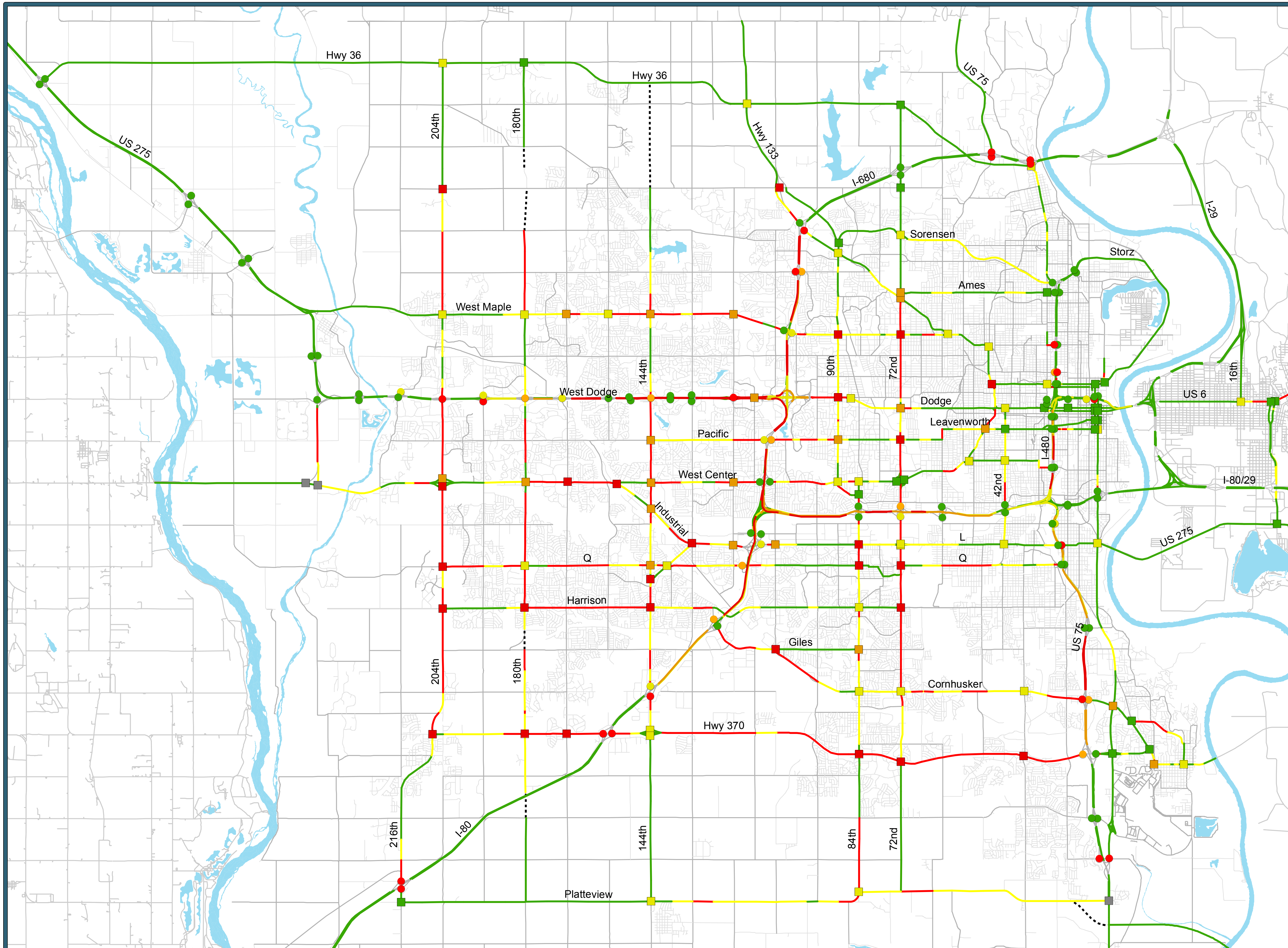


Figure 8.3: Future No-Build 2040 E+C Traffic Operations

Legend

HCM Intersection LOS

- A-C
- D
- E
- F

ICU / Synchro LOS

- A-C
- D
- E
- F
- N/A

HCM Freeway LOS

- A-C
- D
- E
- F

Non-Freeway V/C Ratios

- < 0.800
- 0.800 - 1.000
- > 1.000

Worst case peak hour LOS based on:
- HCM analysis at ramp terminal intersections and freeway system
- ICU / Synchro analysis at non freeway study area intersections
- Daily V/C ratios on non-freeway study area roadways

N

Metro Area Travel Improvement Study

Chapter 9 - Safety

This chapter summarizes the safety assessment of all study area roadways and intersections. Note that Iowa Interstate System was excluded from the safety assessment since the majority of the system is currently being reconstructed or is slated for reconstruction in the coming years.

Varying methodologies were used depending on the facility type, so the safety assessment stratified study area roadways into the following categories:

- Freeway Mainline Segments
- Freeway Ramp Terminal Intersections
- Non-Freeway Roadway Segments
- Non-Freeway Intersections
- Pedestrians

Observed Crashes

Crash data were obtained from NDOR files for the study area from 2008 to 2012. The data included location of the crash; crash type (e.g., single vehicle, multivehicle, pedestrian related); crash severity (e.g., fatal, injury, property damage); and other circumstances of the crash (e.g., road conditions, driver condition). The data shows a noticeable difference in the overall reported frequency of crashes during the 2008 to 2012 time period. Frequencies appear consistent from 2009 through 2011 but drop across all severities in 2012. The Consultant Team decided to use the consistent years (2009 - 2011) as the basis for the existing conditions.

Crashes are disaggregated by severity. The NDOR crash data uses the widely known injury severity scale (KABCO) method of crash severity, in which each crash is labeled according to the most serious outcome (KABCO):

- K - At least one fatality occurred
- A - At least one disabling injury occurred
- B - At least one evident injury occurred
- C - At least one suspected but not evident injury occurred
- O - Property damage exceeding the minimum reporting threshold occurred

Consistent with the current national and NDOR strategic focus on serious crashes, the analyses performed by the Consultant Team are based on only fatal (K) and injury-producing crashes (A,B,C) which represent 20 percent of the total reported crashes. KABCO crashes from 2009 - 2011 are shown in **Table 9.1**.

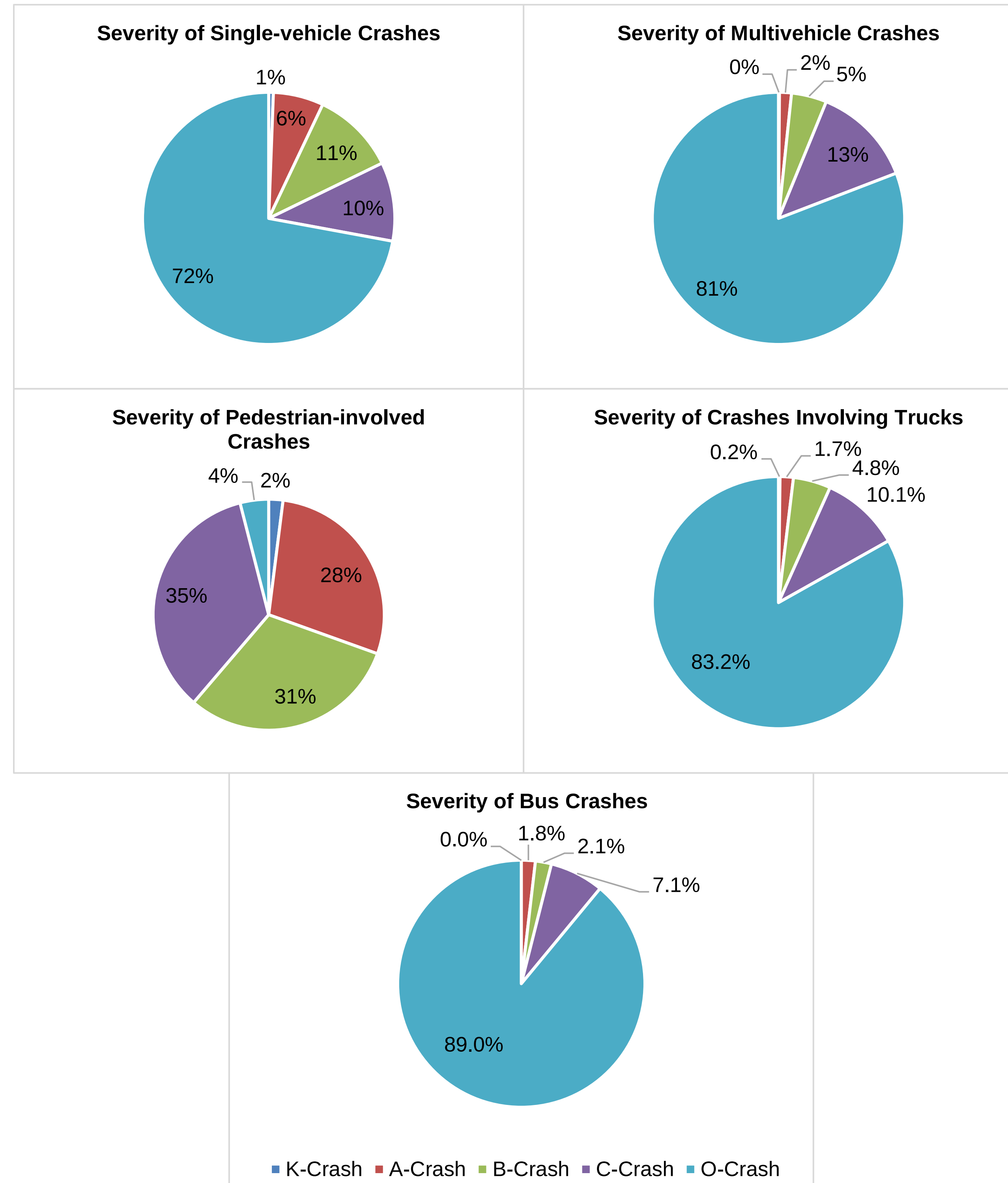
Table 9.1. Frequency of Crashes by Severity in the MTIS Study Area (Nebraska Side)

Year	K-Crash	A-Crash	B-Crash	C-Crash	O-Crash	Total
2009	21	273	718	1,678	9,848	12,538
2010	23	233	600	1,504	9,806	12,166
2011	23	264	617	1,422	9,246	11,572
Total	*67*	*770*	*1,935*	*4,604*	*28,900*	*36,276*

Crashes by Type

Figure 9.1 details crashes by type (single vehicle, multivehicle, pedestrian, trucks, and buses) and severity within the MTIS study area (Nebraska Side) from 2009 - 2011.

Figure 9.1. Crash Severity by Type in the MTIS Study Area (Nebraska Side)



Crash Prediction

The notion of predicting crashes is important for assessing future conditions or options. The concept of predicted crashes recognizes that roadways with traffic will, over time, experience crashes. Crash prediction involves the frequency and severity or risk profile of crashes that may occur. Per the extensive knowledge base on crashes captured in the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM), the expected crash frequency for any facility is a function of the following:

- **Traffic Volume (ADT)** - The greater the traffic volume, the greater the expected number of crashes. The relationship is non-linear for total crashes and for sub-segments of crash types.
- **Facility Types** - Freeways experience different safety risk profiles than two-lane rural highways, or multilane arterials. These differences reflect the design characteristics, access control, and presence of intersections.
- **Segments versus Intersections** - Crash risk, including the relationship of traffic volume to crashes, varies for road segments versus intersections.
- **Geometric Design Features** - The effect of cross section elements (lanes, shoulders, and medians), cross section dimensions, alignment features, and access control influence the frequency and severity of crashes. The influence of these features varies by facility type.
- **Land Use** - The influence of land use on crashes primarily relates to land uses that produce more pedestrian trips. Crashes involving pedestrians (and bicyclists) tend to be severe (producing an injury or fatality).

The task of predicting crashes involves the use of methods for predicting crashes as a function of the type of facility. These methods are described in Part C of the AASHTO HSM and summarized in the following subsection.

Safety Performance Functions and Crash Modification Factors

Research has established relationships between crash frequency, traffic volume, and other factors for most of the basic highway types (such as freeway, urban, and rural arterials). A Safety Performance Function (SPF) expresses the non-linear traffic volume and crash frequency relationship. It is established through modeling of road segments and crashes that are recorded as occurring on them. The SPF is based on the most frequent or common set of road characteristics, referred to as the "base condition." For road segments with characteristics different than the base condition, a Crash Modification Factor (CMF) or function is obtained through the same statistical exercise. Those design elements for which variations in the dimensions have a statistically significant effect on crash frequency are described by their CMF.

SPFs and their associated CMFs are developed from statistical analyses of large-scale databases. In the case of the HSM, the Federal Highway Administration's Highway Safety Information System (HSIS) databases were used by researchers. The AASHTO HSM published SPFs and their associated CMFs for urban arterials, signalized and unsignalized intersections, and rural highways (both two-lane highways and multilane highways). Recent research under National Cooperative Highway Research Program Project 15-47, which is now accepted by AASHTO as part of the HSM, also has established SPFs and CMFs for freeways, freeway interchanges, and crossroad intersections with freeway interchange ramps. This freeway and interchange model set, referred to as Enhanced Interchange Safety Analysis Tool (ISATe), is being used for the characterization of expected crashes given existing traffic and freeway conditions.

HSM model use requires the application of a calibration factor, which serves to address differences in databases associated with the state in which the analysis is performed versus the underlying database research. No calibration factor is available for Nebraska, so all predicted safety model output is uncalibrated indicating a calibration factor of 1.0.

Freeway Segments

Summary of ISATe Safety Performance Relationships

ISATe contains different SPFs for 4-lane, 6-lane, 8-lane, and 10-lane freeway segments. The models are ADT-based. Crash frequency is influenced by the lane and shoulder-width dimensions, the presence and location of roadside and median barriers, mainline horizontal alignment, and presence of entrance and exit ramps, with CMFs calculated for each of these factors.

Mainline crashes are influenced by the proximity of ramps, with specific sensitivity to weaving (that is, an entrance ramp followed by an exit ramp). The location of ramps (left hand versus right hand) and their design (lane balance versus lane drop or trap) also influence crash frequency. Finally, there is an influence of congestion on safety performance, which is described by the number of hours during a typical day in which traffic volume exceeds 1,000 vehicles per hour per lane.

The only significant geometric variable omitted from the ISATe model is vertical alignment, which was not available and not readily attainable by researchers.

ISATe also contains SPF and CMF models describing safety performance of ramps based on geometry. Analysis of expected ramp crashes was limited to the system (freeway to freeway) interchanges

Application of ISATe

The Consultant Team coded the Nebraska Mainline Freeway System within the study area using as-built plans and Google Earth. Coding involved segmenting the mainline according to horizontal geometry and presence of ramps. Given the size of the overall system, service interchange ramps were not coded, but the four system interchanges were fully coded.

The ISATe crash prediction models are ADT-based. Traffic data are required for every ramp and every mainline segment to perform the analysis. Existing peak hour counts detailed in Chapter 7 for all necessary ramp and mainline elements were obtained and used as the basis for the safety evaluation, which were converted to estimated ADT values by assuming a k factor (percent of peak period to ADT) of 10 percent for each segment.

Results

Table 9.2 summarizes the analysis for the overall freeway system. Note that the observed crashes for 2009 to 2011 are annualized (sum of the 3 years divided by 3).

The total observed crashes are 62 percent of those predicted. This ratio may be used as an approximate calibration factor associated with Nebraska (it also would include necessary adjustments for the difference in the base years of predicted versus observed). This quasi-calibration factor is within the limits experienced in other states that use HSM methods.

Table 9.2. Summary of Observed and Uncalibrated Predicted Crashes for the Nebraska Freeway System

		Annualized Fatal and Injury (KABC) Crashes		Ratio
Freeways	**Length (mi)**	**Observed (2009 - 2011)**	**Predicted (2012 Traffic)**	**Observed / Predicted**
US 75 (South)*	9.02	22.8	24.9	92%
US 75 (North)**	2.20	9.3	5.9	159%
I-480	3.01	18.2	16.2	112%
I-80	26.82	77.0	129.2	60%
US 275	13.8	8.0	12.7	63%
US 6	10.43	16.7	44.4	38%
I-680	12.08	20.0	44.7	45%
Total Study Area	*77.36*	*172.0*	*278.0*	*62%*

***North of US 75 / I-480 Interchange; *South of I-80 / I-480 Interchange*

General conclusions include the I-80 and US 275 corridors are performing as expected, I-480 and US 75 corridor has observed crashes greater than expected, and the US 6 and I-680 corridors experience observed crashes fewer than expected.

Major system interchanges also were evaluated separately. ISATe was used to evaluate the geometry of interchanges, including almost every geometric factor other than vertical geometry. **Table 9.3** summarizes the analysis for the system interchanges.

Table 9.3. Summary of Observed and Uncalibrated Predicted Crashes for System Interchanges

	Annualized Fatal and Injury (KABC) Crashes		Ratio
System Interchanges	**Observed (2009 - 2011)**	**Predicted (2012 Traffic)**	**Observed / Predicted**
US 75/I-480 and I-80	18.9	24.8	76%
US 75 and I-480	5.2	5.4	96%
I-80 and I-680	8.6	16.3	53%
US 6 and I-680	26	18.4	141%
Total Study Area	*58.7*	*64.9*	*90%*

Freeway Segments with High Predicted Crash Frequencies

Data from the analyses were used to compute predicted crashes per mile per year. **Table 9.4** lists those segments within the freeway system with the highest predicted crash frequencies per year (greater than 7.0 per mile per year).

Higher frequencies are associated with greater traffic volume and with multiple ramps and weaving sections within them. Increased frequencies also occur on those segments for which traffic volume creates a greater number of hours of the day at lower levels of service (congestion).

Table 9.4. Freeway Segments with Highest Predicted Crash Frequencies per Mile per Year

Freeway Segments with Predicted KABC Crashes > 7.0 per mile per year	Predicted KABC Crashes per mile per year
US 75 from Martha St to Leavenworth St	7.8
I-80 East Side I-680 interchange to 84th St	12.5
I-80 from 84th St to 72nd St	12.6
I-80 from 72nd St to 60th St	12.9
I-80 from 60th St to 42nd St	20.6
I-80 from 42nd St to west side I-480 interchange	12.8
US 6 from 156th St to 150th St	8.0
US 6 from 150th St to 144th St	9.6
US 6 from 120th St to 114th St	8.5
I-680 from North of Center St to Pacific St	7.4
I-680 from Pacific St to Dodge	9.2

Ramp Terminals

Application of ISATe

There are a total of 108 ramp terminals within the Nebraska portion of the study area. Of these 108 ramp terminals, 88 were modeled using the predictive safety method. Because of limitations with the ISATe predictive tool, the geometric configurations of the remaining 20 ramp terminals could not be modeled to compute the predicted fatal and injury (KABC) crashes. ISATe was able to predict fatal and injury (KABC) crashes for the following six ramp terminal configurations:

- Three-leg ramp terminal with diagonal exit or entrance ramp (D3EX or D3EN)
- Four-leg ramp terminal with diagonal ramps (D4)
- Four-leg ramp terminal at four-quadrant partial cloverleaf interchange (parclo) A (A4)
- Four-leg ramp terminal at four-quadrant parclo B (B4)
- Three-leg ramp terminal at two-quadrant parclo A (A2)
- Three-leg ramp terminal at two-quadrant parclo B (B2)

The study area included several single-point urban interchanges (SPUI) that the current HSM predictive methods could not model. In addition to the atypical intersection geometry, ISATe cannot model a one-way crossroad. Therefore, predicted fatal and injury (KABC) crash frequencies could not be obtained for several ramp terminals in the downtown area.

ADT was estimated by expanding peak hour traffic volume counts to 24-hour values. The SPFs that calculate the predicted average annual fatal and injury (KABC) crash frequency depend on traffic volumes in the form of ADT for all approaches and ramps, as well as specific geometric properties at each terminal.

The following geometric data were collected for input in the ISATe worksheet:

- Terminal type (as defined by the ISATe manual)
- Skew angle between ramp and crossroad
- Control type for left and right turn at ramp terminal
- Crossroad median width
- Number of through lanes

- Right-turn channelization
- Left-turn bay (presence and width for inside and outside crossroad)
- Number of driveways present on the outside along crossroad within 250 feet of the ramp terminal

Results

Table 9.5 summarizes the analysis for ramp terminals.

Table 9.5. Summary of Observed and Uncalibrated Predicted Crashes for Study Area Ramp Terminals

		Annualized Fatal and Injury (KABC) Crashes		Ratio
Ramp Configuration	**Count**	**Observed (2009 - 2011)**	**Predicted (2012 Traffic)**	**Observed / Predicted**
4-leg Terminal with Diagonal Ramps (D4)	64	44.7	137.8	32%
4-leg Terminal at Four-Quadrant Parclo A (A4)	13	15.5	64.3	24%
4-leg Terminal at Four-Quadrant Parclo B (B4)	3	2.6	4.8	54%
4-leg Terminal with Diagonal Exit Ramp (D3EX)	3	2.0	2.5	80%
3-leg Terminal with Diagonal Entrance Ramp (D3EN)	3	2.7	1.6	169%
3-leg Terminal at Two-Quadrant Parclo A (A2)	2	0.7	0.6	117%
Total Study Area	*88*	*68.2*	*211.6*	*32%*

The US 75, I-80 and I-680 ramp terminals experienced fewer fatal and injury (KABC) crashes than the ISATe predicted, which indicates a better than expected safety performance. However, ramp terminals on US 275 and US 6 experienced more fatal and injury (KABC) crashes than predicted.

Non-Freeway Segments

Application of Highway Safety Manual's Chapter 12

HSM's Chapter 12 was used to estimate the safety performance for arterial roadway segments. This methodology was used to analyze the following site types:

- Two-lane undivided arterials (2U)
- Two-lane undivided arterials with a center two-way left turn lane (TWLTL) (3T)
- Four-lane undivided arterials (4U)
- Four-lane arterials divided by a raised median (4D)
- Five-lane undivided arterials with a center TWLTL (5T)

The HSM predictive method uses SPFs to calculate predicted crashes for a facility. SPFs are delineated by facility type and area context (urban or rural). The arterial site types with available statistical models for analysis are noted above. Because arterials with greater than four through lanes, an unbalanced number of through lanes, and one-way arterials cannot be analyzed using available predictive methods in the HSM, they were omitted from this study. Although research is currently being performed to develop predictive models for 6- and 8-lane arterials and one-way arterials, the findings are not yet available for use. Thus, the Consultant Team could not perform any predictive analysis for these facilities inside the study area (e.g., NW Radial Highway).

The HSM predictive models require that each segment has similar characteristics for the length of the segment. If any of these characteristics change significantly, then a new segment must be designated. The segmentation process resulted in the establishment of 220 analysis segments encompassing 242.3 miles in the study area. The following list identifies the data geometric design features, traffic control features, and site characteristics considered in the analysis.

- Roadway site type (that is, 2U, 3T, 4U, 4D, and 5T)
- Segment length
- Average annual weekday traffic (AAWT). If traffic changed by at least 15 percent, a new segment was created.
- Type and presence of on-street parking (none, parallel, or angle)
- Proportion of segment length with on-street parking permitted
- Average median width if a median existed
- Presence or absence of street lighting
- Speed limit; it was assumed as 30 miles per hour (mph) or greater if speed limit data were not identified from Google Earth
- Number and type of driveways (commercial, industrial, residential)
- Distance from edge of roadway to closest fixed objects (assumed to be 12 feet)
- Density of fixed roadside objects (assumed to be 30 per mile for suburban segments and 40 per mile for urban segments)

Results

Table 9.6 summarizes the analysis of the arterial roadway segment analysis by type of facility.

Table 9.6. Summary of Observed and Uncalibrated Predicted Crashes for Arterial System Segments

		Annualized Fatal and Injury (KABC) Crashes		Ratio
Type of Facility	**Length (mi)**	**Observed (2009 - 2011)**	**Predicted (2012 Traffic)**	**Observed / Predicted**
4-lane divided roadway (4D)	129.1	161.7	149.3	108%
4-lane undivided roadway (4U)	34.4	34.6	62.4	55%
2-lane undivided roadway (2U)	39.8	14.4	23.8	60%
2-lane with center TWLTL roadway (3T)	14.1	4.0	10.6	38%
4-lane with center TWLTL roadway (5T)	24.9	24.0	66.7	36%
Total Study Area	*242.3*	*238.7*	*312.8*	*76%*

The frequency of predicted annual fatal and injury (KABC) crashes was higher than the annual average observed crashes for all types of facilities except 4D roadways. The HSM predictive model for the 4D roadway type provided the closest fit to the observed fatal and injury (KABC) crashes in this study area. Because this roadway type represented half of the study area segment mileage and 68 percent of the observed annual average fatal and injury (KABC) crashes, the overall ratio of observed to predicted fatal and injury (KABC) crashes was skewed toward the performance of this roadway type. While the models generally performed well with minimal calibration necessary for 4D roadways, there was a greater divergence in predicted versus observed performance of 4U, 2U, 3T, and 5T arterials. The model appears to have significantly overpredicted the fatal and injury (KABC) crashes associated with these roadway types.

Non-Freeway Intersections

Application of Highway Safety Manual's Chapter 12

HSM's Chapter 12 was used to estimate the safety performance for arterial intersections. The HSM predictive methods cover a variety of intersection traffic-control types and geometries - specifically signalized and unsignalized control types. The study area intersection geometries included in the assessment were three- or four-leg approaches that primarily are signalized. Some major, unsignalized, four-leg, stop-controlled intersections were included in the analysis. The following shorthand designation was used for the intersection types:

- Four-leg stop-controlled (4ST)
- Four-leg signal-controlled (4SG)
- Three-leg stop-controlled (3ST)
- Three-leg signal-controlled (3SG)

The HSM predictive method does not support more than four intersection approaches, nor does it allow for the analysis of roundabout safety performance. Intersection skew angle is not considered in the urban version of the model.

The following geometric data were collected for arterial intersections:

- Intersection type and number of legs (3ST, 3SG, 4ST, 4SG)
- AAWT on major and minor approaches
- Number of approaches with left-turn lanes
- Number of approaches with right-turn lanes
- Number of approaches with left-turn-signal phasing
- Left-turn-phasing type (protected versus permissive); assumptions about protected versus permissive phasing were based on the number of signal heads present at each turning movement
- Maximum number of lanes crossed by a pedestrian
- Number of bus stops within 1,000 feet of the intersection center
    - Presence or absence of schools within 1,000 feet of the intersection center
    - Number of alcohol-sales establishments within 1,000 feet of the intersection center
    - Pedestrian volume (assumed to be 50 pedestrians/day for suburban intersections and 240 pedestrians/day for urban intersections)

154 signalized and unsignalized intersections were assessed. This number is larger than the 112 intersections shown in **Figure 8.1**. In addition to the 112 intersections, other signalized intersections were included if the arterial roadway volume changed by at least 15 percent at the intersection, indicating high turning volumes. Note that 14 study intersections could not be modeled with the predictive method because of their geometry or because they served one-way traffic on at least one leg. Intersections were assigned an influence area to determine which observed fatal and injury (KABC) crashes would be attributed to them rather than to arterial segments. According to HSM guidance, this area was defined as 250 feet in each direction from the center of a signalized intersection and 100 feet for an unsignalized intersection. Because many minor intersections were not included in the model in the interest of time, observed fatal and injury (KABC) crashes attributed to the intersections were not counted and excluded from the model.

Results

Table 9.7 summarizes the analysis of the arterial intersection analysis by type of intersection.

Table 9.7. Summary of Observed and Uncalibrated Predicted Crashes for Arterial System Intersections

		Annualized Fatal and Injury (KABC) Crashes		Ratio
Intersection Type	**Count**	**Observed (2009 - 2011)**	**Predicted (2012 Traffic)**	**Observed / Predicted**
4-leg Signalized Intersection (4SG)	121	311.5	179.5	174%
3-leg Signalized Intersection (3SG)	6	20.7	9.6	216%
4-leg Unsignalized Intersection (4ST)	12	15.7	14.1	111%
3-leg Unsignalized Intersection (3ST)	1	0.0	4.6	0%
Total Study Area	140	347.8	207.8	167%

All non-freeway intersections experienced more fatal and injury (KABC) crashes than predicted.

Pedestrian Crashes

The relative infrequency of pedestrian crashes makes their prediction difficult. Crash prediction relies in part on volume as a core measure of exposure, and pedestrian volumes are not typically collected and maintained. Current practice in crash analysis of pedestrian crashes is by geolocating them and relating them to the presence, frequency, and intensity of land uses attractive to pedestrians.

Over the 3-year period from 2009 through 2011, total 353 pedestrian-vehicle collisions were reported in Douglas County. Nearly 61 percent of these collisions resulted in an evident injury (Type A or B), and 2 percent resulted in a fatality (Type K). Pedestrian crashes occurred more often within the more developed, land-use dense area closer to the Omaha city center. In comparison, relatively few pedestrian collisions occurred along the highways and interstates. This is a typical pattern because pedestrian crashes tend to be associated with operation of the arterials and street system.

Needs Screening

The Consultant Team established screening criteria as a method for selecting areas in need of further study during Phase 2. The screening thresholds were based on the average ratio of observed to predicted crashes for freeway segments, ramp terminals, arterial segments, and arterial intersections. Locations with (observed / predicted) ratios above a certain threshold were flagged and considered a need of further study. Some segments and intersections identified as having higher relative observed frequencies than other similar studied facilities were not flagged through the screening method described above. In these locations, the observed frequency value may align with the predicted value, but the potential for safety improvement is still evident given the relatively higher frequency of observed crashes. A summary of safety needs can be found in Chapter 13.

Chapter 10 - Transit Facilities / Service

Metro operates both fixed route and a paratransit service within the City of Omaha. Fixed route service includes local, express/commuter, and circulator service. Metro operates service directly within the Omaha city limits and provides service to five adjacent municipal jurisdictions through private contracts. These are Ralston, LaVista, Papillion, and Bellevue in Nebraska and Council Bluffs in Iowa. Combined, Metro fixed route buses serve 100 square miles or approximately 85% of the City of Omaha. The service area includes approximately 580,000 people.

Metro also operates MOBY, a shared, advance reservation curb-to-curb complementary paratransit service for metropolitan area Americans with Disabilities Act (ADA) certified residents and visiting ADA certified individuals who are unable to use Metro Transit’s conventional ADA compatible fixed-route network. MOBY service mirrors the geographic areas, days and hours of the fixed route transit network. The ADA requires federally-funded public mass transit systems to operate complementary paratransit service for persons who cannot independently use fixed route service because of a disability. This service thus acts as a “complement” to the traditional bus service.

Metro's fleet includes small, medium and large sized buses as well as vans. The system includes a fleet of about 118 buses, approximately 4,000 posted bus stops, six transit centers, and 98 passenger waiting shelters. MOBY consists of directly operated paratransit vans, supplemented by local taxi services. Service is provided using 19 vans and a fleet of 34 taxi cabs. Characteristics of Metro’s fixed route bus service are summarized in **Table 10.1**.

System Performance

This section summarizes detailed data on Metro bus and demand response service between 2009 and 2012, as reported in the National Transit Database (NTD) and the Regional Transit Vision study. Highlights and trends from this historical performance are summarized below

- Annual passenger miles increased from 18.4 million in 2009 to 19.1 million in 2012.
- Annual unlinked trips (fixed route and paratransit ridership) increased from 3.8 million in 2009 to 4.4 million in 2012.
- Annual vehicle revenue miles grew from 4.6 million in 2009 to 4.8 million in 2012.
- Total operating expenses have increased from $24.9 million in 2004 to $26.4 million in 2012.

Fixed Route Performance Summary

Key changes and trends between 2009 and 2012 for the bus system include the following:

- Annual ridership has increased by nearly 15 percent, from 3.7 million to 4.2 million.
- Annual operating expenses have increased by 1.6 percent. Operating cost per passenger has decreased by 11.5 percent.
- Farebox revenue has increased by 16.4 percent, from $4.0 million to $4.6 million, while the farebox recovery ratio (the proportion of operating costs covered by farebox revenue) has increased at a slightly lower rate of 14.5 percent.
- Operating cost per revenue hour and operating cost per revenue mile have both increased slightly, by 4.1 percent and 4.7 percent, respectively.
- Passengers per revenue hour and passengers per revenue mile have both increased over the period, by 17.5 percent and 18.7 percent, respectively.

Table 10.1. Metro Route Attributes for Weekday Service

Route	Route Name	Weekday		
		Span		Frequency
				Peak/Off Peak
2	Dodge	4:25 AM	12:47 AM	15/15
3	North 40th / South 42nd	4:38 AM	12:07 AM	30/30
4	Maple / Fort	4:20 AM	12:43 AM	15/30
5	North 90th / South 96th	4:55 AM	7:20 PM	30/60
8	North 60th / West Blondo	5:08 AM	7:25 PM	60/60
11	Leavenworth	5:00 AM	12:18 AM	30/30
13	13th Street / L Street	5:03 AM	12:30 AM	15/30
14	Maple / Fort	4:30 AM	7:37 PM	30/60
15	West Center / Q Street	4:38 AM	12:36 AM	15/30
16	East Omaha / North 16th	5:08 AM	6:50 PM	30/NS
18	72nd Street / Ames Avenue	4:09 AM	12:50 AM	15/15
24	24th Street	4:38 AM	12:02 AM	30/30
26	North Omaha Circulator	5:08 AM	11:43 PM	60/60
30	Florence	4:33 AM	12:20 AM	30/30
34	Industrial Parks	6:02 AM	4:13 PM	60/NS
35	North 33rd	5:08 AM	12:20 AM	30/30
36	New Downtown Circulator	5:10 AM	11:42 PM	30/30
41	Council Bluffs - Blue	6:35 AM	11:40 PM	60/60
43	Council Bluffs - Yellow	5:02 AM	7:30 PM	60/60
55	West Center / Q Street	4:53 AM	7:51 PM	30/60
200	Green Downtown Circulator	5:45 AM	8:00 PM	6/NS
300	Red Downtown Circulator	6:15 AM	6:40 PM	5/NS
92	Dodge Express	5:10 AM	7:20 PM	15/NS
93	South 84th Express	5:58 AM	6:15 PM	30/NS
94	West Center Express	5:49 AM	6:28 PM	30/NS
95	Bellevue Express	5:59 AM	6:30 PM	30/NS
96	Express	6:21 AM	6:00 PM	30/NS
97	Millard Express	5:34 AM	6:27 PM	15/NS
98	Maple Village Express	5:52 AM	6:39 PM	22/NS

Note: No Service (NS)

Demand Response System Performance Summary

Key changes and trends between 2009 and 2012 for the paratransit system include the following:

- Annual ridership has increased substantially, from about 76,000 in 2009 to more than 103,000 in 2012, an increase of 36%.
- Annual operating expenses have increased by 44%, from $1.8 million to $2.7 million. Operating cost per passenger has decreased by about 35%.
- Farebox revenue has increased by 64%, from $158,000 to $259,000. The farebox recovery ratio has also increased, from about 8.6% to 9.7%.
- Operating cost per revenue hour and operating cost per revenue mile have both increased, by 11% and 8.2%, respectively.
- Passengers per revenue hour and passengers per revenue mile have both increased somewhat, by about 5% and 4%, respectively.

Comparison to Peer Cities

Omaha's Metro system was compared to 10 other cities around the country. The comparison includes both "peer" cities of relatively similar size and characteristics to Omaha as well as several larger cities for additional context including: Albuquerque, Des Moines, Kansas City, Minneapolis, Louisville, Grand Rapids, St. Paul, Oklahoma City, Wichita, and Colorado Springs.

For bus, the Metro system has lower operating expenses per vehicle revenue mile and vehicle revenue hour than nearly all of the comparison cities. On the other hand, Metro's operating expenses per passenger mile are greater than all of the comparison cities, and operating expenses per unlinked passenger trip are greater than many of the other systems. Similarly, the Metro system has a lower number of unlinked passenger trips per vehicle revenue mile and vehicle revenue hour than many of the other systems. While the system appears to be operating efficiently with respect to costs per mile and costs per hour of service, the number of passengers served per hour and mile is less than the peer cities.

Direct comparison of the Metro demand response (paratransit) system to the peer cities is more difficult, as the reported performance measures range widely by system. However, the Metro system appears to be competitive on operating expense and passenger trip measures.

Transit Proximity

One measure of transit system performance in meeting transportation needs is transit proximity. Proximity was measured by identifying the number of households and jobs within ¼ mile and ½ mile of bus routes. Routes were used for this regional-level analysis, rather than individual bus stops. Results are reported for local bus routes, not including express routes. A ¼-mile buffer was used as a typical threshold for the distance people are willing to walk to access transit, in particular for a community with the land use pattern and densities of Omaha; a ½ mile buffer is also used for other planning-level metrics and was included for this analysis. Accessibility percentages are shown in **Table 10.2** and proximity buffers are illustrated in **Figure 10.1**.

Planned Improvements

Metro implemented significant system changed to its routes on May 31, 2015. These near term improvements (Phase 1) to the system included:

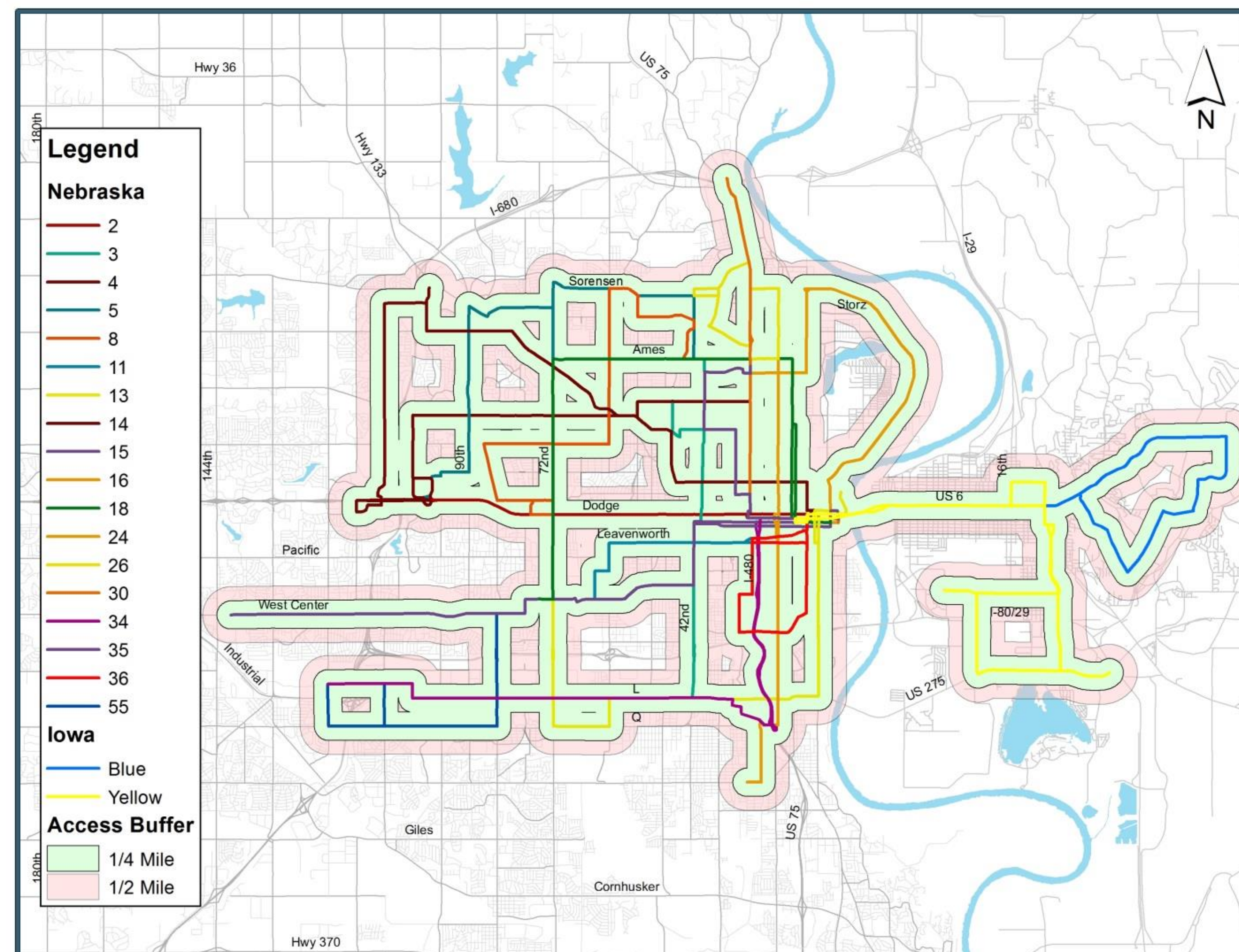
- Adding over 2,300 miles of weekend service
- Extended weeknight service until midnight or later
- More frequent service on highest-ridership routes

There are also Phase 2 and Phase 3 transit system improvements that MAPA and Metro staff assume will be in place in the 2040 baseline ("existing-plus-committed") scenario. Those longer-term planned Metro system improvements include increased frequencies on several local and express routes.

Table 10.2. Current and Future Proximity to Local Bus Routes for Households and Employment

Accessibility Measure	Scenario Year	Percent of Metro Total	
		Households	Employment
Within 1/4 mile of Local Bus Routes	2010	32.3%	45.0%
	2040	27.9%	39.7%
Within 1/2 mile of Local Bus Routes	2010	45.3%	58.4%
	2040	38.5%	51.1%

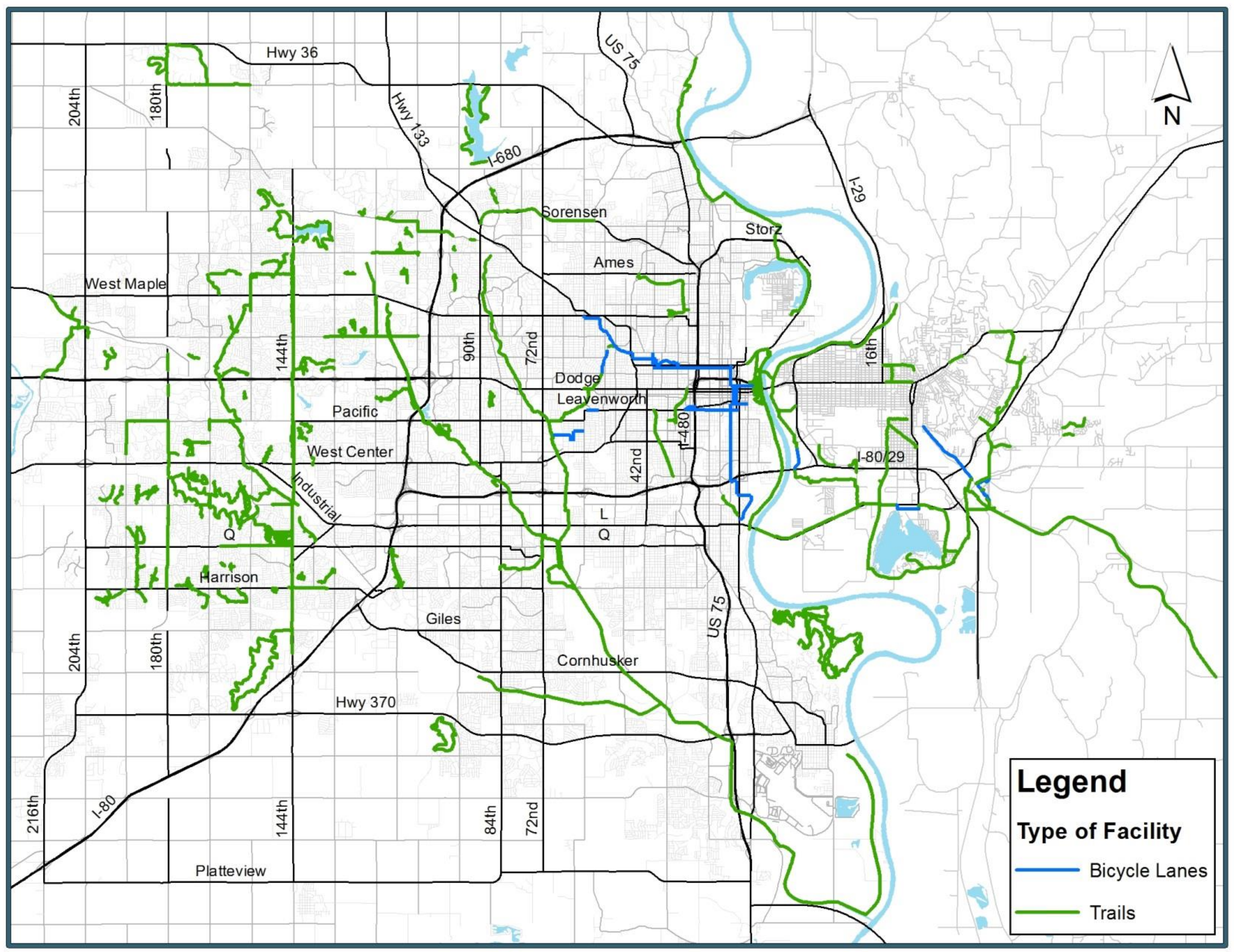
Figure 10.1. Transit Proximity Buffers



Chapter 11 - Pedestrian and Bicycle Facilities / Service

The MAPA planning area has an extensive network of off-street multi-use trails suitable for both pedestrians and bicyclists. Many of the trails follow rivers, streams, and other natural features. Some trails are short, local facilities providing local recreation or transportation connections. Others are longer, regional trails that connect different parts of the metro area and support bicycle commuting. Additional facilities are under discussion as part of efforts to make the system more of a continuous and comprehensive network. The City of Omaha has a relatively small inventory of on-street bicycle lanes, located primarily in the central portion of the city and has also developed shared lane ("sharrow") facilities. Trails and on-street bicycle lanes are shown in **Figure 11.1**.

Figure 11.1. Existing Trails and On-Street Bicycle Lanes



Sidewalks are another element of the pedestrian circulation and multimodal transportation system. Within the City of Omaha portion of the study area, the Transportation Element of Omaha's 2012 Master Plan describes the existing sidewalk system. In the absence of a sidewalk inventory, the plan estimates the percent of sidewalk coverage based on when the various neighborhoods were developed. Pre-1940's neighborhoods and post 2000's neighborhoods are typically the most complete (80-100% coverage), with others falling somewhere in between.

Bicycle Level of Service

Bicycle level of service (BLOS) is a measure of on-road bicyclist comfort level as a function of the roadway's geometry and traffic conditions. **Figure 11.2** shows the BLOS for roads in the MAPA area developed as part of the *Heartland Connections Bicycle and Pedestrian Plan*. Roadways with a better (higher level grade) LOS are more attractive and often safer for cyclists. LOS A reflects the best conditions for bicyclists; for example, a separated bike lane. LOS F represents the worst conditions for bicyclists; for example very narrow lanes for bicyclists adjacent to heavy traffic.

As shown in **Table 11.1**, the BLOS was estimated for 344 miles of roadway in the metro area as a part of the *Heartland Connections Bicycle and Pedestrian Plan*. BLOS ranges widely, with only about 21% of roadway miles meeting the criterion for LOS A and or B.

Table 11.1. Bicycle Level of Service Results

Level of Service	Roadway Miles	% of Total
A/B	73	21.2%
C	83	24.2%
D	118	34.3%
E / F	70	20.3%

Barriers and Service Gaps

In MAPA's *Heartland Connections Bicycle and Pedestrian Plan*, the challenges for the regional pedestrian and bicycle systems were summarized into a few themes. These challenge themes for the pedestrian system included:

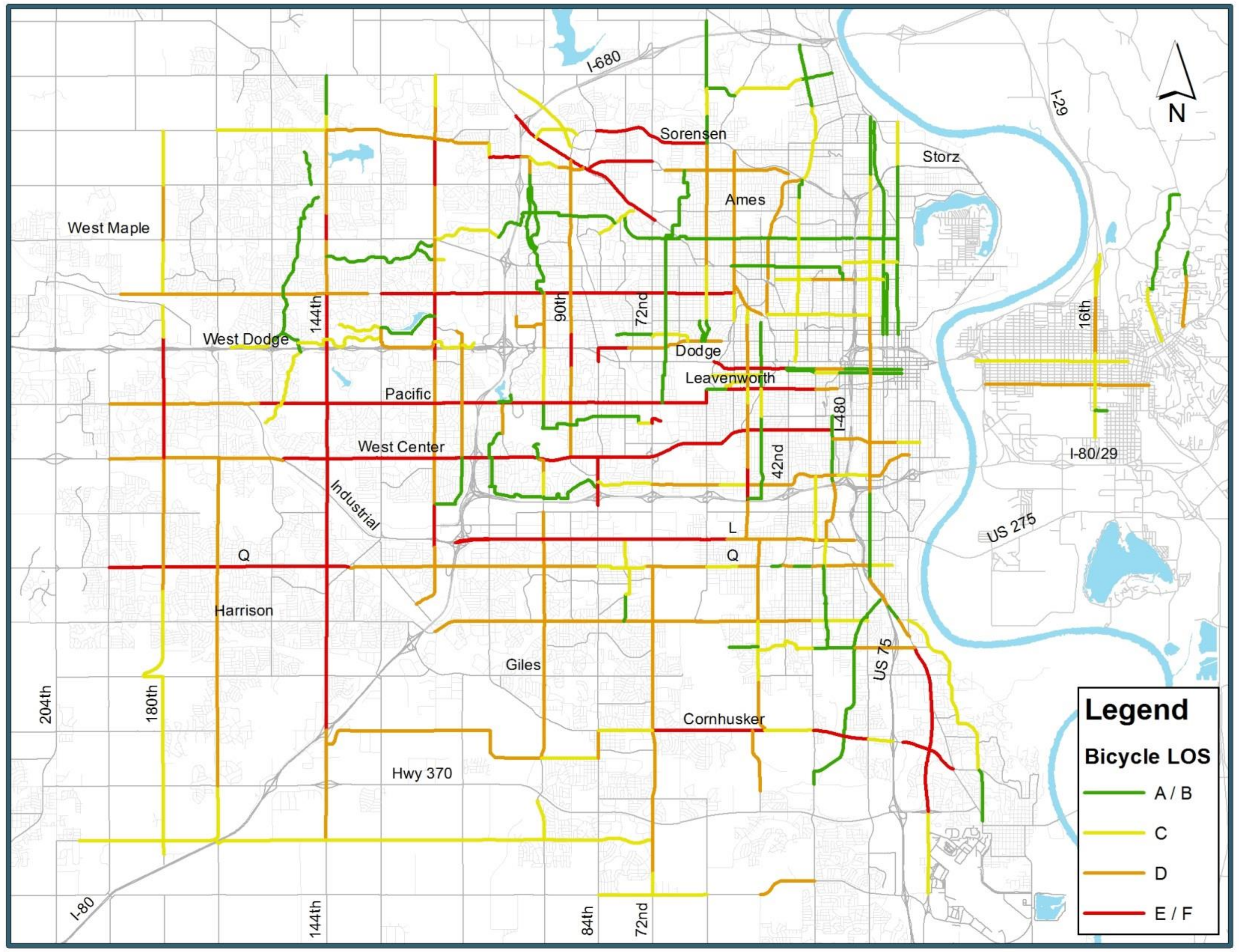
- While generally the arterial network has good pedestrian access levels, due to the lack of a grid pattern, there are access gaps between the neighborhood / subarea sidewalk and path system and the arterial system. This adds significant amounts of time and circuitousness to functional pedestrian travel.
- In many parts of the metro area, there are neighborhood / residential gaps in the sidewalk and side path system.

The noted challenges for the bicycle system included:

- System-wide lack of connectivity. The continuous routes that exist do not hit many of the major destinations in the metro area.
- Much of the street system is not conducive or friendly to biking. Large portions of the metro area have developed in ways that make identifying continuous bike-friendly corridors difficult.
- Many of the arterials in these less bike-friendly portions of the metropolitan area are not easily retrofitted without major reconstruction. Thus, as corridors are reconstructed, there are opportunities to better incorporate bicycle facilities into the street.

Challenges expressed in the *Heartland Connections Bicycle and Pedestrian Plan* were reiterated in an MTIS stakeholder workshop. Stakeholders noted that bicycle and pedestrian barriers exist at a number of interstate / freeway crossings.

Figure 11.2. On-Street Bicycle Level of Service



Source: Heartland Connections Bicycle and Pedestrian Plan

Bike System Accessibility

To understand how accessible the bicycle system is on a regional basis, estimates of the current number of households and employment located within ¼ mile and ½ mile of bicycle facilities were completed. **Table 11.2** shows the accessibility of households and jobs in the MAPA planning area to multiuse trails and bike lanes. Over time, the percentage of jobs and households with ¼ mile and ½ mile proximity to bicycle facilities will decrease with no change to the bicycle system.

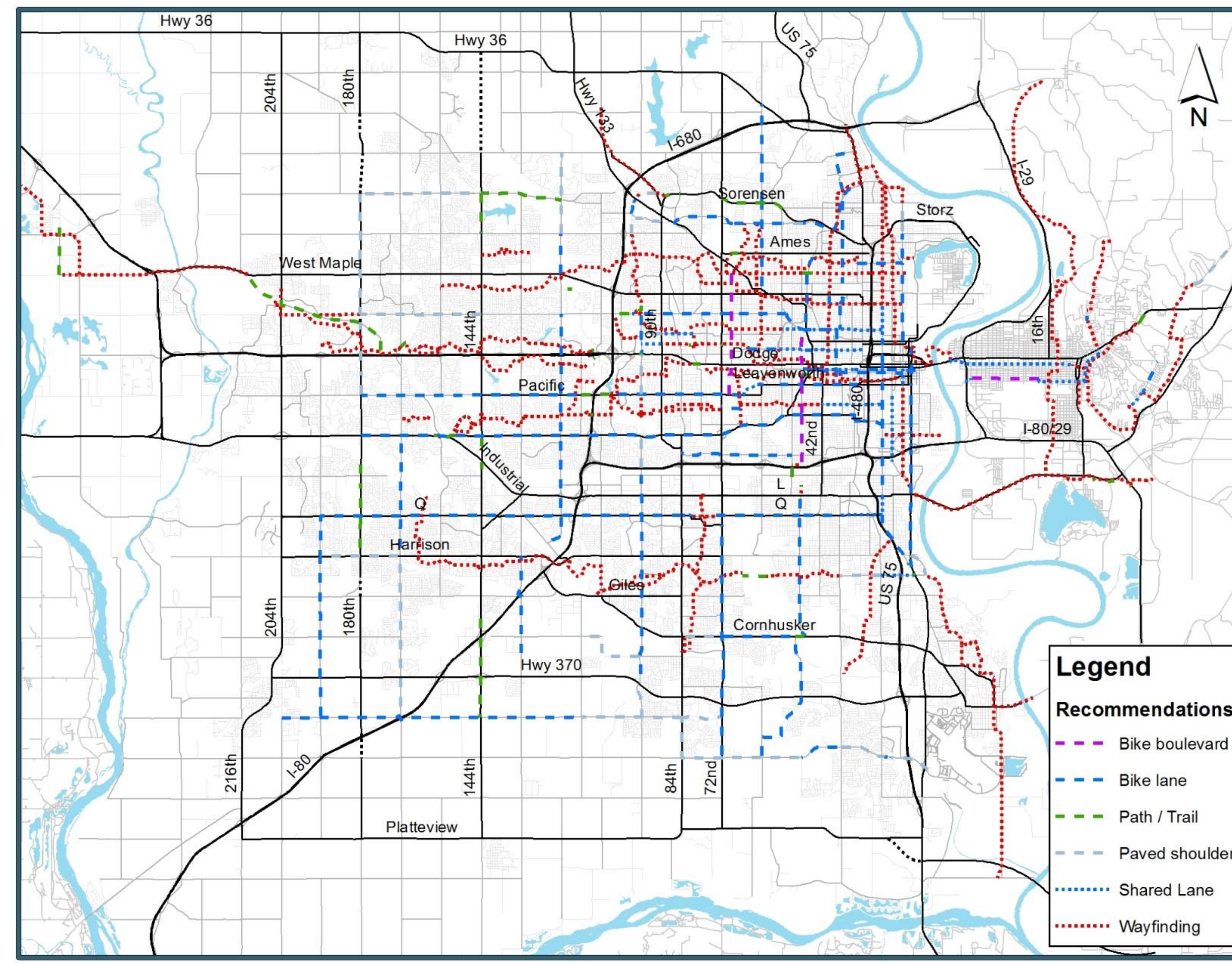
Planned Improvements

The *Heartland Connections Bicycle and Pedestrian Plan* provided some facility recommendations to improve bicycling and walkability in the study area. Those recommendations are prioritized in a phased (short-, medium-, and long-term) timeframe. The recommended projects are summarized in **Figure 11.3**.

Table 11.2. Current and Future Proximity to Trails and Bike Lanes for Households and Employment

Accessibility Measure	Scenario Year	Percent of Metro Total	
		Households	Employment
Within 1/4 Mile of Trails and Bike Lanes	2010	32.6%	38.2%
	2040	28.7%	34.7%
Within 1/2 Mile of Trails and Bike Lanes	2010	56.2%	61.5%
	2040	50.2%	57.2%

Figure 11.3. Pedestrian and Bicycle Facility Recommendations



Source: Heartland Connections Bicycle and Pedestrian Plan

Chapter 12 - Baseline Conditions for Other Performance Measures

System Reliability

Travel reliability captures the variability of travel time across a corridor. The more reliable a corridor, the less travel time varies from day to day. AASHTO's Standing Committee on Performance Measures (SCOPM) recommends using the Reliability Index (RI_{80}), which compares the 80th percentile travel time to a threshold time, or median time as applied for MTIS. The RI_{80} captures the variability a commuter might encounter during a single work week, producing a ratio of the worst travel time during a work week (80th percentile) to the typical daily travel time (median). It is intended to reflect the extra time a traveler should budget to account for recurring travel variability. For instance, for a typical 20 minute trip with an RI_{80} of 1.3, the traveler should budget an extra 30% travel time and allow for 26 minutes of travel time.

Travel reliability was measured for the major routes in the MAPA region which had available INRIX travel time data. The historical data were reviewed for completeness. The amount of historical data was somewhat limited as much of the data in key corridors for the MTIS study area has recently come "on line" for INRIX. Data for weekdays for the months of March, April, and November (2014) and March (2015) were used for this assessment. Data were assessed in 5-minute bins for the AM and PM peak periods. The 5-minute time bin with the highest RI_{80} levels for each peak period was reported. On a system wide basis, current peak RI_{80} levels are:

- Non-Freeways -
  - Urban: 1.17
  - Rural: 1.05
- Freeways -
  - Urban: 1.18
  - Rural: 1.03

Figure 12.1 illustrates the AM reliability levels by segment, and **Figure 12.2** illustrates the PM reliability levels by segment.

Nearly all of the routes covered by the INRIX data for calculating travel reliability were truck routes, so the overall system reliability data reflected in the figures are representative of truck reliability conditions as well.

Figure 12.1. AM Reliability Index Summary Map

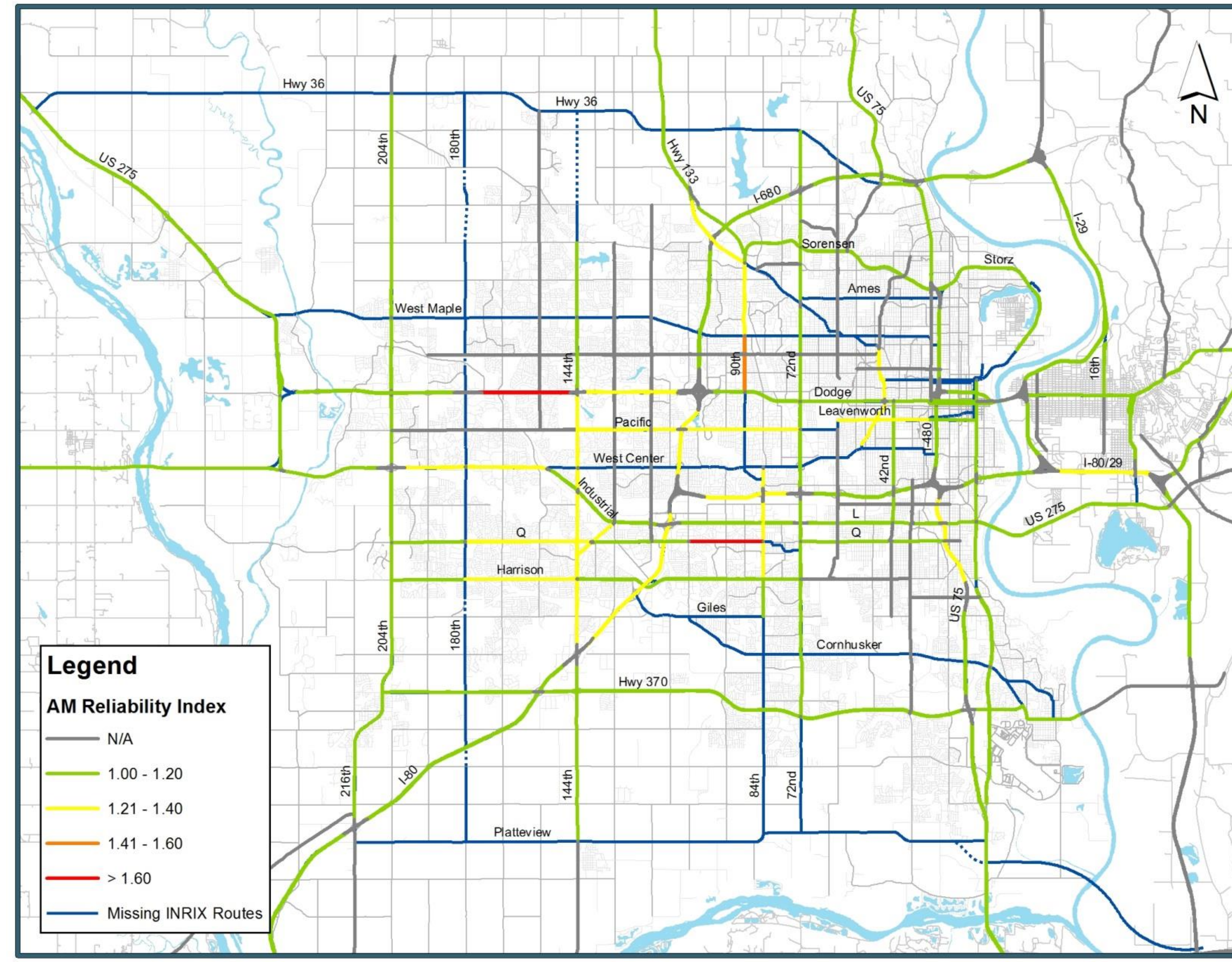
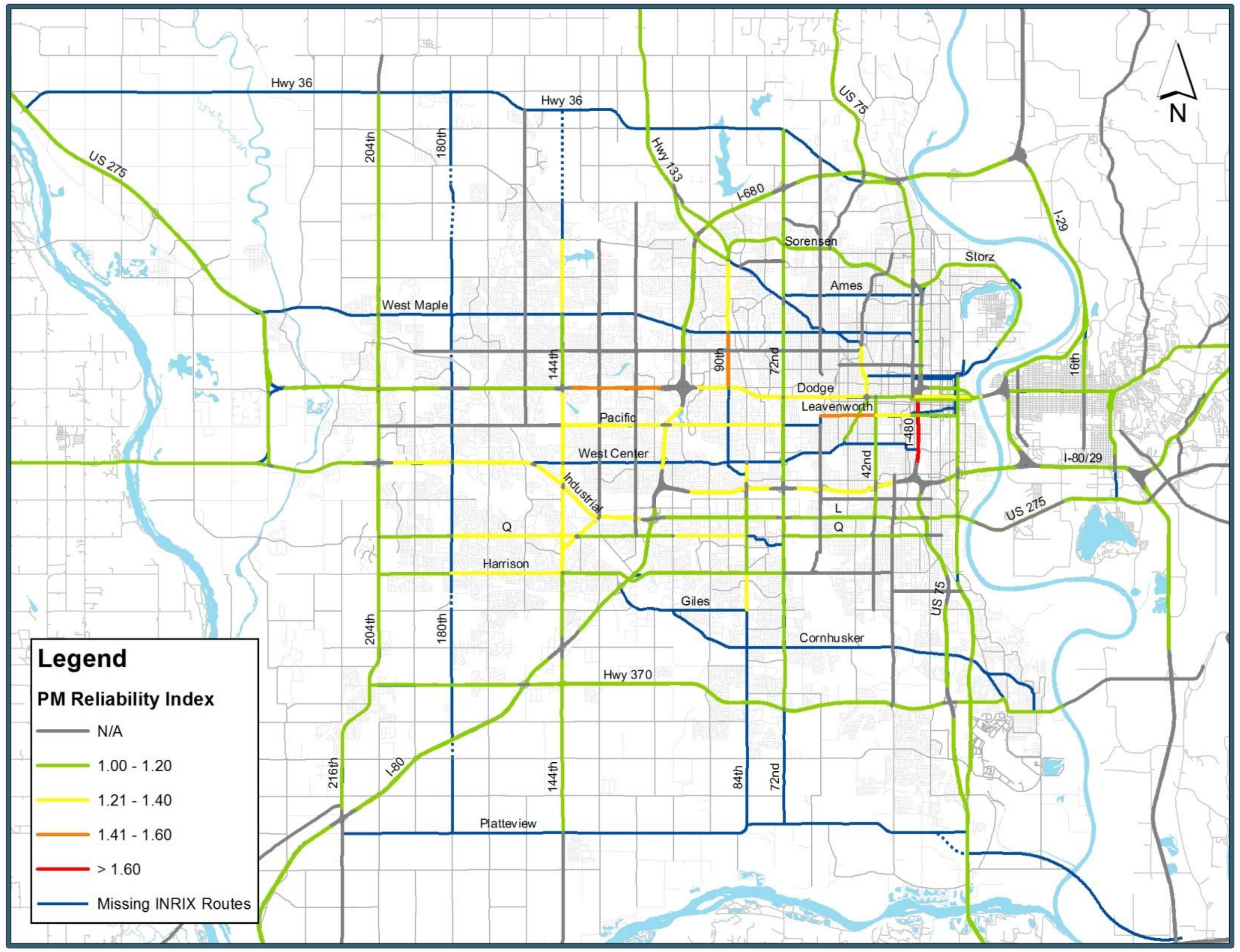


Figure 12.2. PM Reliability Index Summary Map



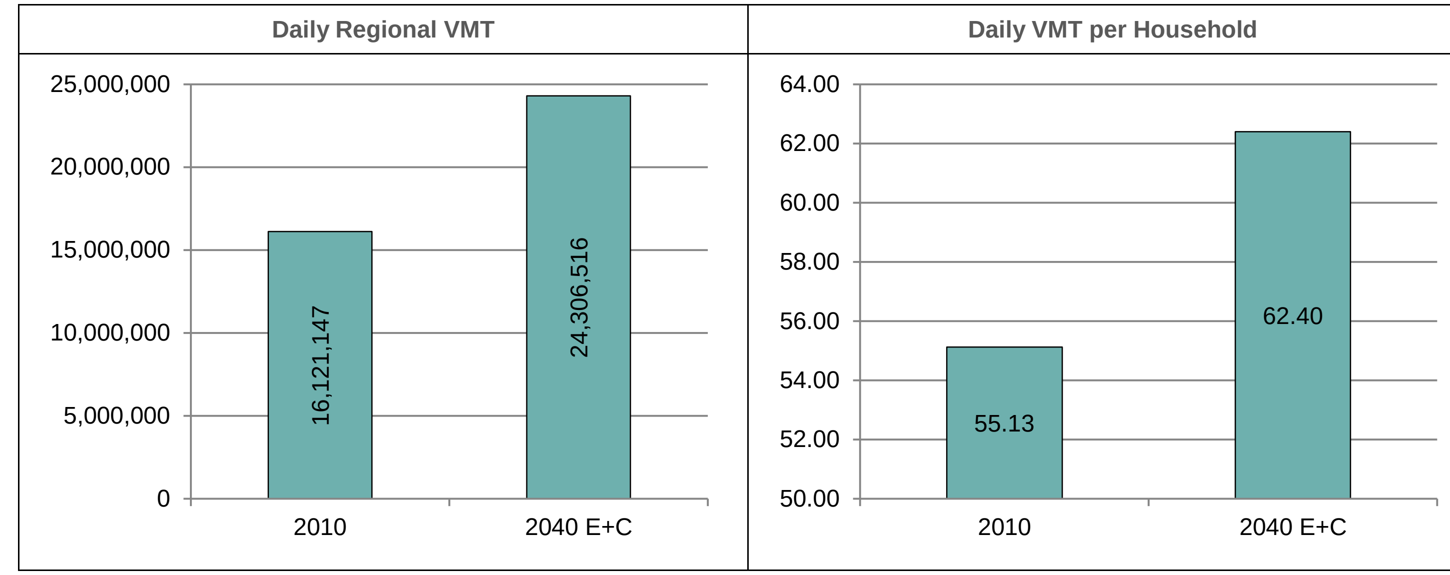
Vehicle Miles Traveled

Vehicle Miles Traveled (VMT) is the cumulative distance traveled by all vehicles in the metropolitan area. VMT was calculated with the MAPA travel demand model for existing (2010) conditions and the Future No-Build 2040 E+C scenario, which represents a scenario in which no improvements beyond the current TIP. VMT was calculated on the basis of:

- Total daily VMT for the region
- Daily VMT per household.

Figure 12.3 shows the VMT comparison. As shown, regional VMT is anticipated to increase by 51%, and by 13% per household.

Figure 12.3. Comparison of 2010 and 2040 E+C Estimated Daily VMT



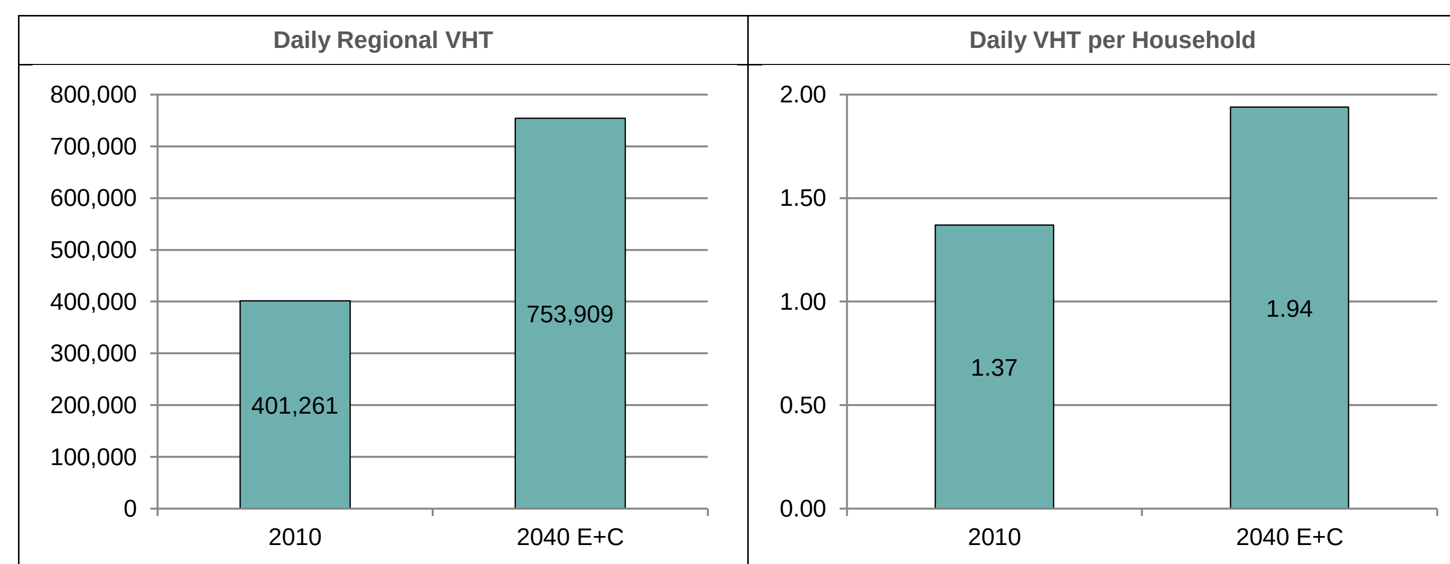
Vehicle Hours Traveled

Vehicle Hours Traveled (VHT) is the cumulative time spent traveling by all vehicles in the metropolitan area. VHT was calculated with the MAPA travel demand model for existing (2010) conditions and the Future No-Build 2040 E+C scenario on the basis of:

- Total daily VHT for the region
- Daily VHT per household.

Figure 12.4 shows the VHT comparison. As shown, regional VHT is anticipated to increase by 88%, and by 41% per household.

Figure 12.4. Comparison of 2010 and 2040 E+C Estimated Daily VHT

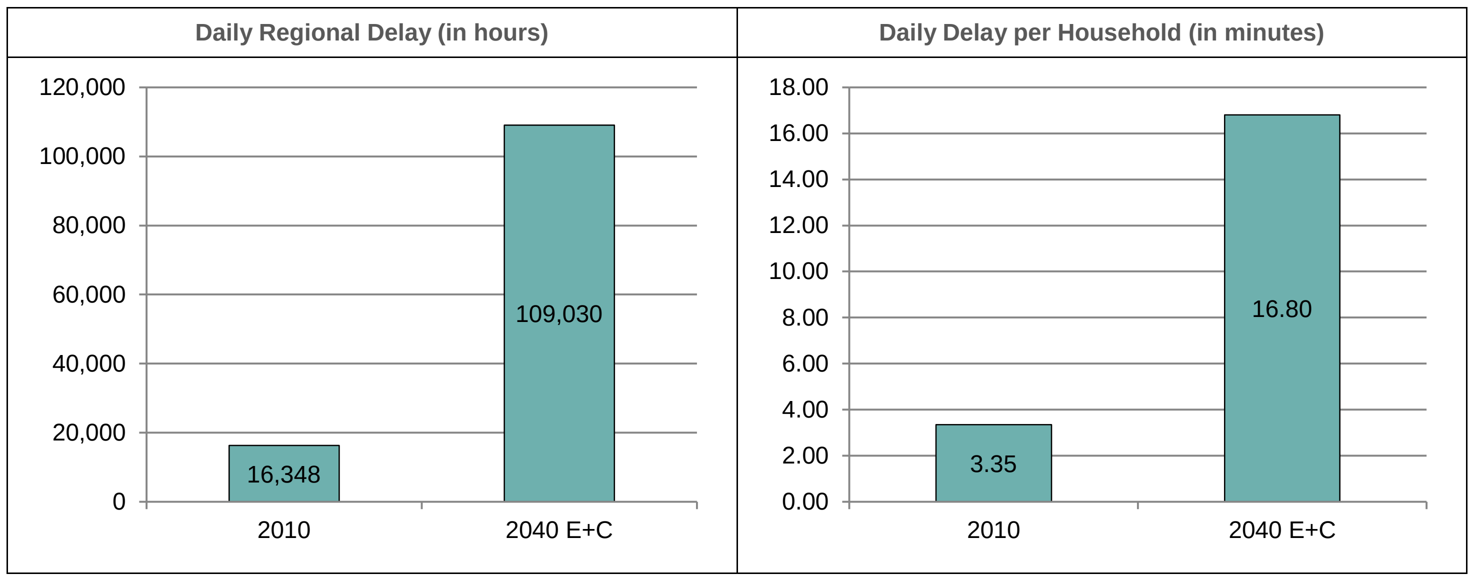


Delay

Delay is the cumulative "extra" time spent traveling due to congestion during peak travel times. For this study, delay was calculated by comparing the congested travel time estimated by the MAPA travel demand model for a scenario, compared to a congestion threshold for the region. Various congestion thresholds can be defined, but for the purposes of this study the threshold is "free-flow" travel time in the absence of any congestion at normal travel speeds.

Figure 12.5 shows the delay comparison. As shown, regional delay is anticipated to increase by 567%, and by 401% per household.

Figure 12.5. Comparison of Existing 2010 and Future No-Build 2040 E+C Estimated Delay

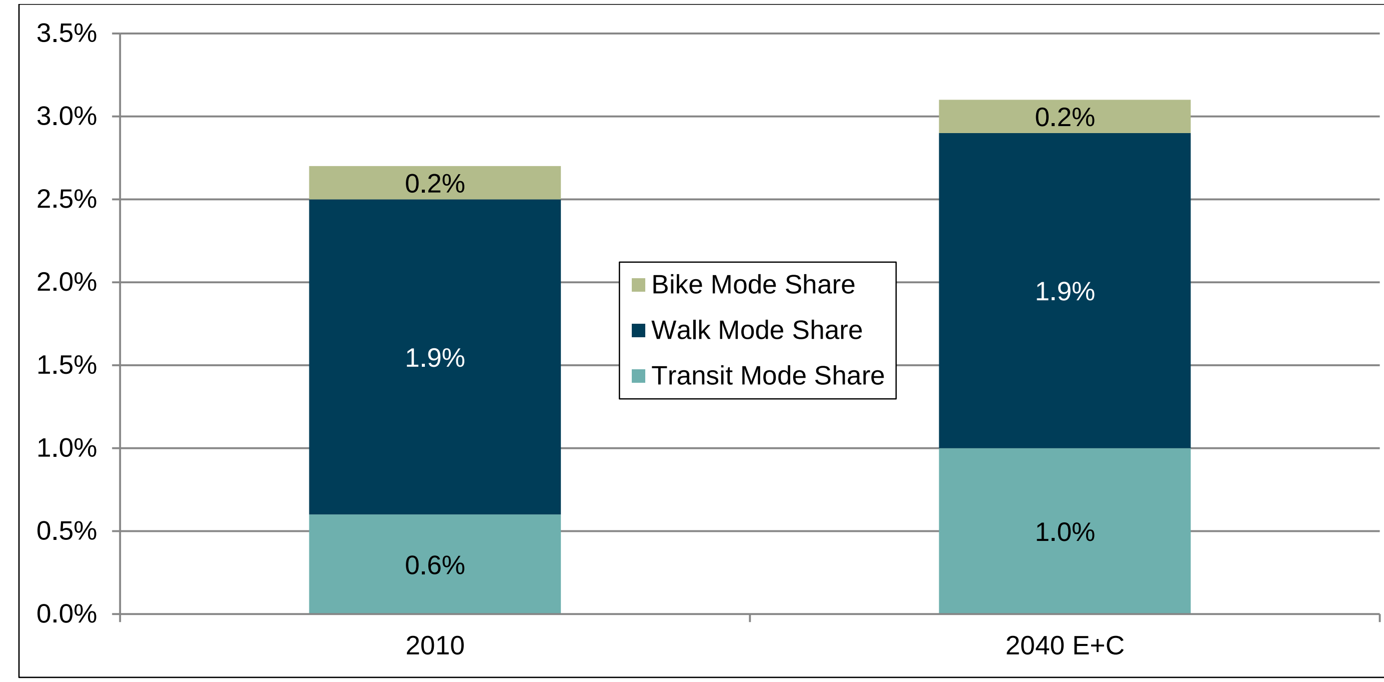


Regional Mode Share

Regional mode share estimates were established to determine what portion of all trips were made by transit. The mode share data were developed by comparing the level of transit trips to all modal trips forecasted by the travel demand model, and by incorporating available American Community Survey (ACS) data to account for walking and biking trips (which are not explicitly forecasted in the MAPA model). The MAPA model does not have a validated walk or bike mode share element. The current levels of walking and biking reported in the ACS were carried forward and assumed constant through 2040.

Figure 12.6 shows estimated mode share for Existing 2010 and Future No-Build 2040 E+C scenarios. The travel demand model was used to forecast current and future transit mode share, while bicycle and pedestrian mode shares were assumed consistent through 2040 for the Future No-Build E+C condition.

Figure 12.6. Comparison of Existing 2010 and Future No-Build 2040 E+C Estimated Mode Share



Access to Jobs

One of the key functions of a transportation system is to facilitate connections between home and work for commuters. This measure looked at the percentage of model regional employment within a specified travel time threshold. Household and employment data from Traffic Analysis Zones (TAZ) in the MAPA travel demand model was utilized for this analysis. Access to jobs was measured in two different ways:

- Percentage of employment within a 15 minute automobile drive. This is the total travel time via automobile estimated between the home place and the employment place. This computation was carried out for every TAZ in the model.
- Percentage of employment within a 60-minute transit trip. This is measured for walk-access (trips where riders walk to the bus stop). The transit trip considers the combined total travel time of the trip, not just the time spent on the transit vehicle.
    - *Access Time* - this is the time spent walking between trip origin (often home) and the bus stop.
    - *Wait Time* - this is the time spent waiting at the transit stop for the transit vehicle. Note that in the MAPA model, wait time is assumed to be half of the "headway", or the amount of time between transit vehicles arriving at the stop.
    - *In-Vehicle Travel Time* - this is the time spent traveling between the two transit stops on the transit vehicle.
    - *Egress Time* - this is the time spent walking to the trip destination, after the traveler has exited the transit vehicle.

Each access to jobs measure can be used for performance assessment at two levels:

- On a TAZ by TAZ basis, by developing the level of access for each TAZ.
- As a system-wide average, to compare the level of system access by scenario.

Figure 12.7 illustrates the percentage of regional jobs accessible within a 15-minute automobile trip for existing conditions in 2010. **Figure 12.8** shows the same 15-minute auto accessibility measure for Future No-Build 2040 E+C conditions.

The system-wide averages for auto accessibility are:

- Existing 2010: 47.6% jobs within 15-minute auto trip
- Future No-Build 2040 E+C: 36.9% jobs within 15-minute auto trip

Figure 12.7. Percentage of Regional Jobs Within 15 Minutes by Auto, Existing 2010

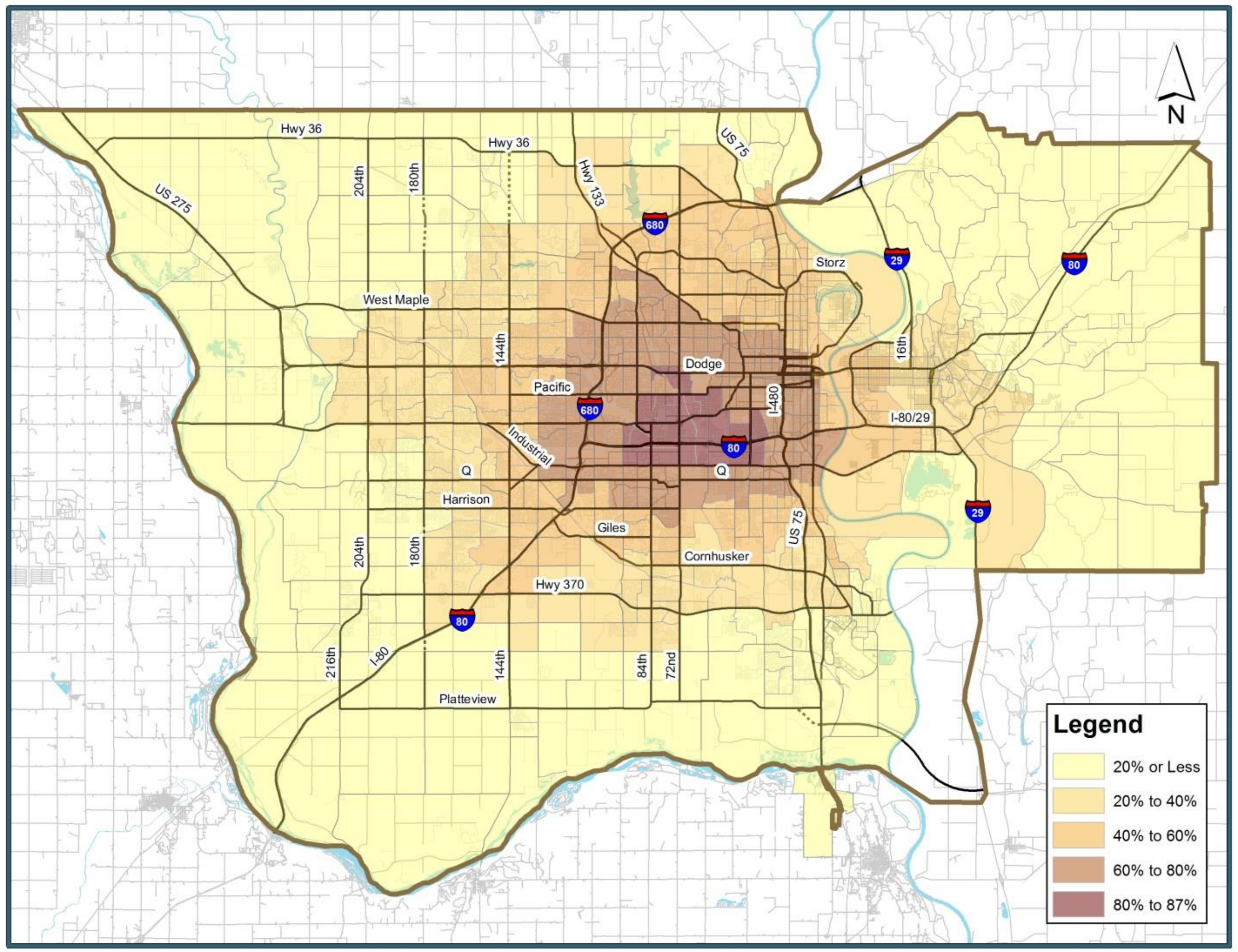


Figure 12.8. Percentage of Regional Jobs Within 15 Minutes by Auto, Future No-Build 2040 E+C

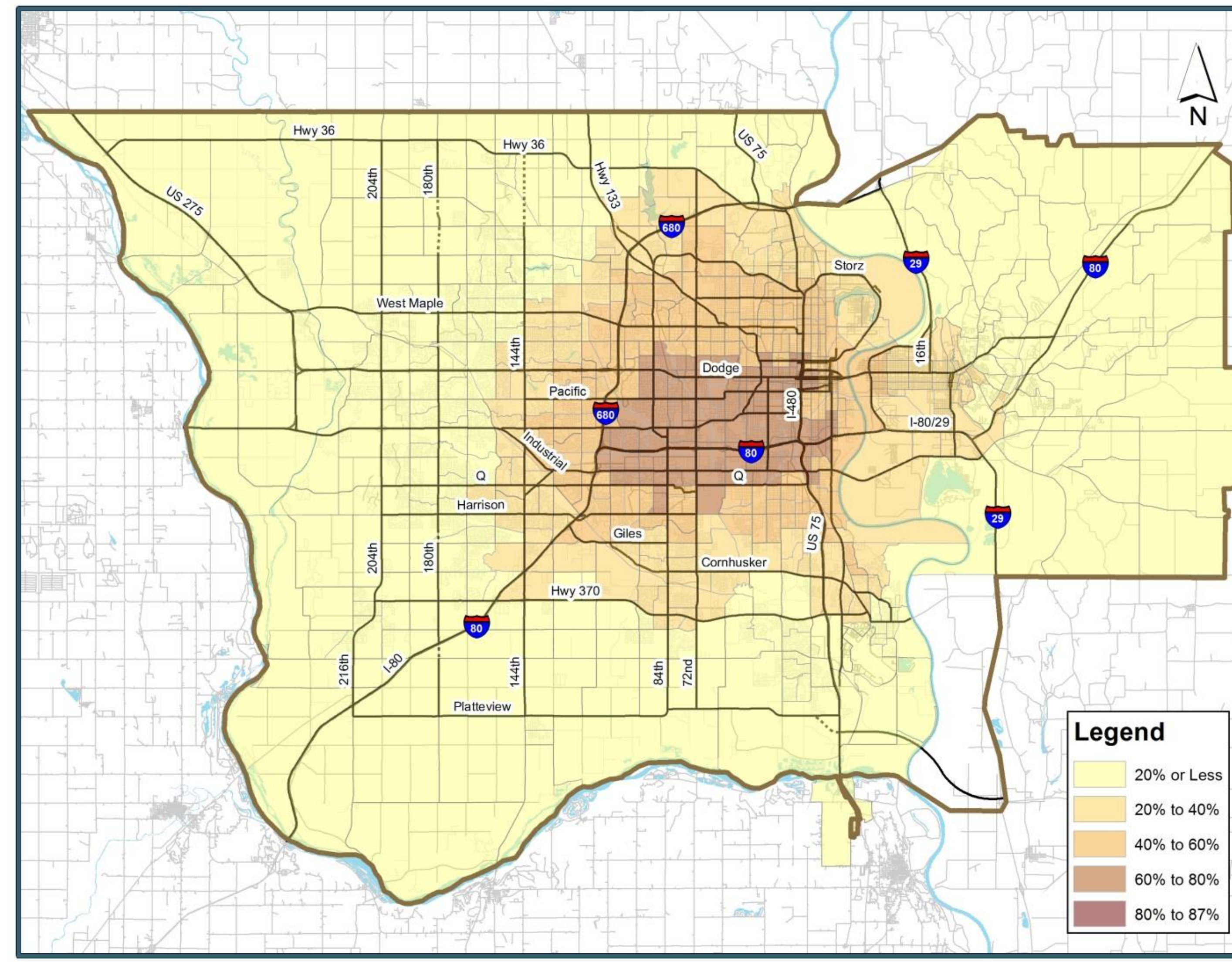


Figure 12.9 shows the percentage of regional jobs accessible within a 60-minute total transit trip for existing conditions in 2010. **Figure 12.10** shows the same 60-minute transit accessibility measure for Future No-Build 2040 E+C conditions.

The regional averages for transit accessibility are:

- Existing 2010: 7.0% of jobs within a 60-minute total transit trip
- Future No-Build 2040 E+C: 8.6% of jobs within a 60-minute total transit trip

Figure 12.9. Percentage of Regional Jobs Within 60 minutes by Transit, Existing 2010

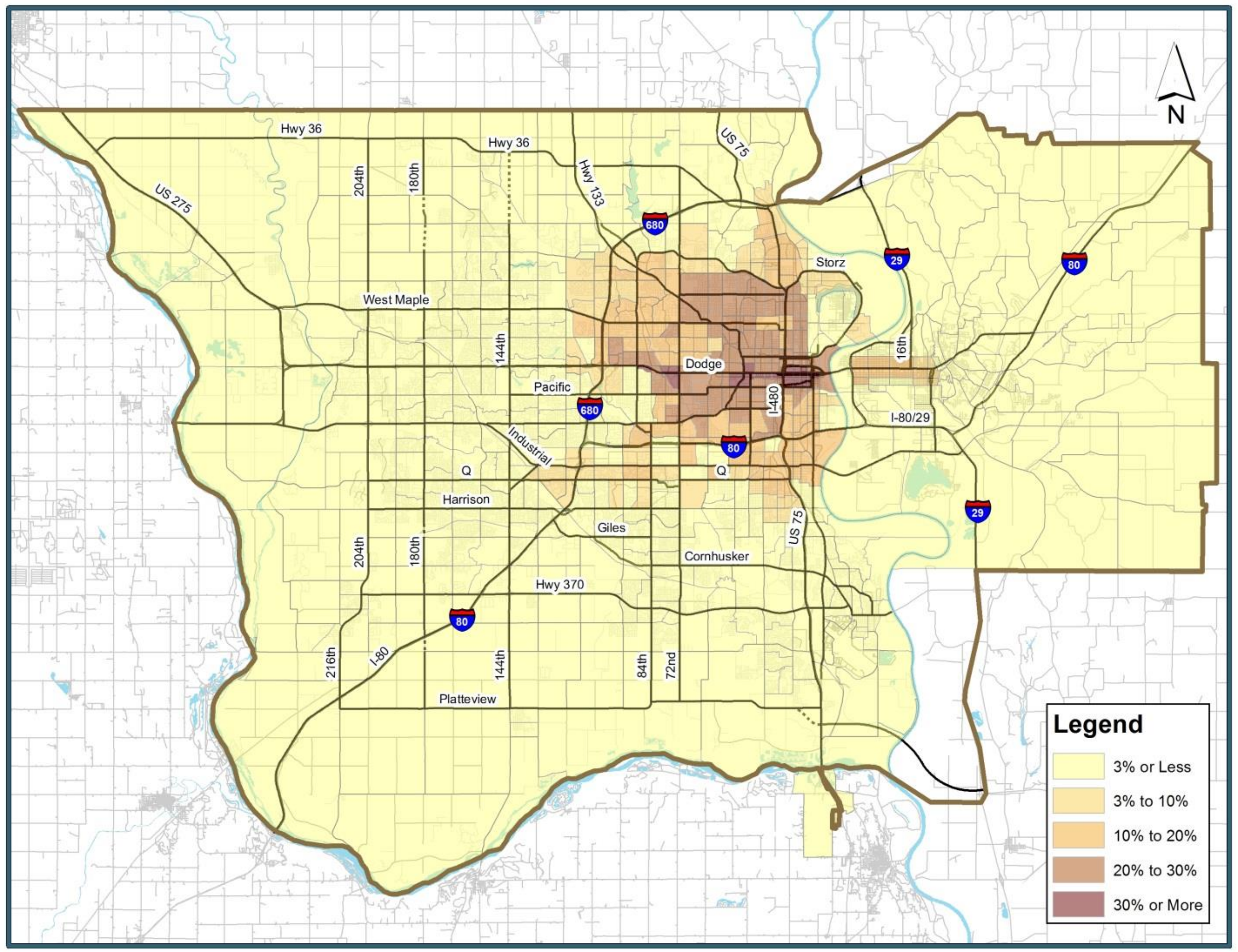
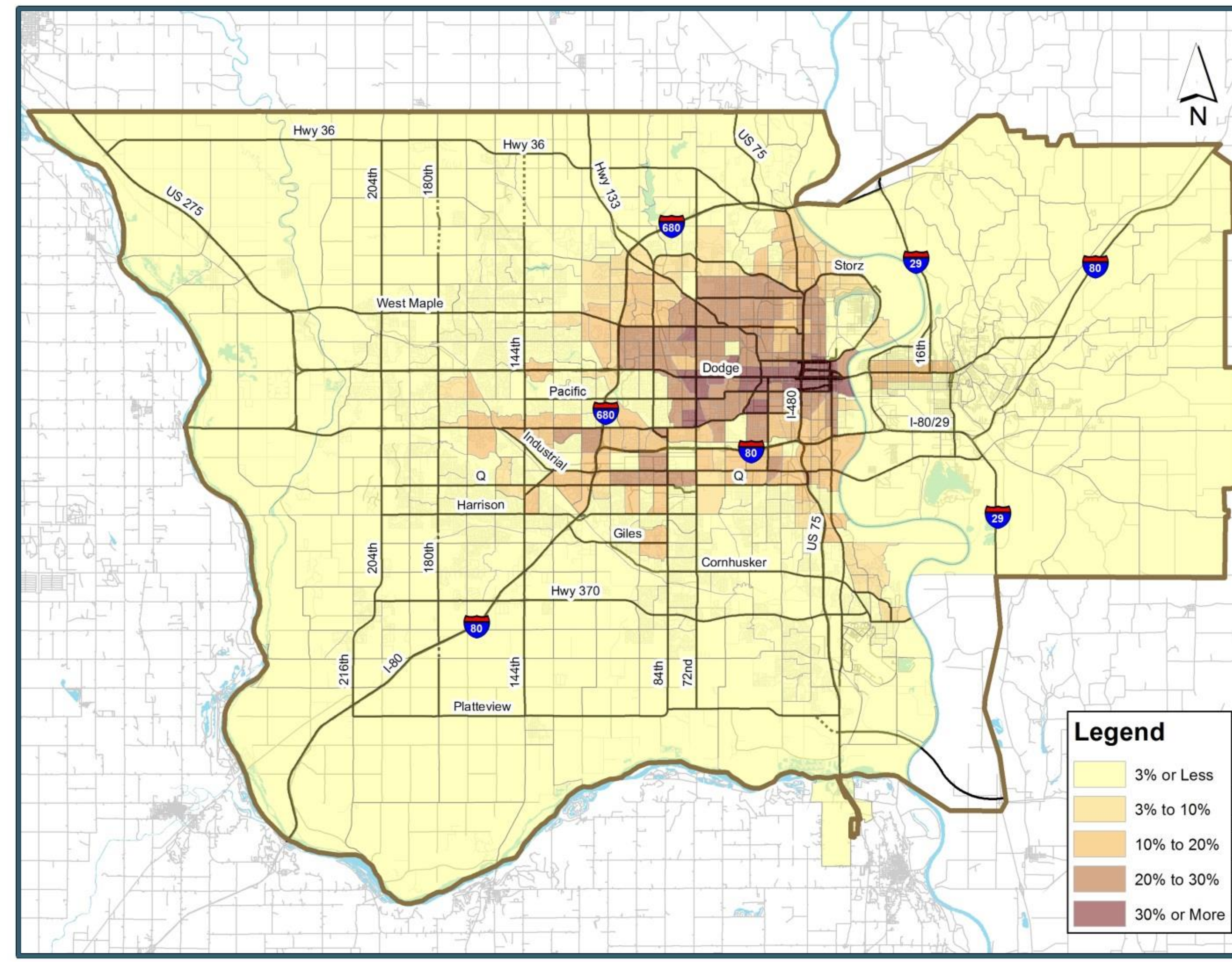


Figure 12.10. Percentage of Regional Jobs Within 60 Minutes by Transit, Future No-Build 2040 E+C



Environmental Justice Access to Jobs

Access to jobs for Environmental Justice (EJ) populations was evaluated in a manner similar to that used for the overall population. Environmental Justice is intended to ensure that Federal actions treat all populations equally, and was introduced into federal actions and funding by the Executive Order 12898 of 1994. Environmental Justice directs federal agencies to identify and address the effects of its programs, policies, and activities on "minority populations and low-income populations". For the purposes of this study, Environmental Justice is used as a reference for ensuring equal access to transportation systems and providing additional consideration for transportation improvements and programs that benefit Environmental Justice populations. **Table 12.1** provides the summary of employment accessibility for all EJ and all regional TAZs. The accessibility numbers presented reflect the average TAZ's percentage of regional jobs that are within 15-minute auto trip or 60-minute transit trip.

Table 12.1. Average Percentage of Regional Job Accessibility for EJ and All Regional TAZs

Job Access Measure	Job Accessibility All Regional TAZs		Job Accessibility EJ TAZs	
	2010	2040	2010	2040
Within 15 min. by Auto	47.6%	36.9%	47.5%	53.4%
Within 60 min. by Walk to Transit	7.0%	8.6%	13.6%	19.6%

Environmental Justice Proximity to Transit

Proximity to transit for EJ populations was evaluated in a manner similar to that used for the overall population. The results of the comparison of EJ transit proximity and the regional average proximity is shown in **Table 12.2**.

Table 12.2. Average Proximity to Transit for EJ and All Regional TAZs

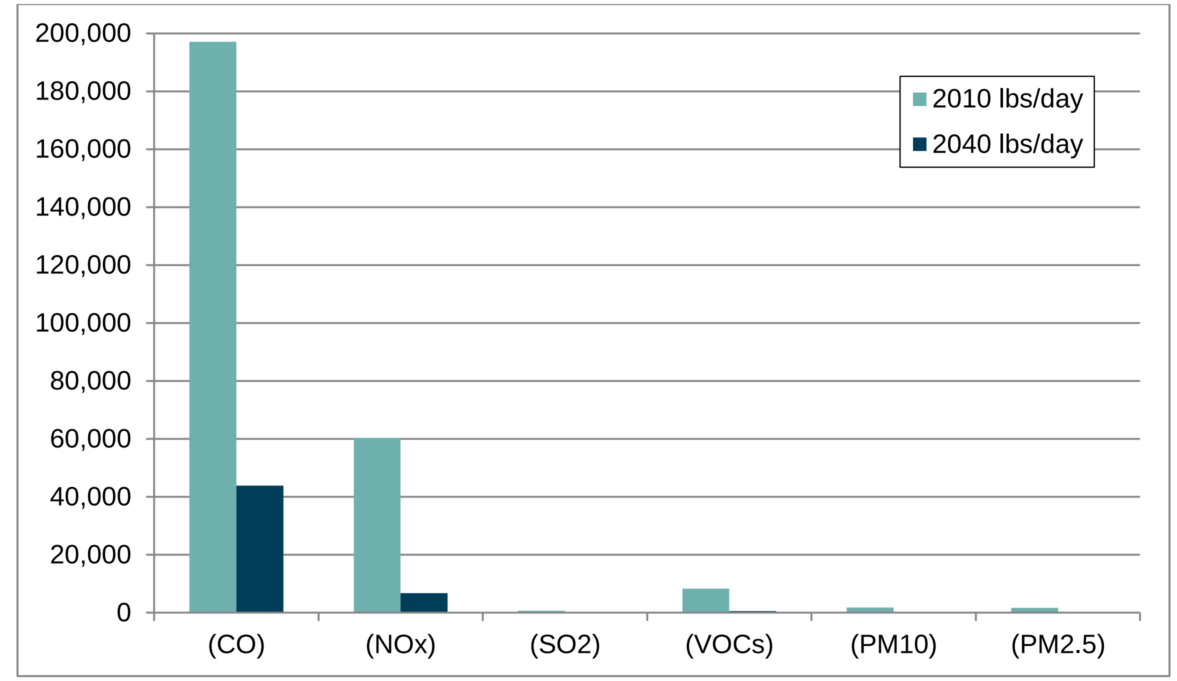
Transit Proximity Measure	Proximity - All Regional TAZs	Proximity - EJ TAZs
Within ¼ mile of local transit	32.3%	74.1%
Within ½ mile of local transit	45.3%	89.3%

Criteria Pollutant Emissions

Estimates of the pollution emissions from the study area motor vehicle fleet were completed through application of the MOVES software and MAPA's regional travel demand model. The MOVES software was applied for Douglas, Sarpy and Pottawattamie Counties, to develop the appropriate emissions inventories for each criteria pollutant. The results provided Existing 2010 and Future No-Build 2040 E+C scenario emissions rates for each mile of travel at various travel speeds. Those rates were applied to the travel demand model output for the appropriate model scenario.

The results of the criteria pollutant emissions estimates for 2010 and 2040 are shown in **Figure 12.11**. As shown, despite travel mileage and congestion increasing by 2040, the total vehicle emissions forecasted for the study area decline by 2040. This decline is a function of the significant decline in per-mile emissions rates for each mile traveled by 2040 due to improved emissions efficiency in the vehicle fleet.

Figure 12.11. Daily Transportation Pollution Emissions for Existing 2010 and Future No-Build 2040 E+C



Chapter 13 - Needs and Areas for Further Study

The needs identified herein represent areas/components of the study area that do not the meet the evaluation criteria or performance measure targets that have been developed for MTIS and are thus worthy of further study. This is not to suggest that all of the identified needs "must" be addressed or mitigated. In some cases, the identified needs might be better described as "wants" or "opportunities for improvement". For example, the Safety Assessment (Chapter 9) identified "locations with the greatest potential for safety improvement" while the Pavement/Bridge Assessment (Chapter 6) identified "current short/near-term recommendations". In addition, the alternatives and strategies that will be evaluated in Phase 2 will primarily be evaluated against system or regional performance measures. Thus, it will be possible that the regional plan that is ultimately recommended will meet regional performance measure targets without addressing all of the needs identified in this chapter.

Per direction from the Management Committee, the following assessments were used to identify the study area needs that will be addressed in Phase 2:

- Pavement Conditions
- Bridge Conditions
- Traffic Operations
- System Discontinuities / Access Gaps
- Safety

Note that the findings in Chapter 5 (Freeway System Geometry and Operational Features) were not directly used to identify needs. However, those segments of the study area that were identified as "poor" for various geometric criteria will be cross-checked with the findings from the other assessments to determine if the geometric conditions could possibly be contributing to other identified needs (i.e., could a substandard horizontal curve be a contributing factor to congestion or crashes?)

The study area needs are shown graphically in the following figures:

- **Figure 13.1**: Pavement and Bridge Needs (Existing)
- **Figure 13.2**: Traffic Operational Needs (Future No-Build 2040 E+C)
- **Figure 13.3**: Discontinuities / Access Gaps (Existing)
- **Figure 13.4**: Locations with the Potential for Safety Improvement (Existing)

Tabular summaries of the study area needs are provided in **Table 13.1** through **Table 13.3**.

Table 13.1. Summary of Pavement & Bridge Needs (Existing)

Type	Percent of Studied Lane Mileage (or Count)
Pavement	9.7%
Bridge	3.5%

Table 13.2. Summary of Traffic Operational Needs (Future No-Build 2040 E+C)

Facility Type	Percent of Studied Mileage (or Count)
Freeway Segments	34%
Ramp Terminals	29%
Arterial Segments	35%
Arterial Intersections	43%

Table 13.3. Summary of Safety Needs (Existing)

Facility Type	Percent of Studied Mileage (or Count)
Freeway Segments	12%
Ramps (Interchanges)	34%
Ramp Terminals	12%
Arterial Segments	18%
Arterial Intersections	22%

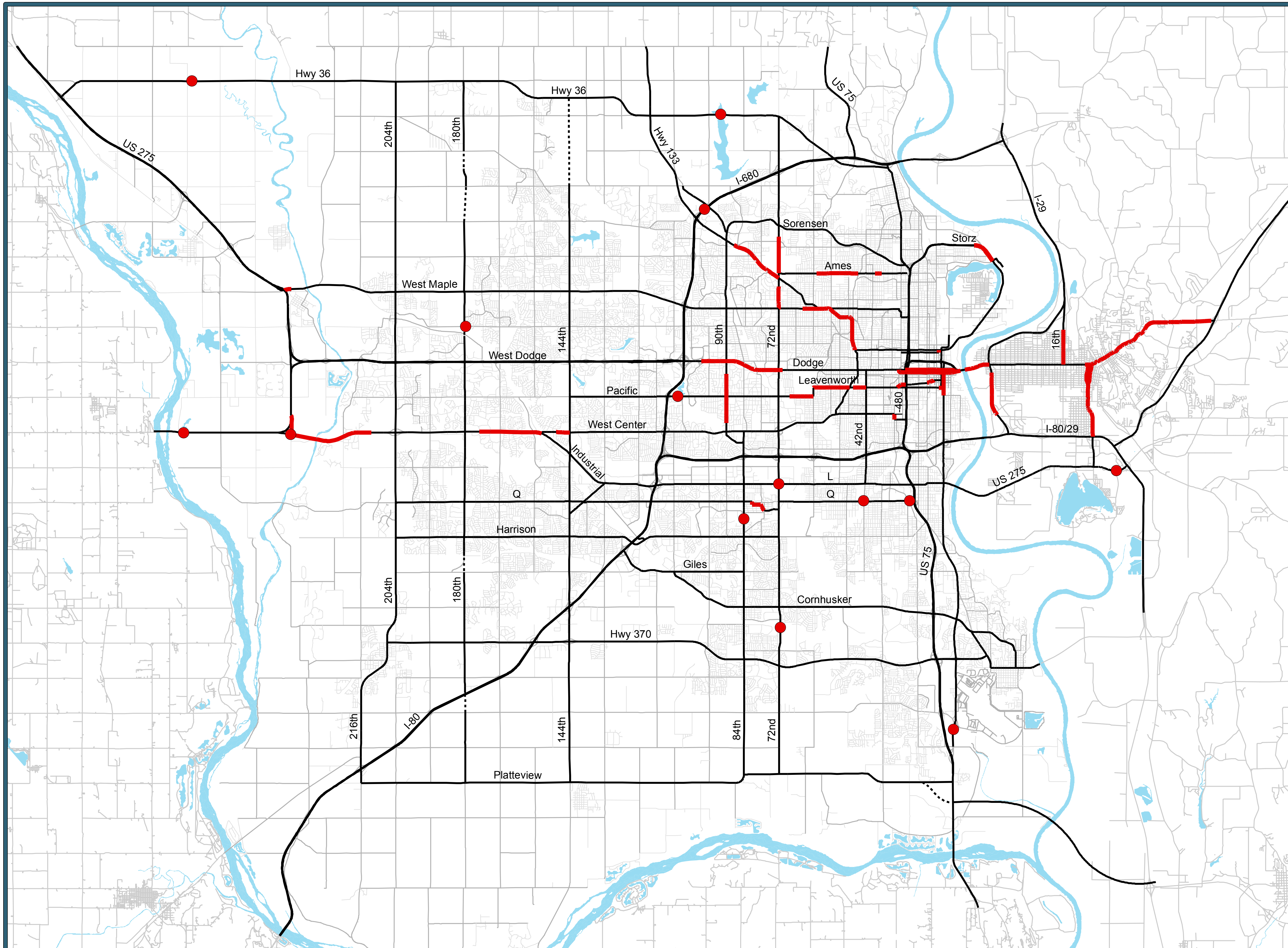


Figure 13.1: Pavement & Bridge Needs (Existing)

Legend

- Bridge Needs
- Pavement Needs

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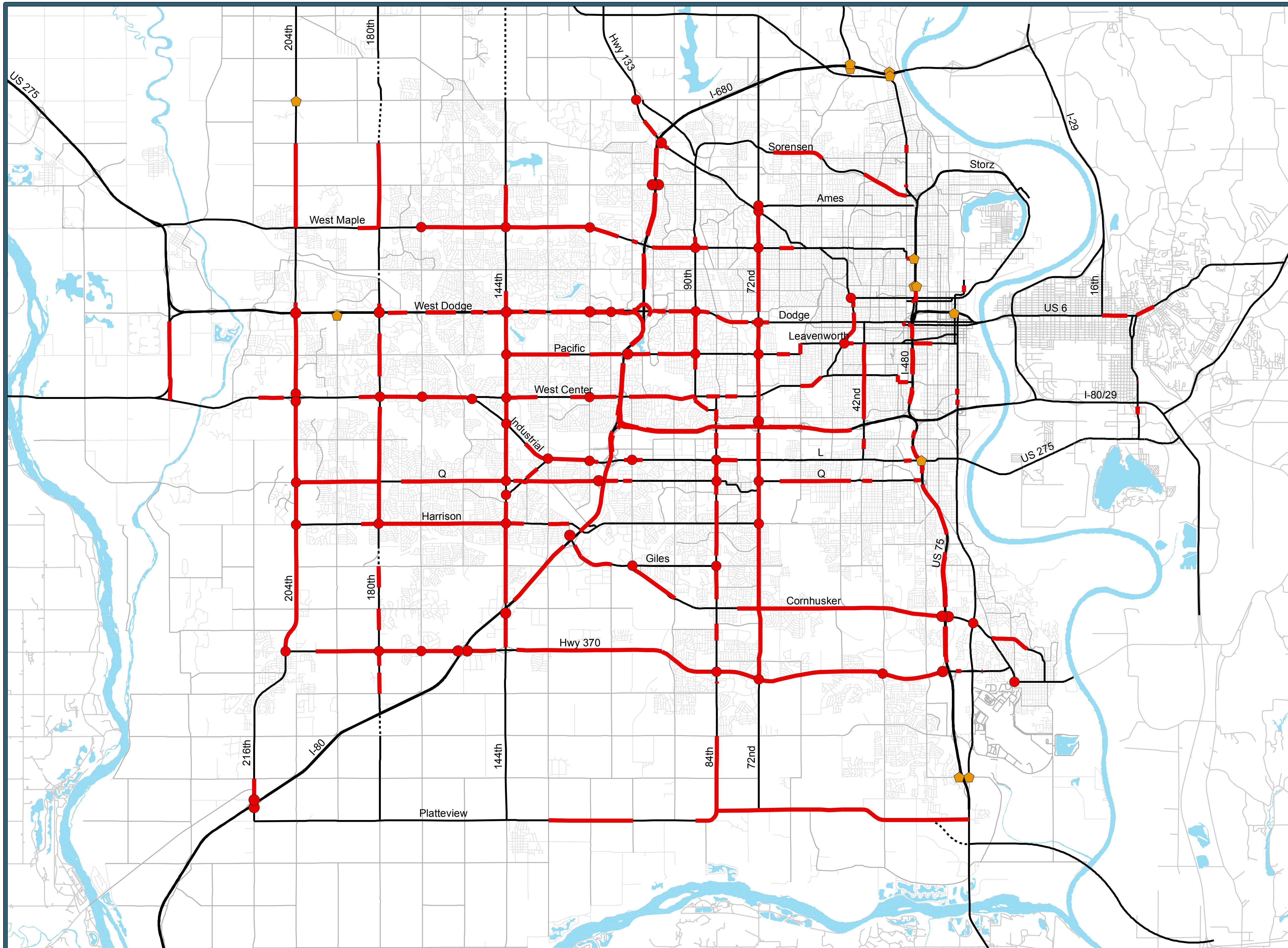

Figure 13.2: Traffic Operational Needs (Future No-Build 2040 E+C)

Legend

Needs

- Signalized
- Unsignalized
- Segment Needs

Needs based on:
- *HCM LOS 'E' or 'F'*
- *V/C ratios > 0.9*

Unsignalized intersection needs would likely be mitigated by signalization.

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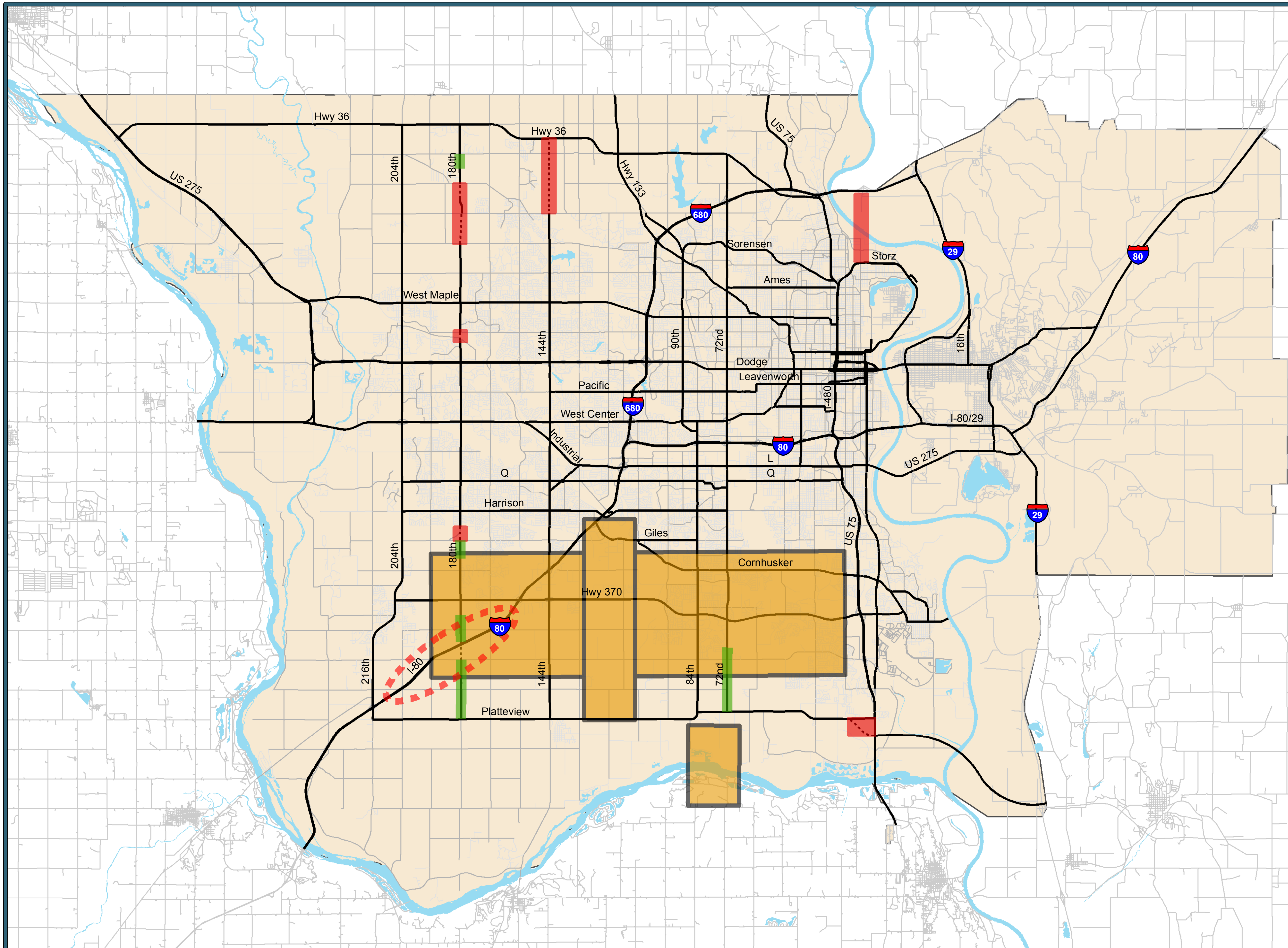
Figure 13.3: Discontinuities / Access Gaps (Existing)



Legend

- Gravel Roads
- Gap Needs
- Potential New Corridor
- Study Routes
- Future Routes
- MTIS Study Area

N

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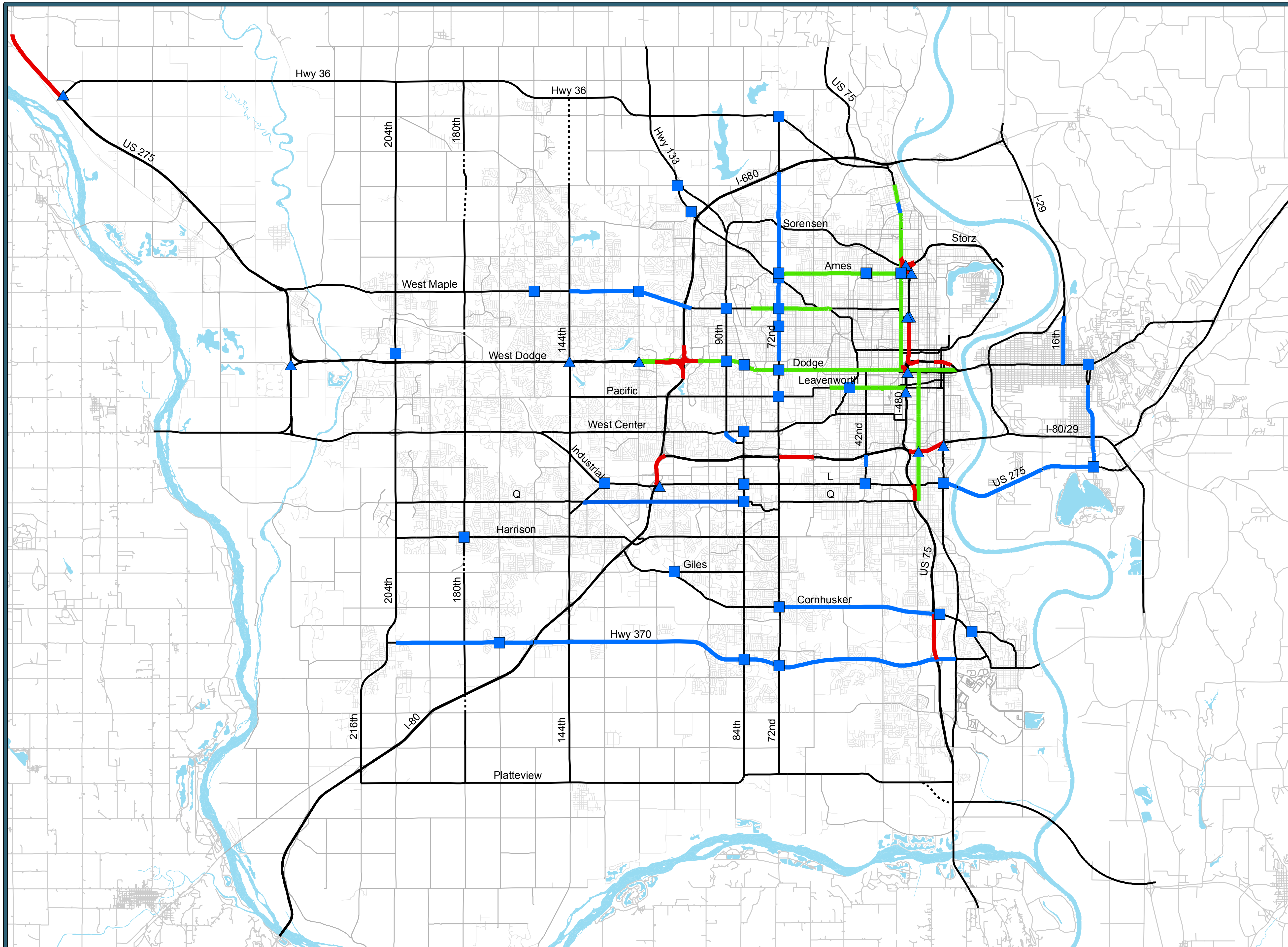
Figure 13.4: Locations with the Potential for Safety Improvement (Existing)



Legend

- Freeway/Ramp Segments
- Arterial Segments
- Arterial Intersections
- Ramp Terminals
- Pedestrian Corridors
- Study Roadways

N

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Chapter 14 - Funding Sources and Levels

This chapter provides and overview of traditional and innovative funding sources for consideration in the MTIS study area.

Traditional

Highway Trust Fund (HTF)

Started in 1956 by an act of congress, the Highway Trust Fund was how America built her Interstate System. The Fund was to be used exclusively for highway construction and maintenance. Set to expire in 1972, Congress renewed the act due to the continually changing landscape of America including more Americans owning cars and travelling longer distances.

In 1983, Congress expanded the reach of the HTF from being exclusively for roadways to allowing some of the funding to go to building Bike and Pedestrian paths and Freight and Passenger Trains with the creation of the Mass Transit Account. The Highway Account and the Mass Transit Account helped DOTs across the country build roads and tracks to move the growing, mobile population of the country.

HTF was funded exclusively form highway-user fees. These include motor fuel taxes, which constitute about 83% of the fund, and various truck related taxes such as the Heavy Vehicle Use tax and the Tire Tax. The idea of the fund was that it would be a user-supported fund, i.e., the highway users would pay for the construction and preservation of the highways they were using.

The HTF, however is on decline due in large part to the gas tax not being increased in over 20 years (1993) and the Fund's increasing reach. There were also decreases in gas used during the 2008 recession and with the increase in gas prices in the past years. Congress has directed monies from the General Fund (GF) to keep the HTF from going insolvent.

The Highway Trust Fund with its different accounts, Surface Transportation (STP) funds, and State Bridge Program Funds have been one of the most common funding methods for DOTs across the county. Nebraska has used other methods, detailed below, as well to fund their highway projects.

Other Traditional Funding Sources

Distribution of State Highway Allocation Funds: These funds have been sourced from numerous state taxes including (but not limited to): State Motor Fuel Tax, State Sales Tax on sales of motor vehicles, and the State Motor Vehicle Registration Fee, through the State Highway Trust Fund.

Distribution of Motor Vehicle Fee Proceeds, which replaced the Personal Property tax on motor vehicles.

Federal Highway Safety Improvement Program (HSIP) Funds: Where funding can be used to correct or improve hazardous road locations.

Because of the decline in the reserves of many of the traditional funding sources, DOTs are beginning to explore other funding and financing options.

Innovative

State Infrastructure Banks (SIBs)

Nebraska's SIB was started in 1997 as one of the NHS's State Infrastructure Bank pilot programs. State Infrastructure Banks work like a private bank with the ability to give loans for both federal and non-federal highway, transit, or rail projects in their state.

The original capitalized money was federal money provided by the pilot program from various federal programs and grants including the Highway System Program, the Surface Transportation Program, and the Urbanized Area Formula Grants. States were required to match the federal money capitalized on an 80/20 Federal to non-federal basis excepting highway projects which have a sliding scale match. As the project loans are repaid, new loans and capital can be issued. This allows the state more leeway in selecting projects.

The state can issue a variety of assistance to projects. Under the heading of loans, SIBs can issue **loans** at subsidized rates with flexible repayment options, **Grant Anticipation Notes (GANs)**, **Short-term construction financing**, **Long-term debt financing**, and **Certificates of Participation**. SIBs can also provide Credit Enhancements to projects which include: **Lines of Credit**; **Letters of Credit**; **Bond Insurance**; and **bond or debt instrument financing**.

Legislative Bill 626 of the 104th Nebraska Legislature

As of May 2015, this bill is still in committee.

The Bill would create a Nebraska Bridge Infrastructure Bank Fund similar to the SIBs, but to be used exclusively for bridges. The new fund would change the current motor vehicle tax, fee, and registration amounts to an as yet unspecified amount. The monies from those taxes and fees would be funneled into the Bank Fund. The Bill would also appropriate an as yet unspecified amount from the General Fund to the Bank Fund for FY 2015/2016 and FY 2016/2017.

TIFIA Loans: Transportation Infrastructure Finance and Innovation Act

TIFIA Loans are credit assistance for nationally or regionally significant transportation projects. These loans can be compared to student loans but for roads; low interest rates, long terms. Current fixed interest rates are at 2.98% for 35 year term.

There are three main kinds of TIFIA Loans: Secured (Direct) loans, Loan Guarantee, or Standby Line of Credit. **Secured (Direct) loans** have a maximum term of 35 years from substantial completion. Repayments start up to five years after substantial completion with flexible payments throughout the lifetime of the loan. **Loan Guarantees** provide full-faith-and-credit guarantees by the federal government. Repayment for loan guarantees are to start no later than five years after substantial completion of the project. **Standby Lines of Credit** "represents a secondary source of funding in the form of a contingent Federal loan to supplement project revenues, if needed, during the first 10 years of project operations, available up to 10 years after substantial completion of project" (US DOT www.transportation.gov/tifia/overview).

A TIFIA loan cannot exceed 49% of the total anticipated eligible project costs. Each $1 of federal funds can provide up to $10 in TIFIA credit and support up to $30 in transportation infrastructure investments. "Overall, borrowers benefit from improved access to capital markets and potentially achieve earlier completion of large-scale, capital intensive projects that otherwise might be delayed or not built at all because of their size and complexity and the market's uncertainty over the timing of revenues" (US DOT www.transportation.gov/tifia/overview).

PAB: Private Activity Bonds

PABs are debt instrument issued by State or local governments whose proceeds are used to construct projects with significant private involvement. They are a low-cost financing option which provided public benefit while allowing for tax-exempt debt on behalf of private entities undertaking the project. PABs and TIFIA loans generally happen within the same project.

The Bond has limitations on how its monies can be used including that 95% of the Bond must be used for land or depreciable property and no more than 2% can be used on issuance of the bond.

GARVEEs: Grant Anticipation Revenue Vehicles

GARVEEs allow states to pay debt service and other bond-related expenses with future Federal-aid highway funds. They generate up front capital at tax exempt rates which can allow for faster completion with lower inflation costs. A benefit of GARVEEs is that the cost of facility is spread over useful life rather than all during construction.

There are two main types of GARVEEs, direct and indirect. “Direct GARVEE bonds are those in which Federal assistance directly reimburses debt service paid to investors in a debt-financed Federal-aid project or program,” (FHWA www.fhwa.dot.gov/ipd/finance/tools_programs/federal_debt_financing/garvees). Indirect GARVEE bonds are issued by states without Federal authorization, which will make the bond a non-Federal financing tool but rather a method for a state to pledge its Federal funding to that project with reimbursements not tied to a specific projects.

Table 14.1. Direct GARVEE Bond vs. Indirect GARVEE Bond

	Eligible Project	FHWA Approval	Regulations	Flexibility in Using Bond Proceeds	Interest and Issuance Cost Reimbursable
Direct GARVEE Bond	Federal	Yes	Federal	No – Bond proceeds used for specified project(s)	Yes
Indirect GARVEE Bond	Federal and State	No	State	Yes – Bond proceeds used for any eligible project	NO

Note: fhwa.dot.gov/ipd/finance/tools_programs/federal_debt_financing/garvees

P3s: Public Private Partnerships

Public Private Partnerships allow greater private sector participation specifically with enhanced roles in planning, financing, design, construction, operation, and maintenance. They provide access to private equity and commercial financing for roadway projects. They also encourage private entrepreneurial development, and operation of highways and/or related assets.

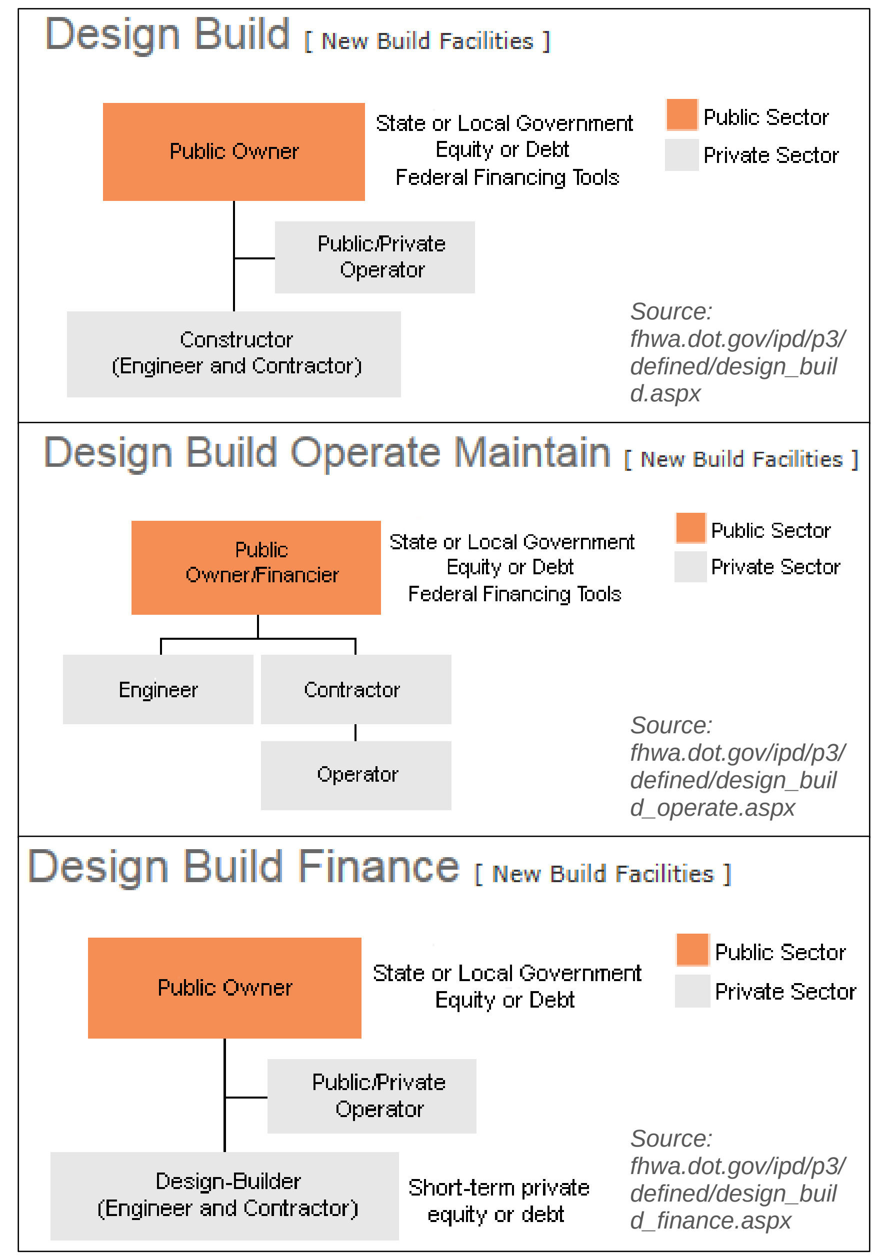
There are three main kinds of P3s, including; Design-Build; Design Build Operate Maintain; Design Build Finance. **Design-Build** “is a project delivery method that combines two, usually separate services into a single contract. With design-build procurements, owners execute a single, fixed- fee contract for both architectural/engineering services and construction. The design-build entity may be a single firm, a consortium, joint venture or other organization assembled for a particular project” (FHWA, www.fhwa.dot.gov/ipd/p3/defined/design_build.aspx).

Design Build Operate Maintain (DBOM) combines the Design-Build with operations and maintenance. There is a single contract with the private sector with financing secured by the public sector. This kind of P3 is sometimes known as a “turnkey” contract.

Design Build Finance (DBF) procurement model has one contract for design, construction, and financing of a facility. The long-term maintenance and operation is still the requirement of the project sponsor.

P3s do have some drawbacks wherein some states have not allowed them. However, other states are beginning to pass laws to allow them after their success in the states which do allow them.

Figure 14.1. Public Private Partnerships



Chapter 15 - Potential Regional Strategies

Description of Strategies

The following multimodal strategies were developed and assessed at a high level to determine their potential impact on the existing / planned transportation system and regional performance measures. A brief description of each strategy is provided below.

System Preservation / Asset Management Life-Cycle Strategies

System preservation is one of the study goals and objectives from MTIS. System preservation / asset management life cycle strategies aim to achieve state-of-good-repair by prioritizing projects that address timely and cost-beneficial asset rehabilitation. These strategies vary greatly between different types of assets.

Freeway Capacity Improvements

Freeway capacity improvements would consist of a comprehensive program to add capacity to an entire freeway corridor or system. These projects aim to provide capacity well into the future rather than focusing on current localized issues (e.g., bottlenecks).

Non-Freeway Capacity Improvements

Non-freeway capacity improvements would consist of a comprehensive program to add capacity to a non-freeway corridor or system. These projects aim to provide additional capacity while alleviating congestion on other roadways or systems (i.e. freeways).

Managed Lane Concepts (High Occupancy Vehicle (HOV) Lanes / High Occupancy Toll (HOT) Lanes)

Managed Lane Concepts are strategies that use highway facilities or a distinct set of lanes to maximize throughput by giving incentives for travelers to use the roadway more efficiently. Managed lanes are different from traditional traffic strategies because they proactively implement and manage the traffic on the road by affecting traveler behavior through pricing and occupancy incentives and may involve the use of more than one operational strategy. The different types of managed lane concepts are listed in **Table 15.1**.

Table 15.1. Managed Lane Concepts

Strategy	Description
HOV lane	A traffic lane or roadway that only vehicles carrying two (occasionally three) or more people can use. All drivers have the option to use the general purpose lanes.
HOT lane	Similar to a HOV lane, however a single occupancy vehicle (SOV) has the option to pay a variable fee in order to use the HOT lane.

Transportation Systems Management (TSM) Strategies

TSM is a set of strategies that focus on improving mobility through improving the capacity and efficiency of the existing transportation system. TSM strategies tend to be “low-cost” and often focus on one area or corridor. Examples of TSM strategies are listed in **Table 15.2**.

Table 15.2. TSM Strategies

Strategy	Description
Ramp Metering	Managing traffic entering the freeway system during peak hours to improve mainline freeway operations and safety.
Traffic Signal Improvements	The use of more effective signal timings, coordination, and new technologies to decrease intersection delay.
Traffic Incident Management (TIM)	Planned procedures to reduce the duration of congestion resulting from roadway incidents.
Bottleneck Removal	The targeted addition of turn lanes, through lanes, grade separation, or acceleration/deceleration lanes to reduce congestion.
Hard Shoulder Running (HSR)	Temporary shoulder use during peak periods or in response to incidents to allow additional capacity and reduce congestion.
* Active Traffic Management (ATM)	The use of adaptive and dynamic technologies to manage recurring and non-recurring congestion. I.e. adaptive ramp metering, adaptive traffic signal control, dynamic junction control, dynamic lane reversal, dynamic lane use control, dynamic merge control, dynamic shoulder lanes, dynamic speed limits, queue waning, transit signal priority.

**ATM can be applied in conjunction with other TSM strategies to increase effectiveness.*

Intelligent Transportation Systems (ITS) Strategies

ITS is the use of technology and traffic management to improve traffic conditions, minimize delay, and improve safety. ITS processes real time information about traffic and travel conditions in order to share that data with local and state agencies, emergency personnel and the traveling public. ITS strategies are listed in **Table 15.3**.

Table 15.3. ITS Strategies

Strategy	Description
Dynamic Message Signs (DMS)	Used to provide motorists with information on what to expect ahead: what happened, where it happened, and alternative routes.
Lane Management System	Changes designated lanes based on downstream traffic flow, incidents, or lane closures.
Variable Speed Limit (VSL) Signs	Changes speed limits depending on downstream speeds or current weather conditions.
Travel Time Signs	Provides real time travel information to drivers to help them make informed route choice decisions.
Traffic Sensors	Provides real time information to traffic management centers to detect congestion or incidents.
Closed Circuit Television Camera (CCTV)	Enables operators to verify reported incidents, monitor traffic flow, and monitor roadway conditions.
Roadway Weather Information Systems (RWIS)	Sensors that monitor and identify weather related events impacting traffic conditions to be displayed on DMS.
Traffic Management Centers	A hub where operators receive information from ITS devices and make informed decisions to keep traffic flowing.

Transportation Demand Management (TDM) Strategies

TDM is a set of strategies that aim to manage how and when people travel in order to use the transportation system more efficiently. TDM strategies are listed in **Table 15.4**.

Table 15.4. TDM Strategies

Strategy	Description
Pedestrian Facilities	Can include sidewalks and trail connections between neighborhoods, activity centers, and existing sidewalks facilities. Can also be policies / design guidelines that promote pedestrian-friendly site layout.
Bicycle Facilities	Expanded trail and bike route systems, provision of shower and locker facilities, bicycle parking, and public bike systems
Employee Transportation Coordinator (ETC)	A person who provides education and administers employee transportation benefits for a single employer or an association of employers.
Rideshare Matching	A service that identifies people living and working in geographically nearby locations for whom ridesharing might be an efficient arrangement.
Vanpool Subsidies	Vans, whether employee-sponsored, owner-operated, or third-party operated, that transport people living within the same area to common work area.
Telecommute Programs	Allowing employees to work from home or a “satellite” or other off-site location part-time or full-time.
Alternative Work Schedules	Companies that offer employees more flexibility in work schedule to encourage commuting in off-peak times. Examples include flextime, compressed work week (CWW), and staggered shifts.
Incentives	Money or benefits (prizes, recognition, etc.) that encourage employees to start or continue alternative commuting behaviors, including enhanced transit pass, cash for not driving/using a parking spot, money to furnish a home office.
Commuter Tax Benefit	The federal tax code includes several financial incentives from employers and employees to promote alternative modes of transportation through parking and transit benefits. The employer must participate in the program for its employees to participate.
Guaranteed Ride Home	One concern employees who rideshare, bike, or use transit to commute is being stranded without their vehicle if an emergency should arise during the workday, or if they have to work late. A guaranteed ride home program can provide a back-up ride to employees who use alternative modes of commuting.
Managed Parking	Managing parking through pricing, policy or incentives can limit parking demand and encourage the use of alternative modes of transportation.

Source: vtpi.org/tdm/index.php#TDM

Transit Strategies

Transit strategies can have a range of approaches. Metro’s recent service changes, which focused on improving transit service along current high-productivity routes, is an example of a transit strategy that uses current rolling stock and routes, but attempts to optimize that service. Some transit strategies and technologies that would be new to the MTIS study area are listed in **Table 15.5**.

Table 15.5. Transit Strategies

Strategy	Description
Bus Rapid Transit (BRT)	Advanced bus service with higher frequencies and fewer stops, improved amenities over regular bus service and potential “branding”, that operates in an exclusive lane or receives signal priority.
Light Rail Transit (LRT)	Fixed-guideway electric rail passenger service that typically operates along a separated right-of-way at ground level.
Modern Streetcar	Fixed-guideway electric rail passenger service that operates in mixed traffic within the street.

Pedestrian / Bicycle Strategies

Pedestrian / Bicycle strategies are listed in **Table 15.6**.

Table 15.6. Pedestrian / Bicycle Strategies

Strategy	Description
Sharrows & Wayfinding	A way to quickly build the bike network by adding shared lane markings and signage (wayfinding) to low volume local streets that can be used to connect existing bike lanes or trails
Bike Lanes / Tracks	Designated lanes for bicycle use only.
Shared Use Trails	Path that is separated from the street that can be used by cyclists or pedestrians.
Chokepoint Removal	Implementing infrastructure improvements (bike lanes, shared use trails, sidewalks, etc.) at targeted disconnections and gaps to connect communities and activity hubs.

Strategies Carried Forward to Phase 2

In June 2015, Technical Committee members provided feedback on the strategies listed above through small and large group discussions and a polling exercise. **Table 15.7** summarizes the average polling score for each strategy. Polling respondents were asked if a strategy is worth studying in Phase 2 on a scale of 1 (Not Recommended) to 5 (Highly Recommended). Participants were encouraged to consider the following when voting:

- Is there potential for the strategy to be effective here?
- Is there potential for the strategy to be implemented here?
- Think long-term, not short-term.

Technical Committee members agreed that all strategies from Phase 1 should be carried forward for further consideration and study in Phase 2.

Table 15.7. Strategy Polling Results

Strategy	Mean
Traffic Signal Improvements	4.43
Non Freeway / Arterial Capacity Improvements	4.26
Bottleneck Removal	4.26
ITS Expansion	4
System Preservation / Asset Management Life - Cycle Strategies	3.87
TDM Strategies	3.83
Traffic Incident Management	3.65
Dynamic Lane Use Control	3.57
Freeway Capacity Improvements	3.52
Ramp Metering	3.52

Strategy	Mean
BRT	3.35
Expanded Park & Ride	3.35
Variable Speed Limits	3.09
Vanpool / Carpool Rideshare	3.09
Bike / Pedestrian Strategies	3
HOV Lanes	2.83
HOT lanes	2.48
Hard Shoulder Running	2.39
Modern Streetcar	2.26

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Appendix

The following operational figures are included in the Appendix.

Existing

Future No-Build

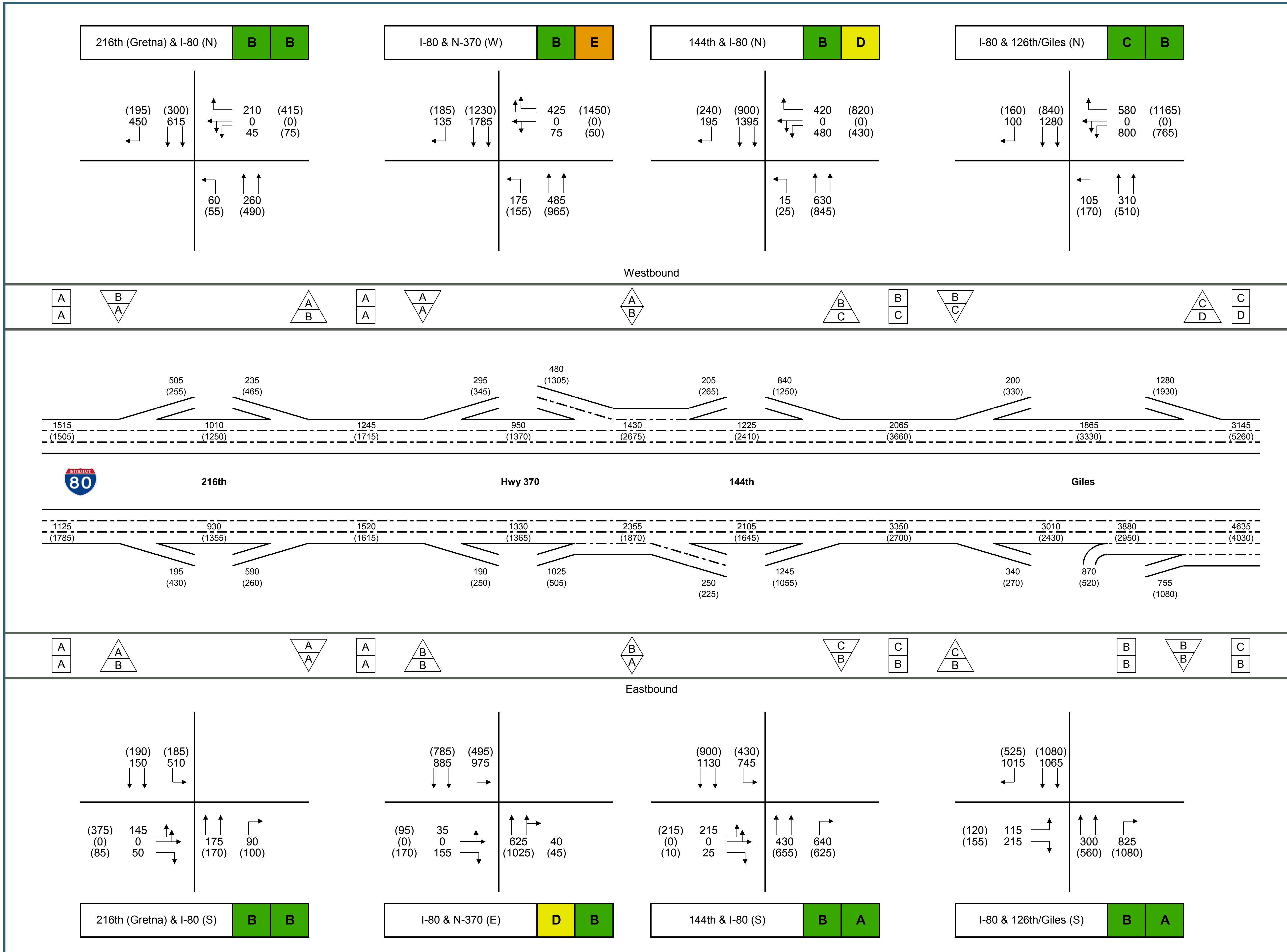

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

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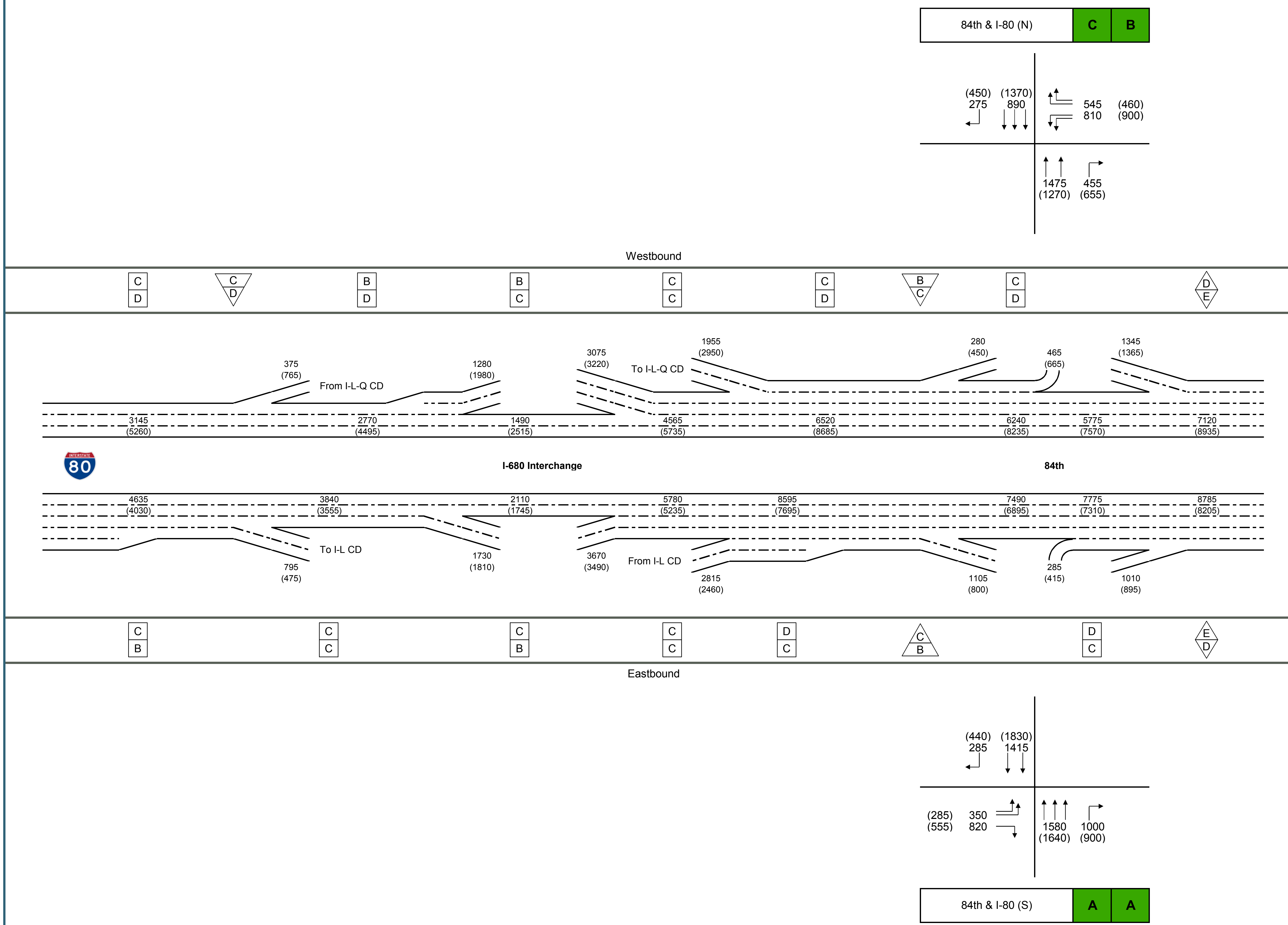

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

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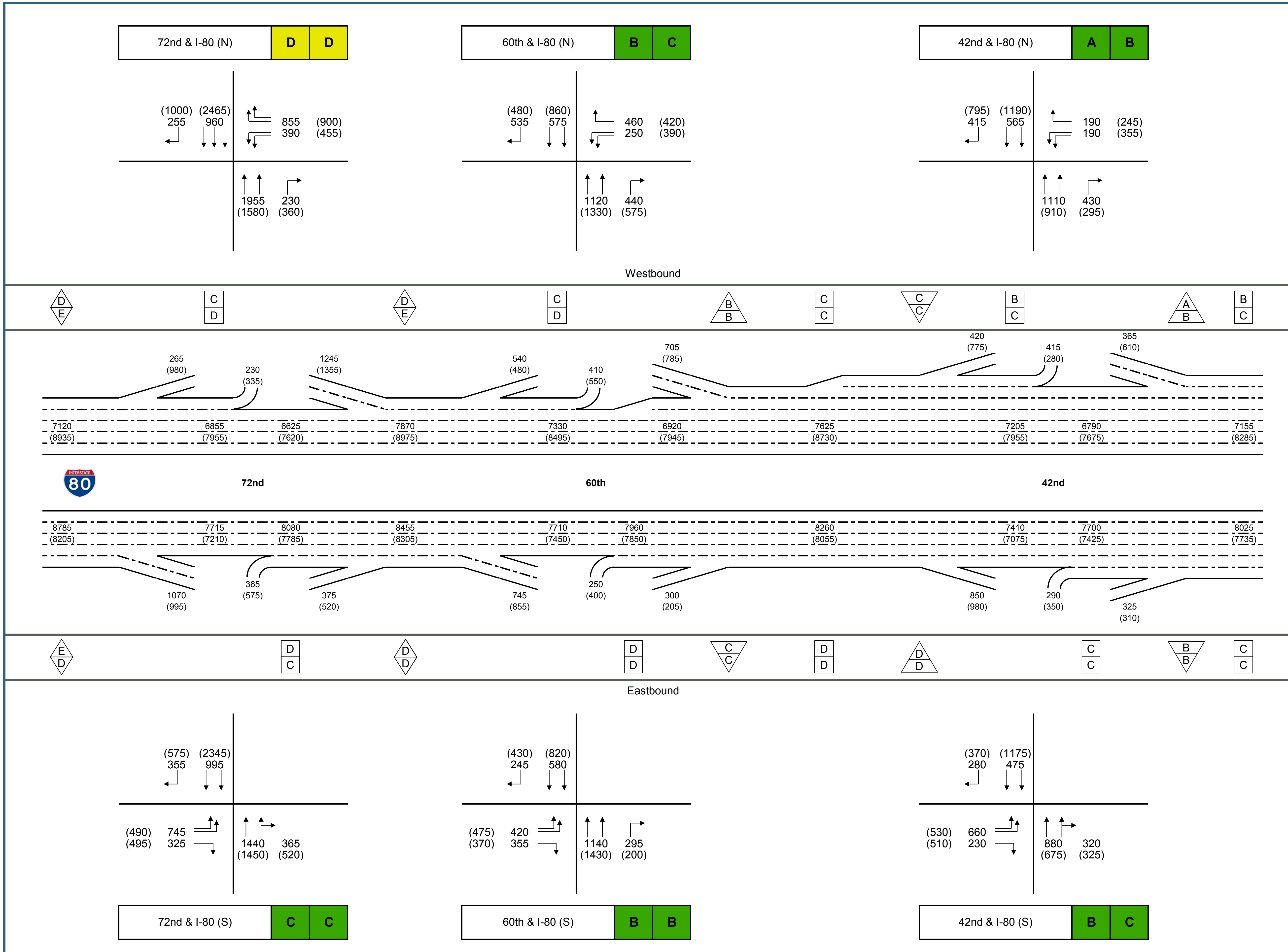


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

Note:

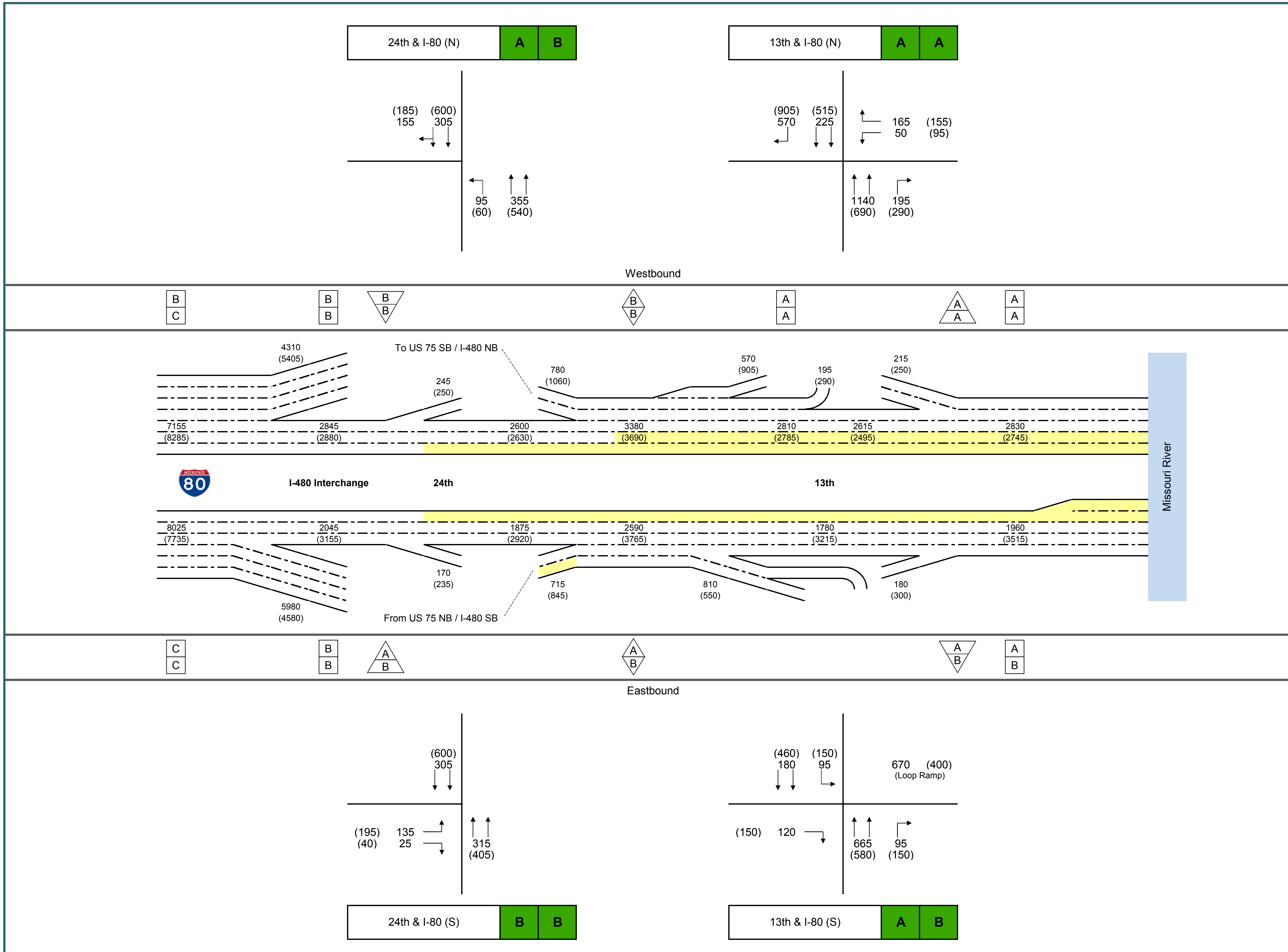
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS
X / X — AM Ramp Merge LOS / PM Ramp Merge LOS
X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X — AM Weave LOS / PM Weave LOS

Near Term Expansion Project

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

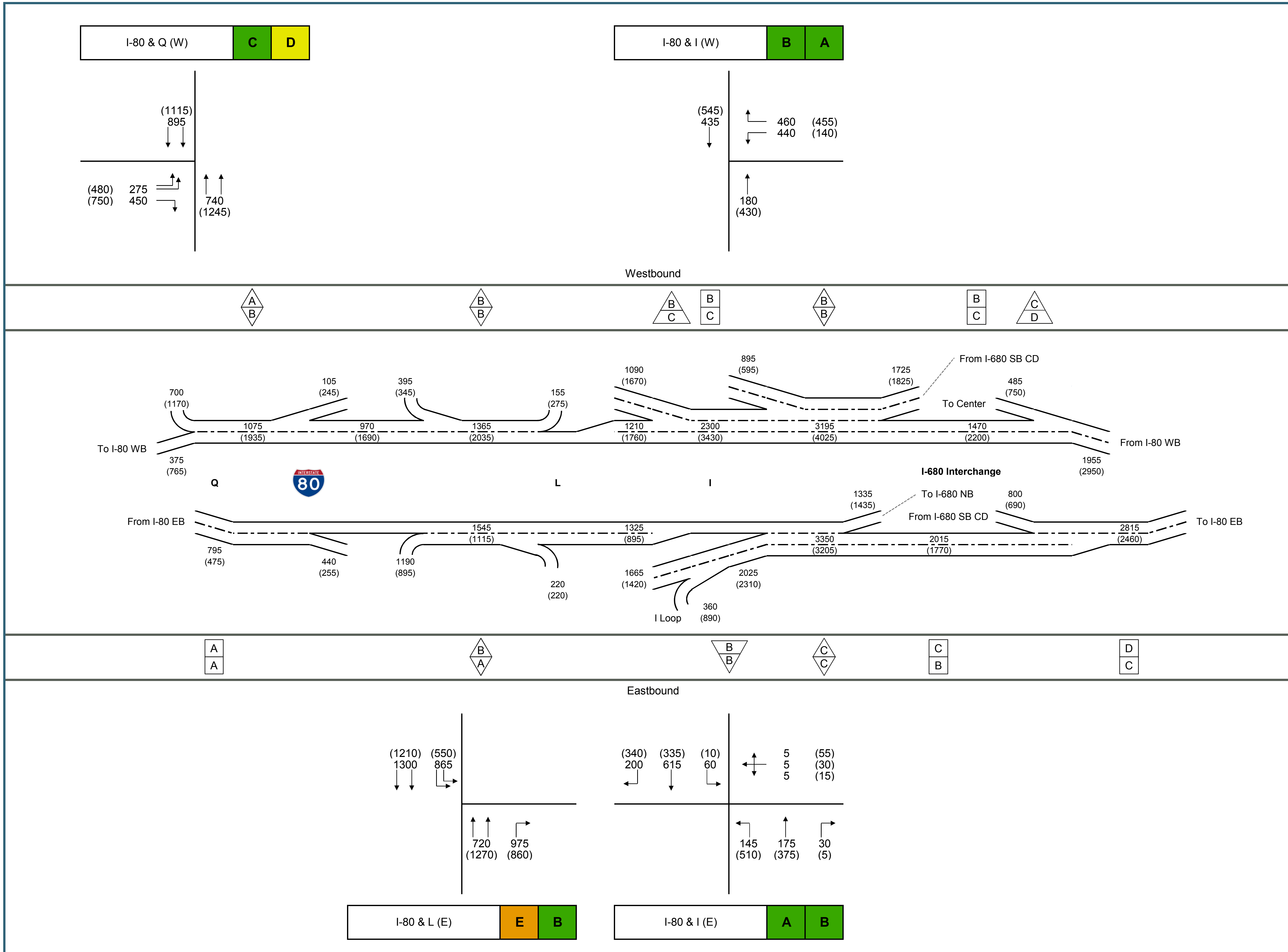


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

I-80 Collector-Distributor Road

Note:

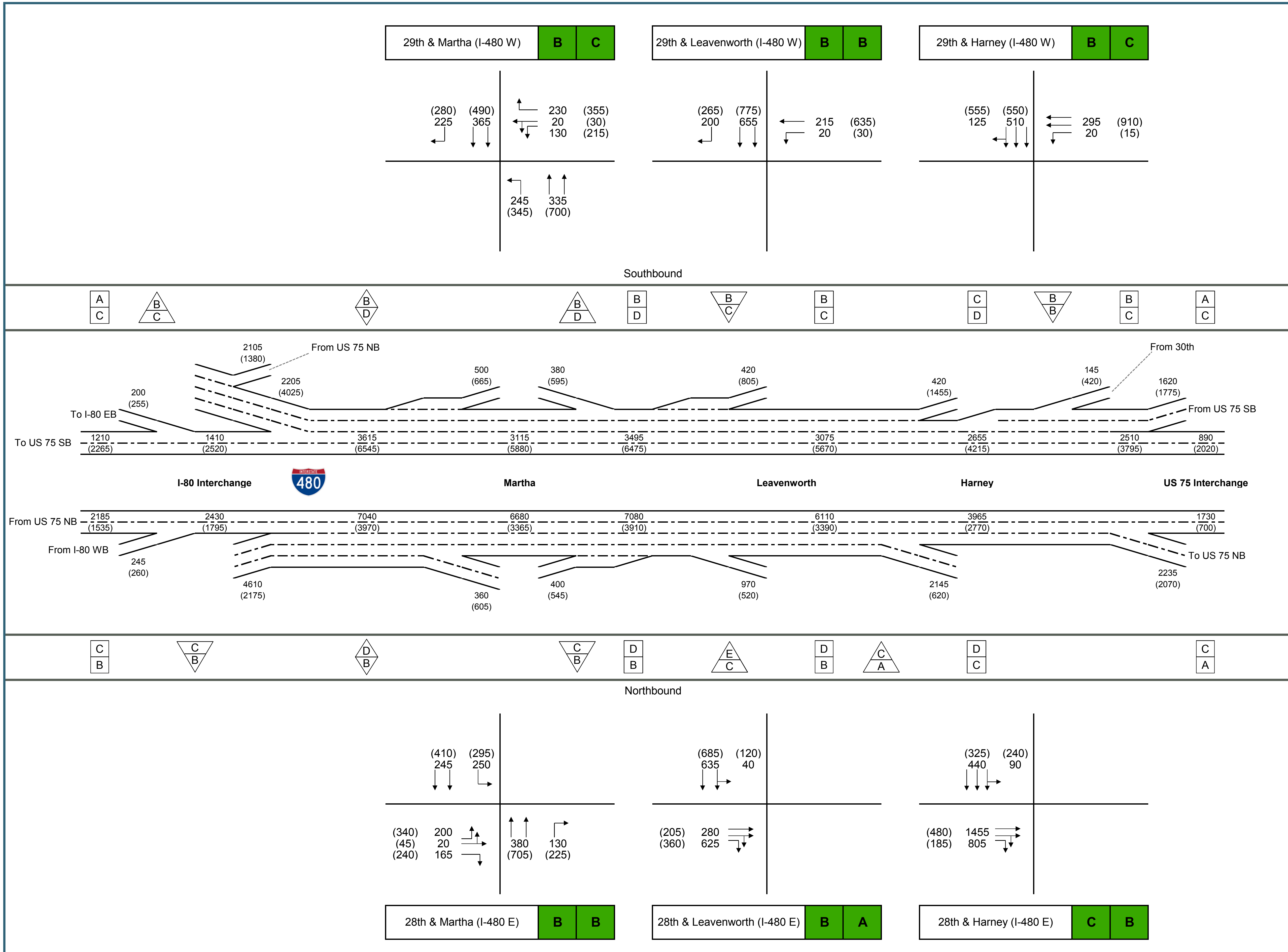
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

Note:

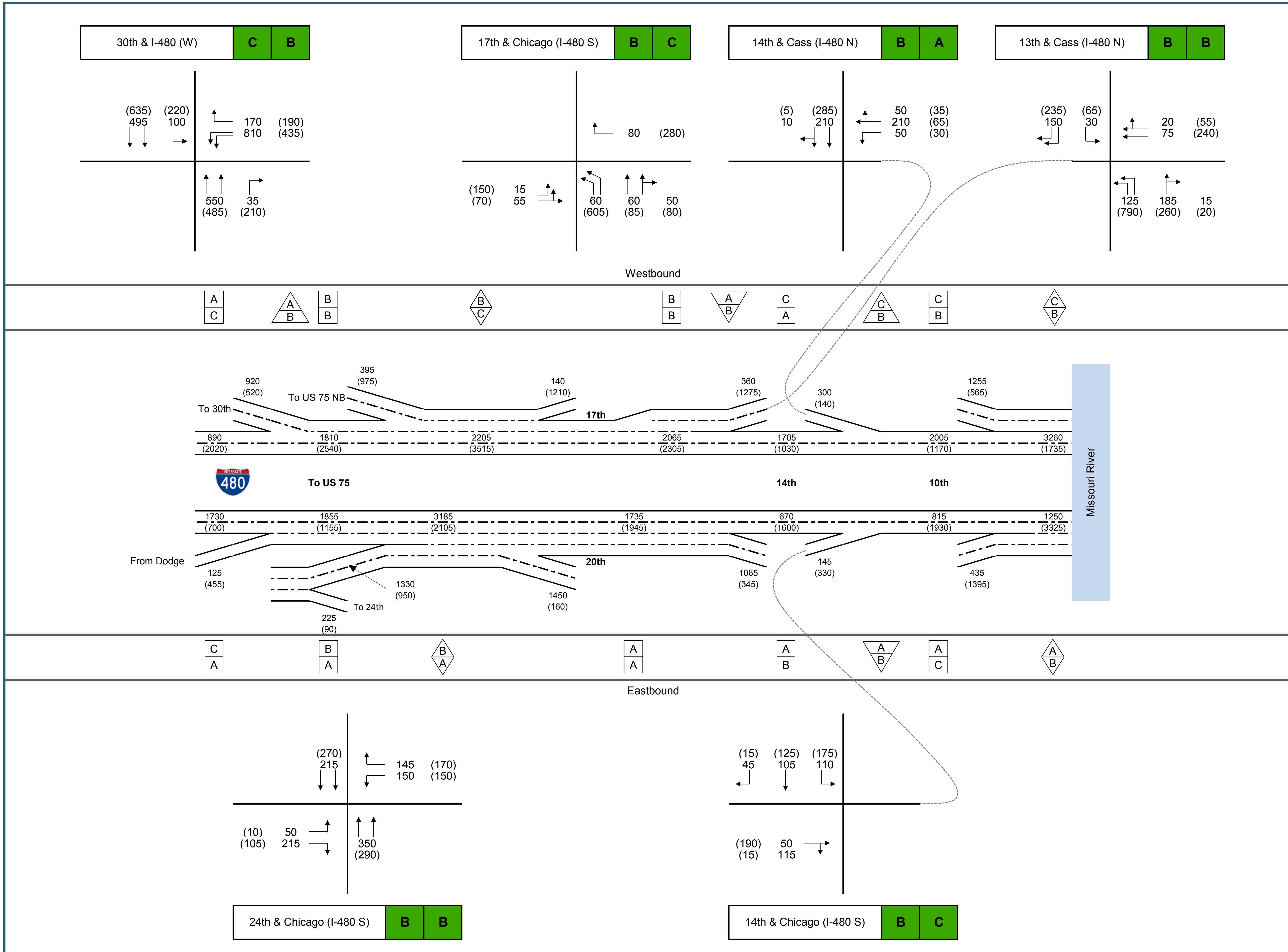
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

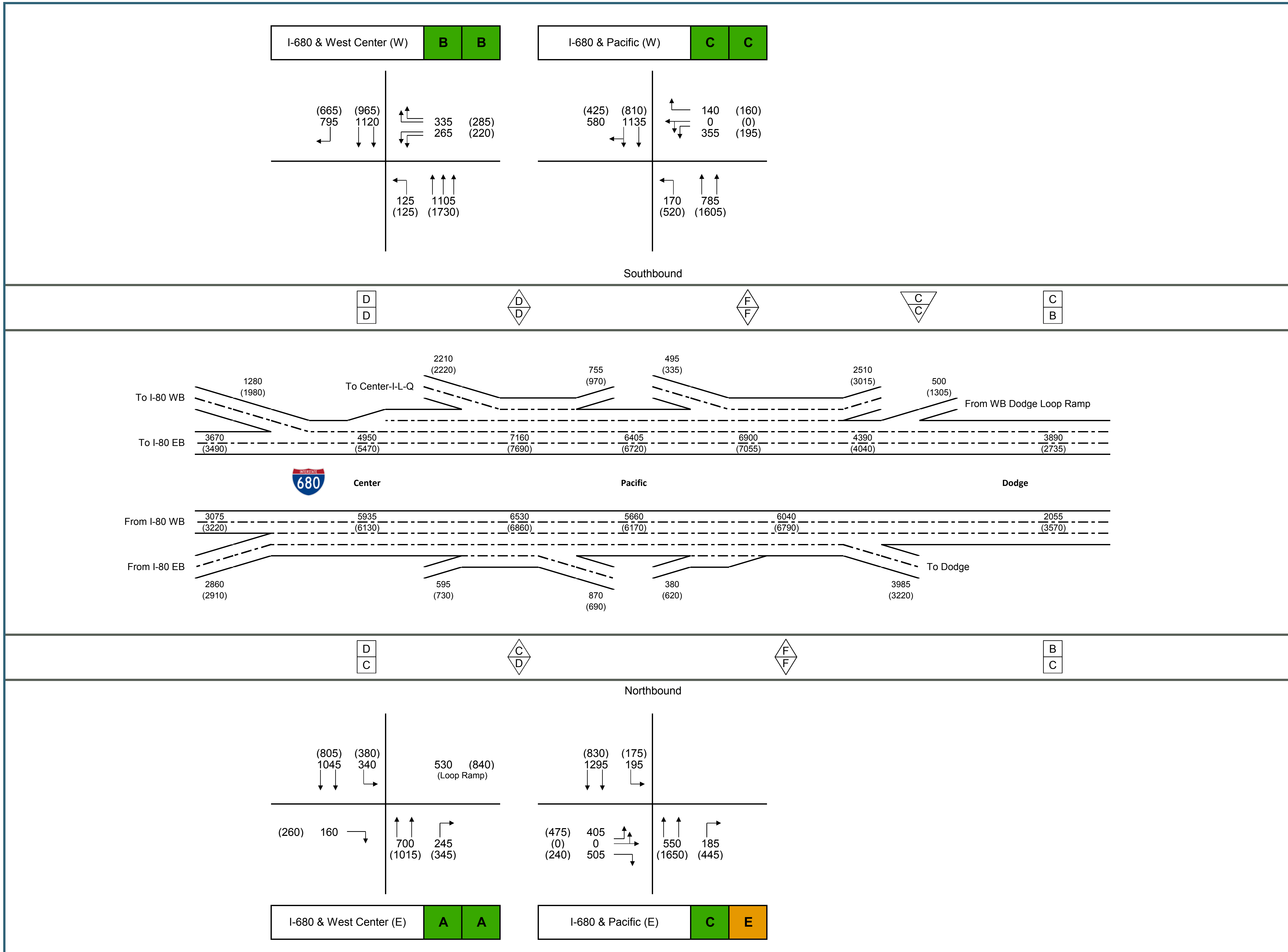


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

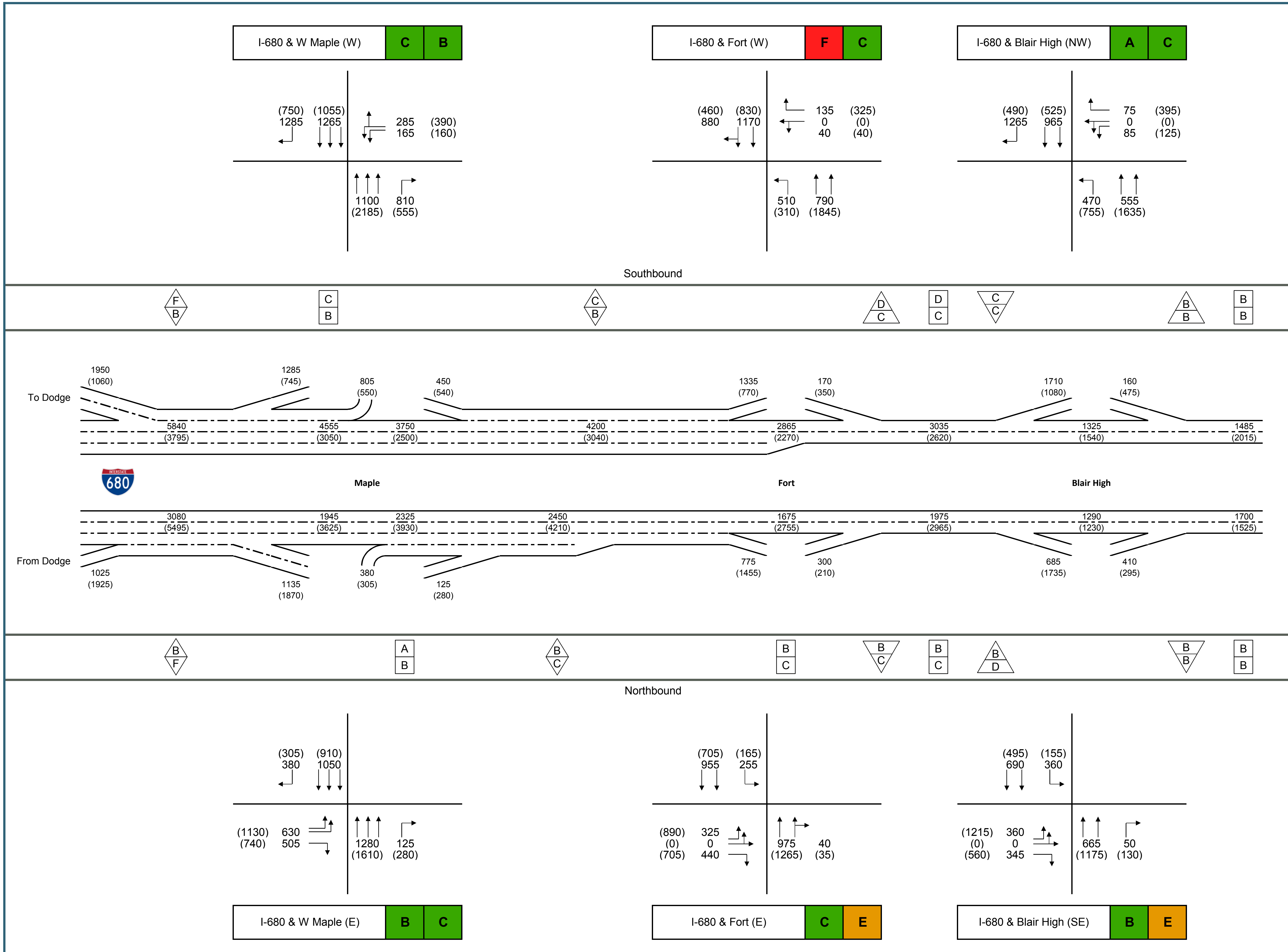
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX	AM Peak Hour Volume
(X,XXX)	PM Peak Hour Volume
→	Intersection Geometrics
N/S Street & E/W Street (Direction) / AM LOS / PM LOS	
X / X	AM Basic Freeway LOS / PM Basic Freeway LOS
X / X	AM Ramp Merge LOS / PM Ramp Merge LOS
X / X	AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X	AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

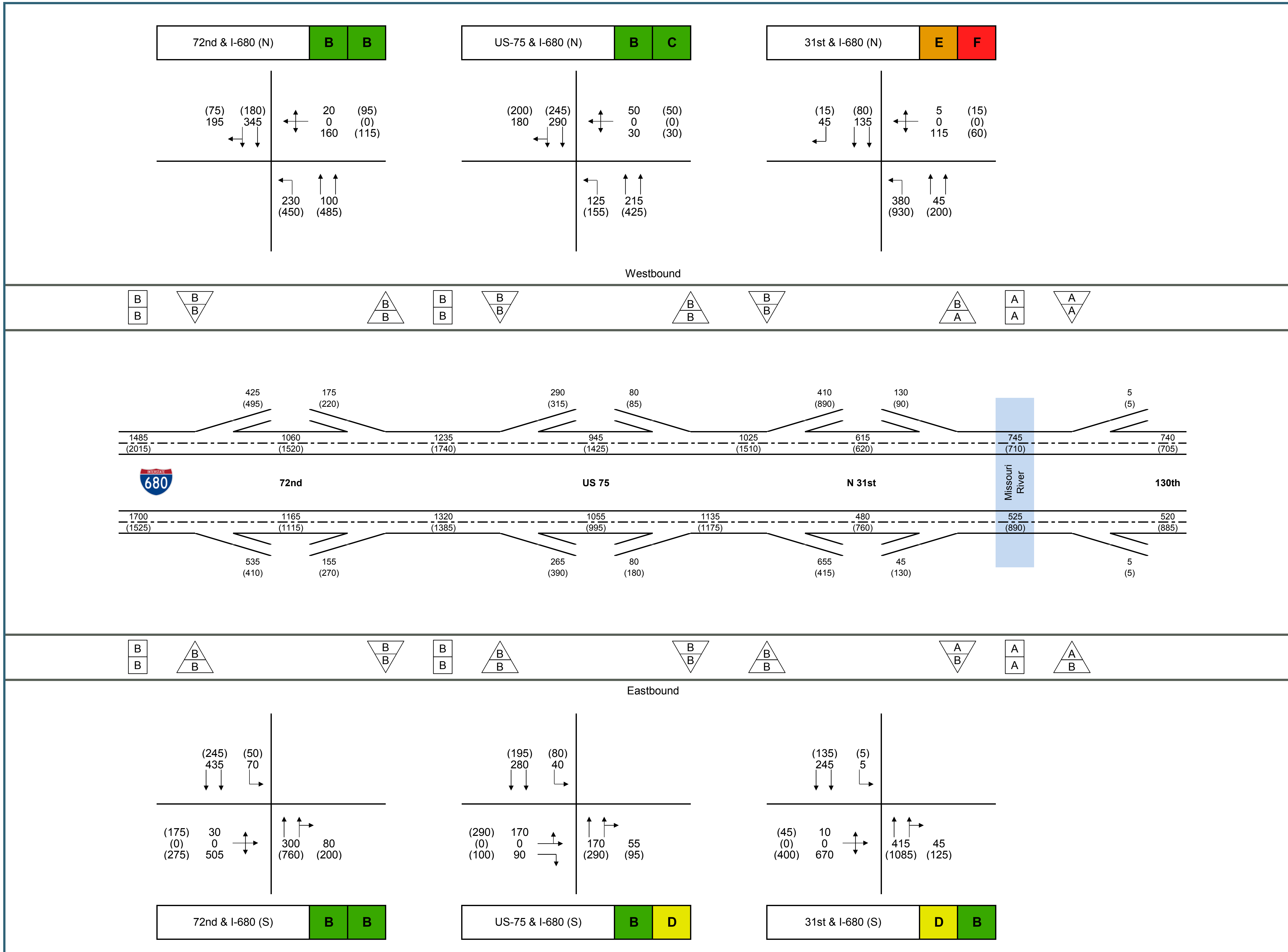


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS / PM Basic Freeway LOS
AM Ramp Merge LOS / PM Ramp Merge LOS
AM Ramp Diverge LOS / PM Ramp Diverge LOS
AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

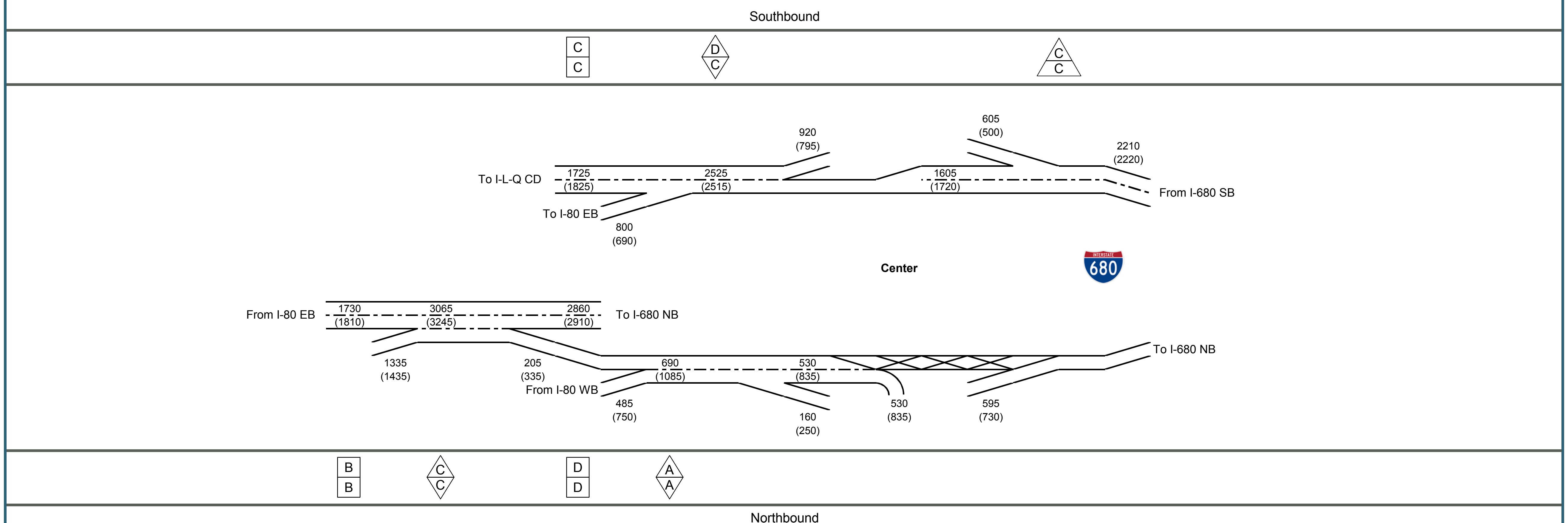


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

I-680 Collector-Distributor Road

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

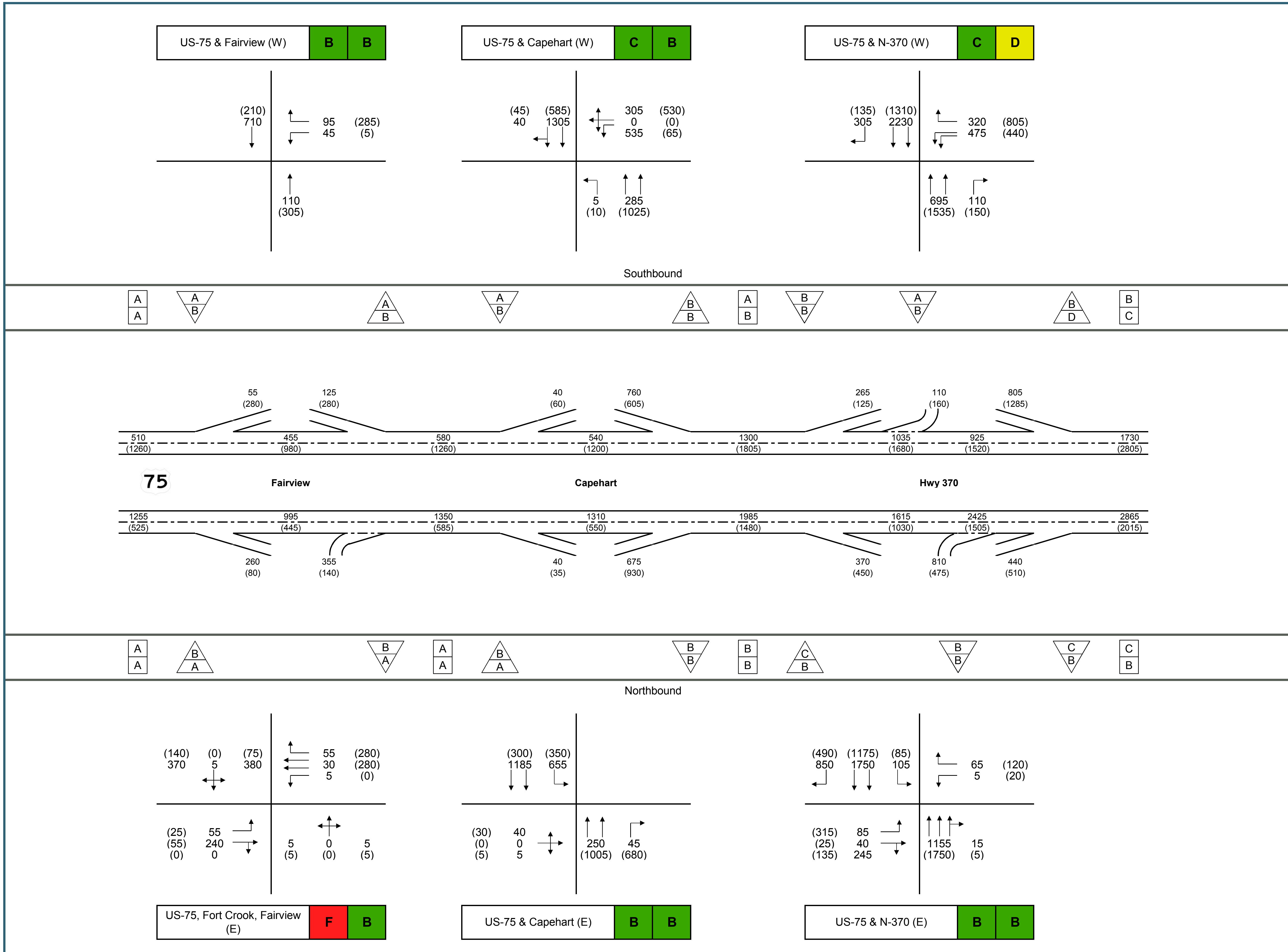


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS
X / X — AM Ramp Merge LOS / PM Ramp Merge LOS
X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X — AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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N

Metro Area Travel Improvement Study

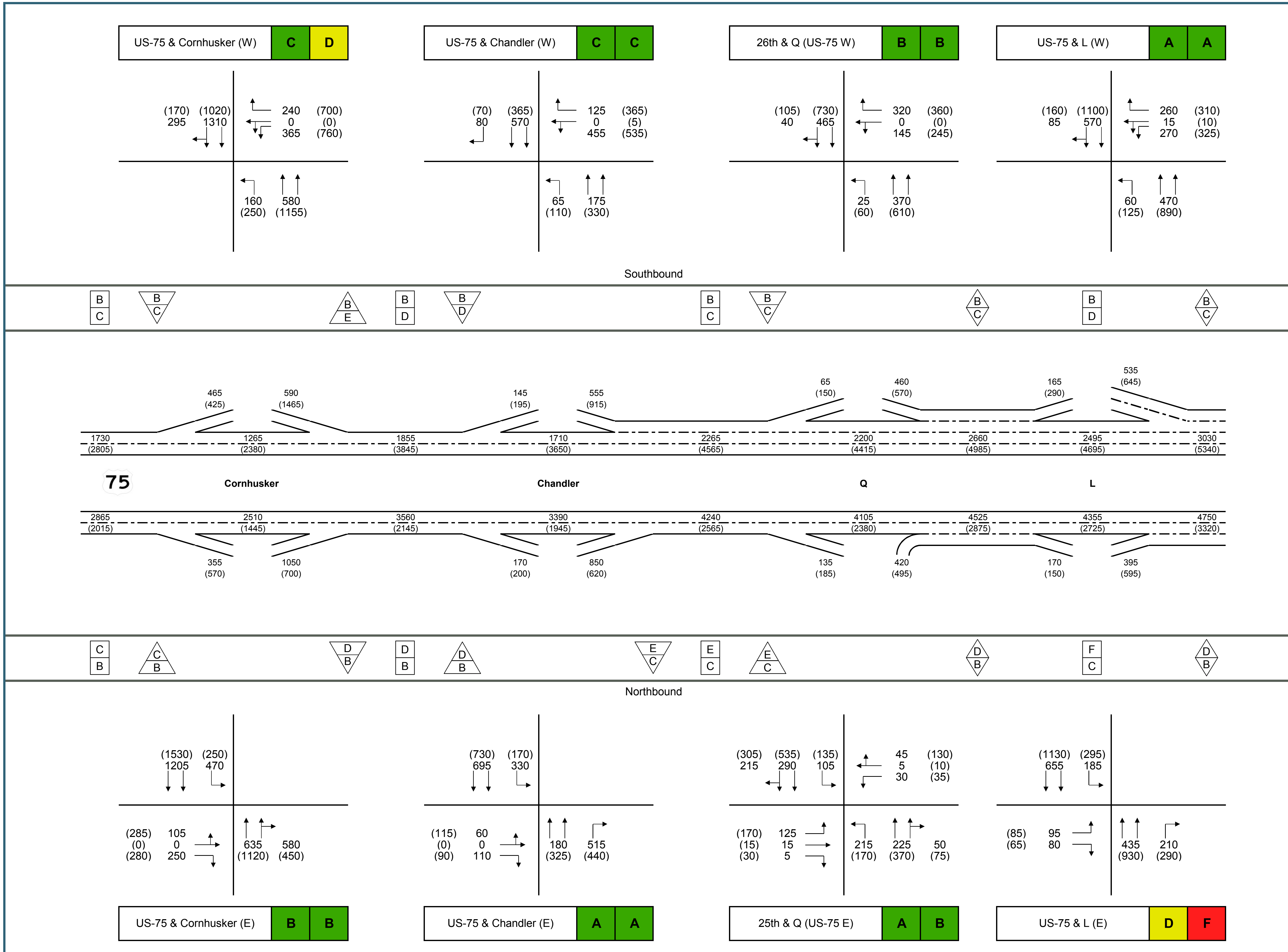

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

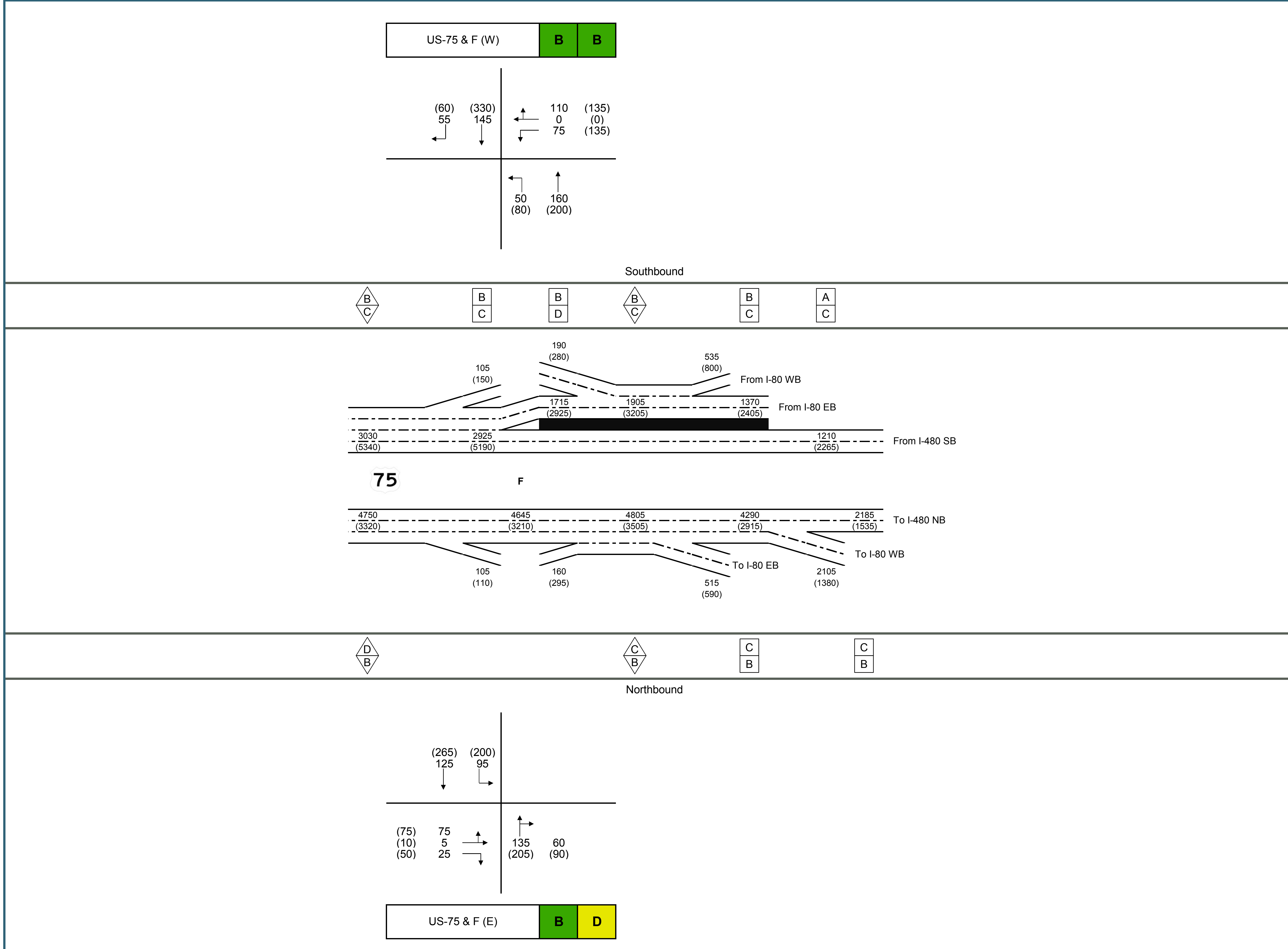

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

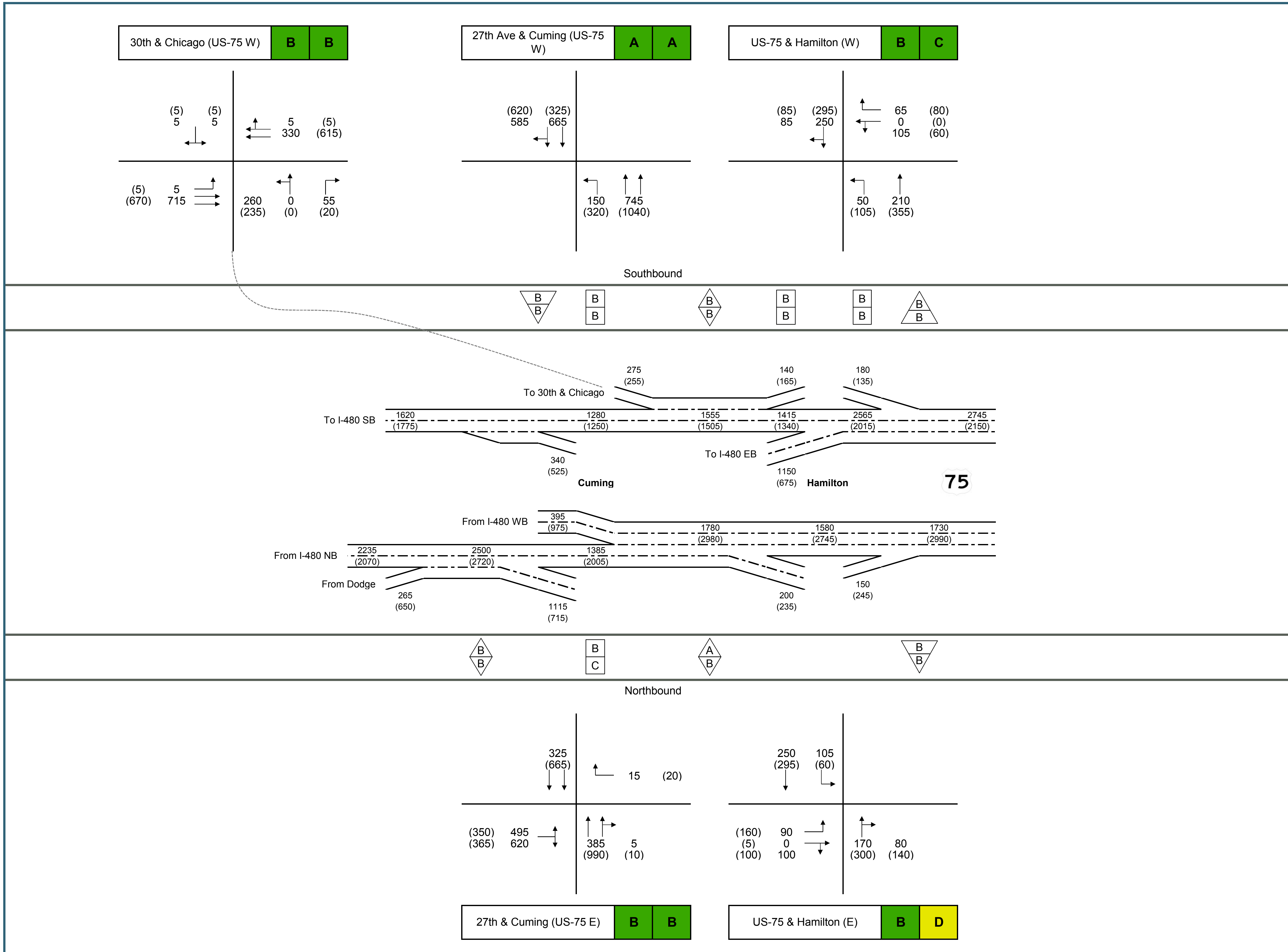

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX	AM Peak Hour Volume
(X,XXX)	PM Peak Hour Volume
→	Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

Note:

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Metro Area Travel Improvement Study

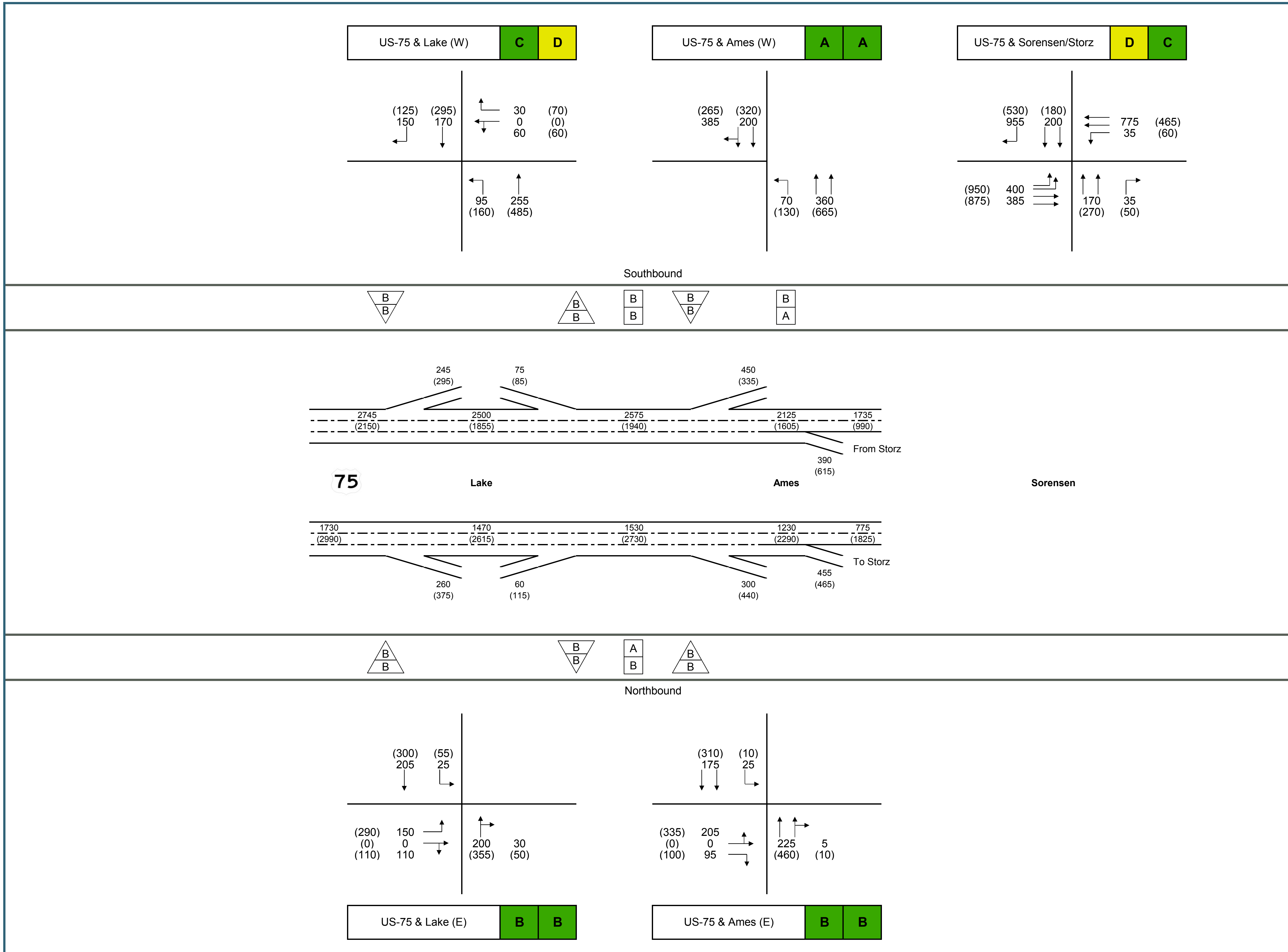

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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N

Metro Area Travel Improvement Study

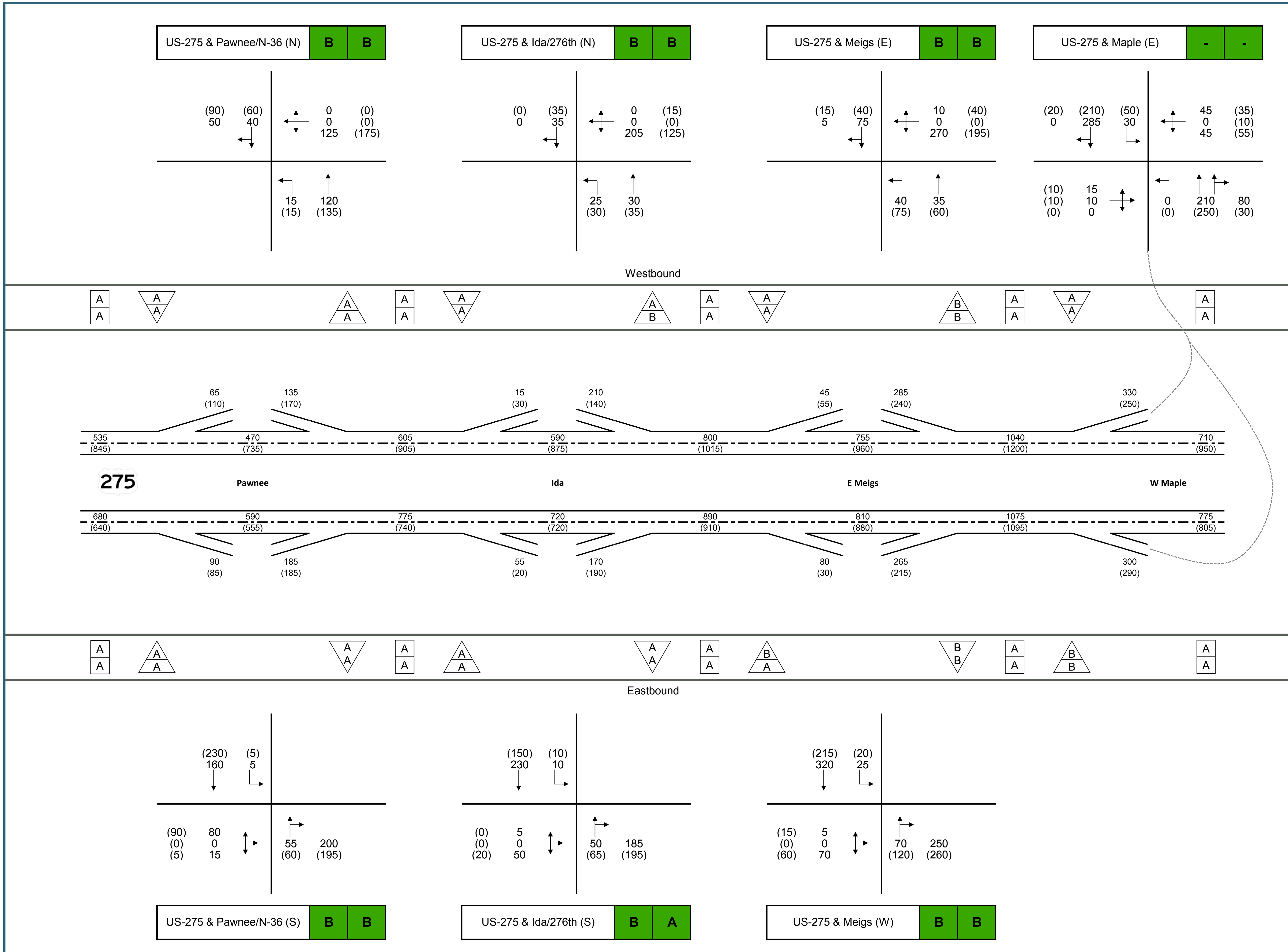

Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

Note:

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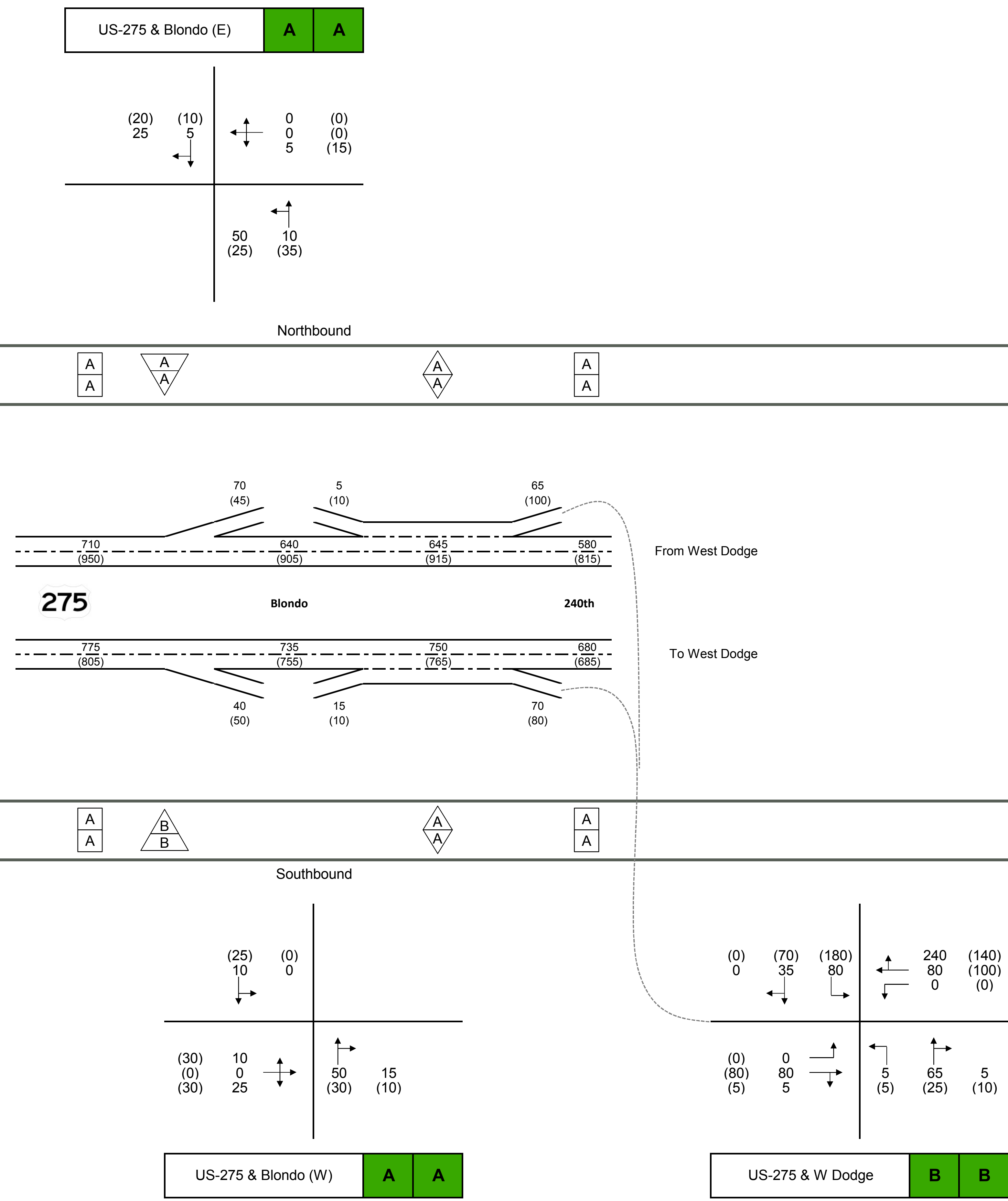
Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X X AM Basic Freeway LOS / PM Basic Freeway LOS
X X AM Ramp Merge LOS / PM Ramp Merge LOS
X X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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N

Metro Area Travel Improvement Study

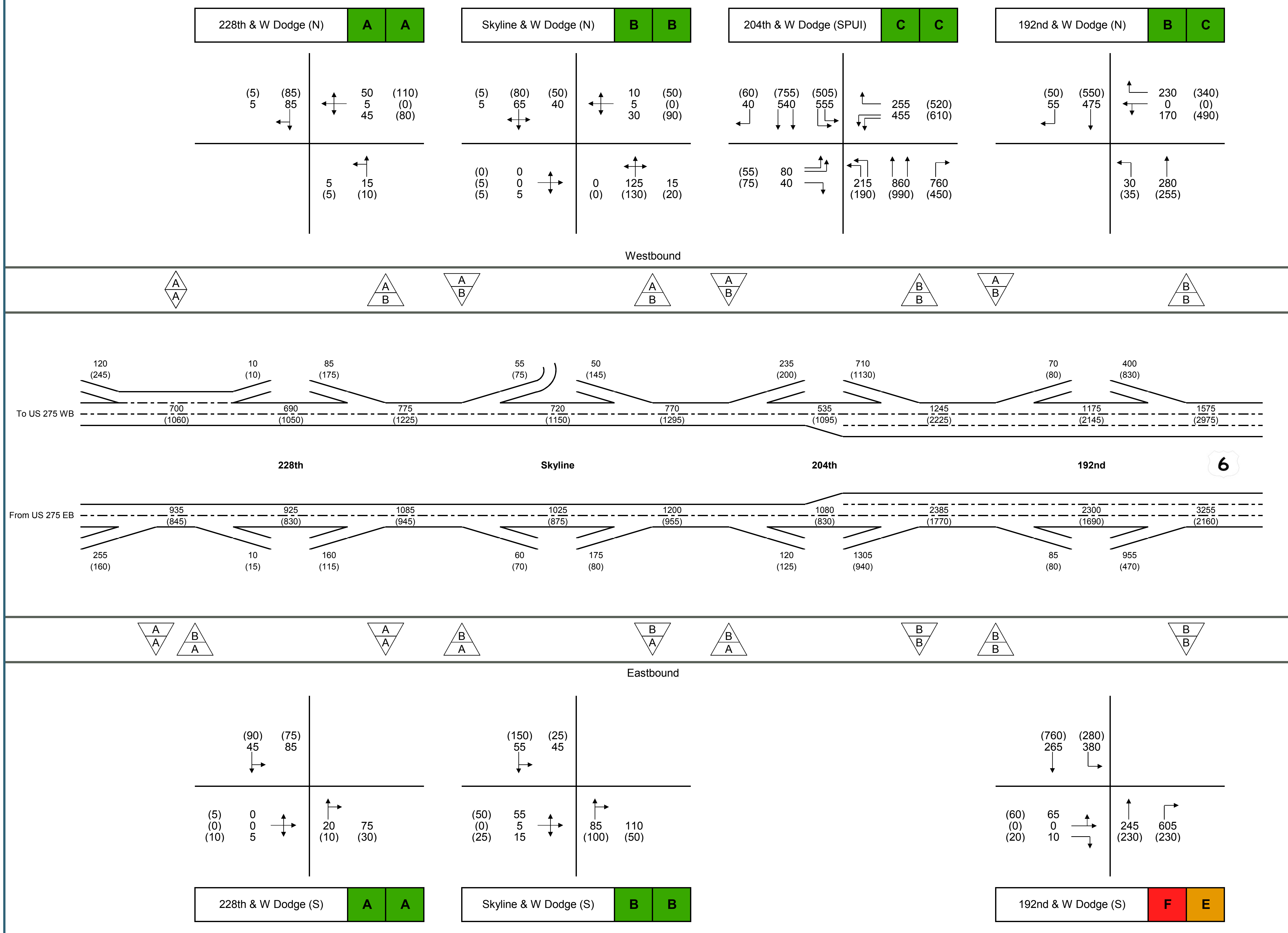


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

Note:

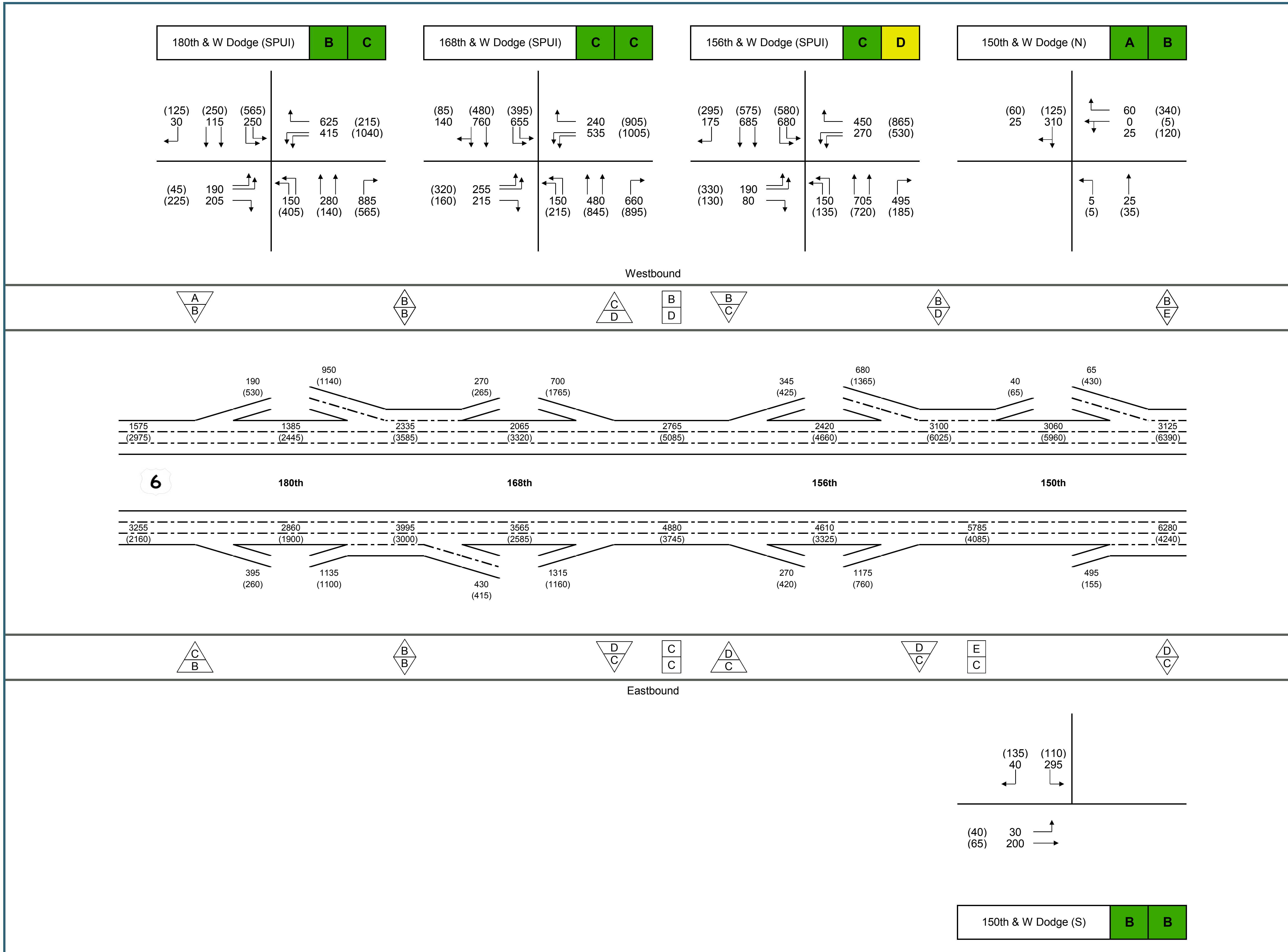
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X: AM Basic Freeway LOS, PM Basic Freeway LOS
X / X: AM Ramp Merge LOS, PM Ramp Merge LOS
X / X: AM Ramp Diverge LOS, PM Ramp Diverge LOS
X / X: AM Weave LOS, PM Weave LOS

Note:

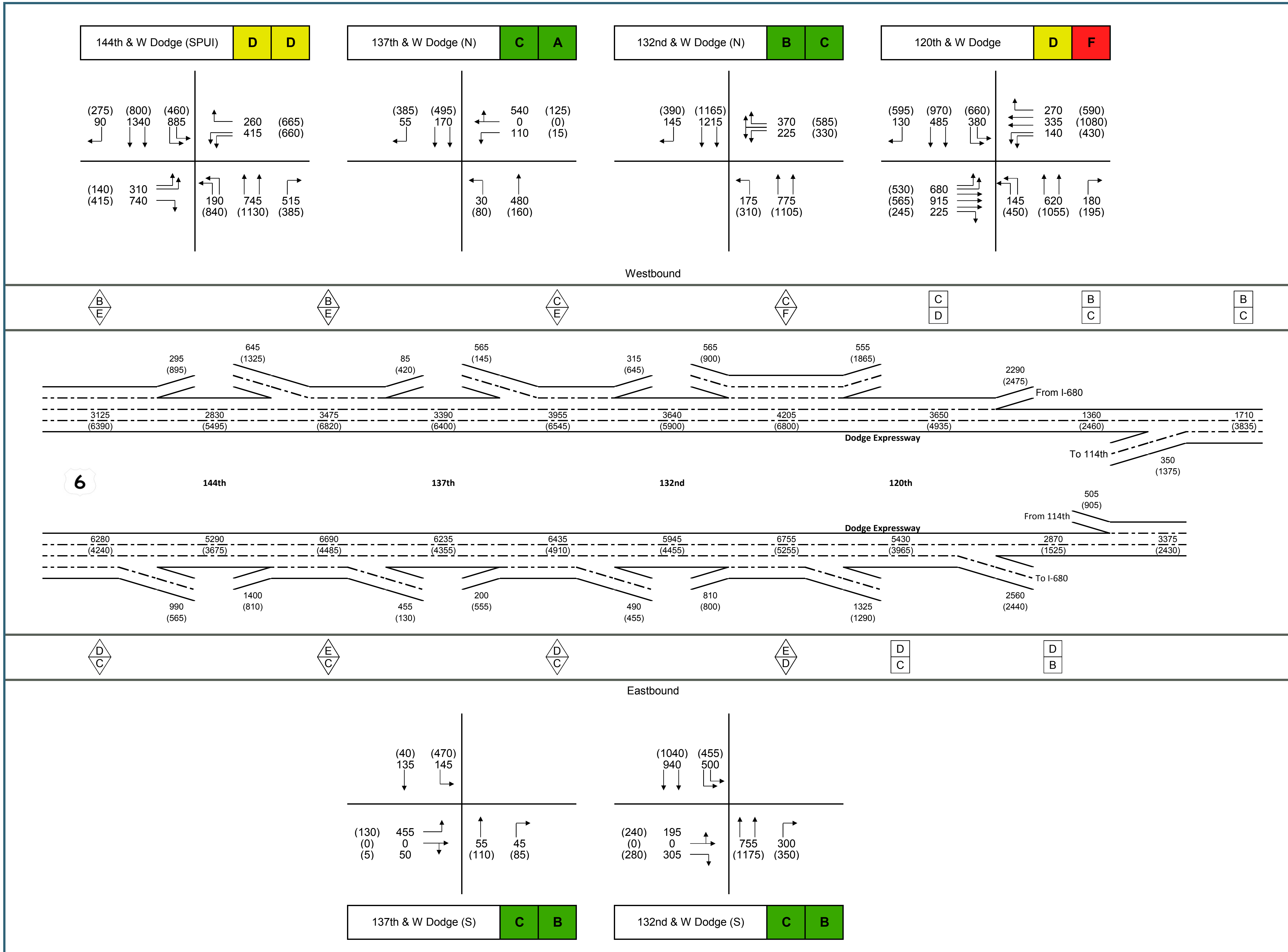
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X: AM Basic Freeway LOS / PM Basic Freeway LOS

X / X: AM Ramp Merge LOS / PM Ramp Merge LOS

X / X: AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X: AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

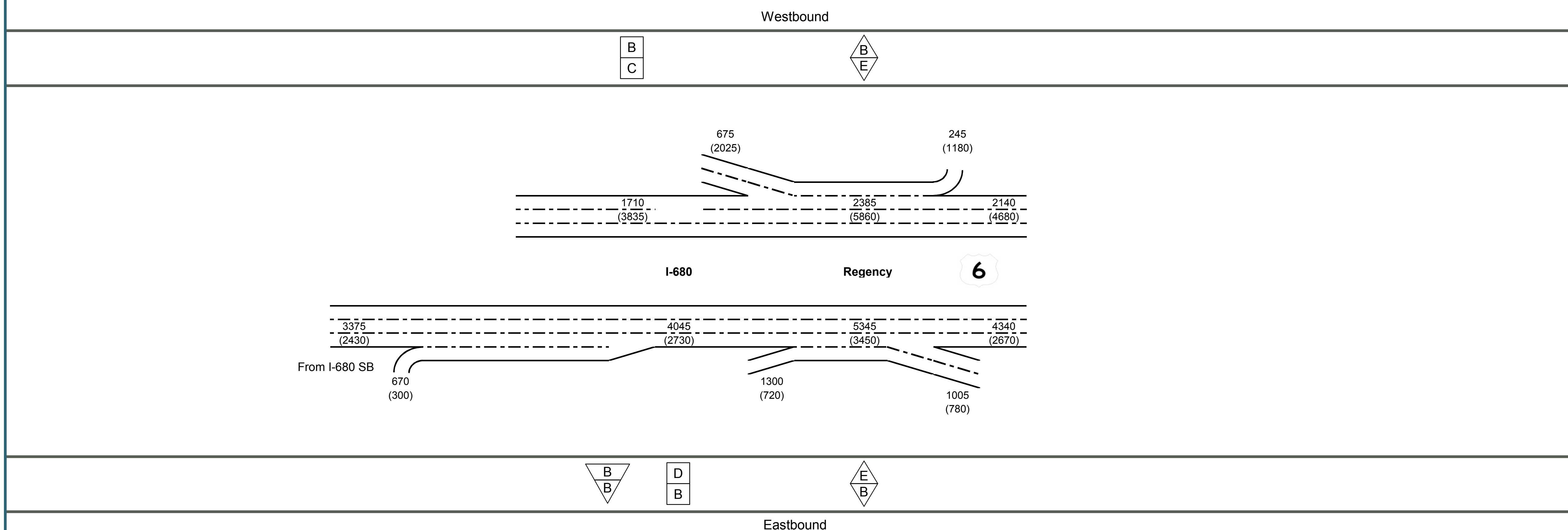


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

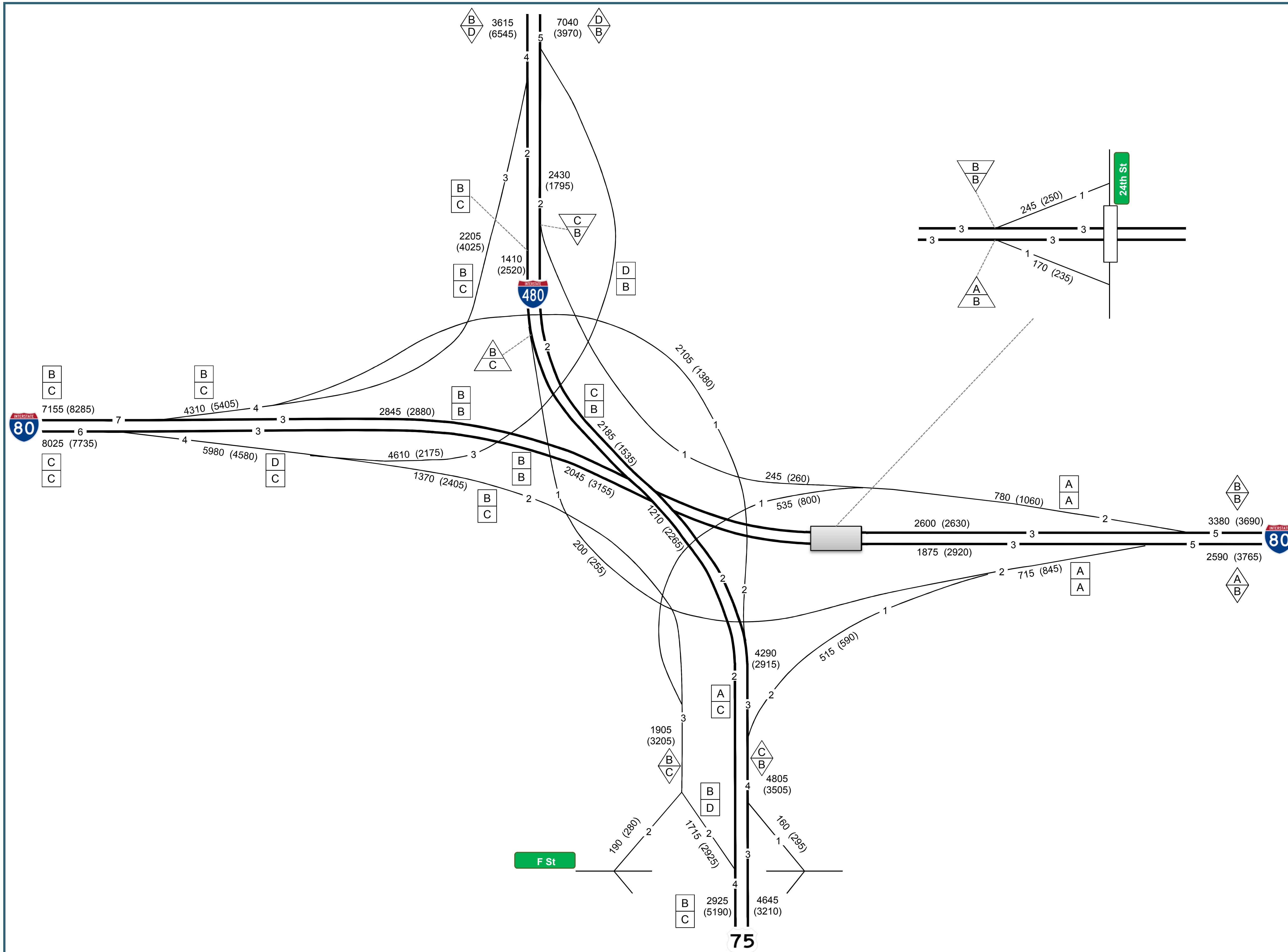


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX (X,XXX)	AM Peak Hour Volume PM Peak Hour Volume
→	Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X	AM Basic Freeway LOS PM Basic Freeway LOS
X / X	AM Ramp Merge LOS PM Ramp Merge LOS
X / X	AM Ramp Diverge LOS PM Ramp Diverge LOS
X / X	AM Weave LOS PM Weave LOS

I-80 & I-480 / US 75 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

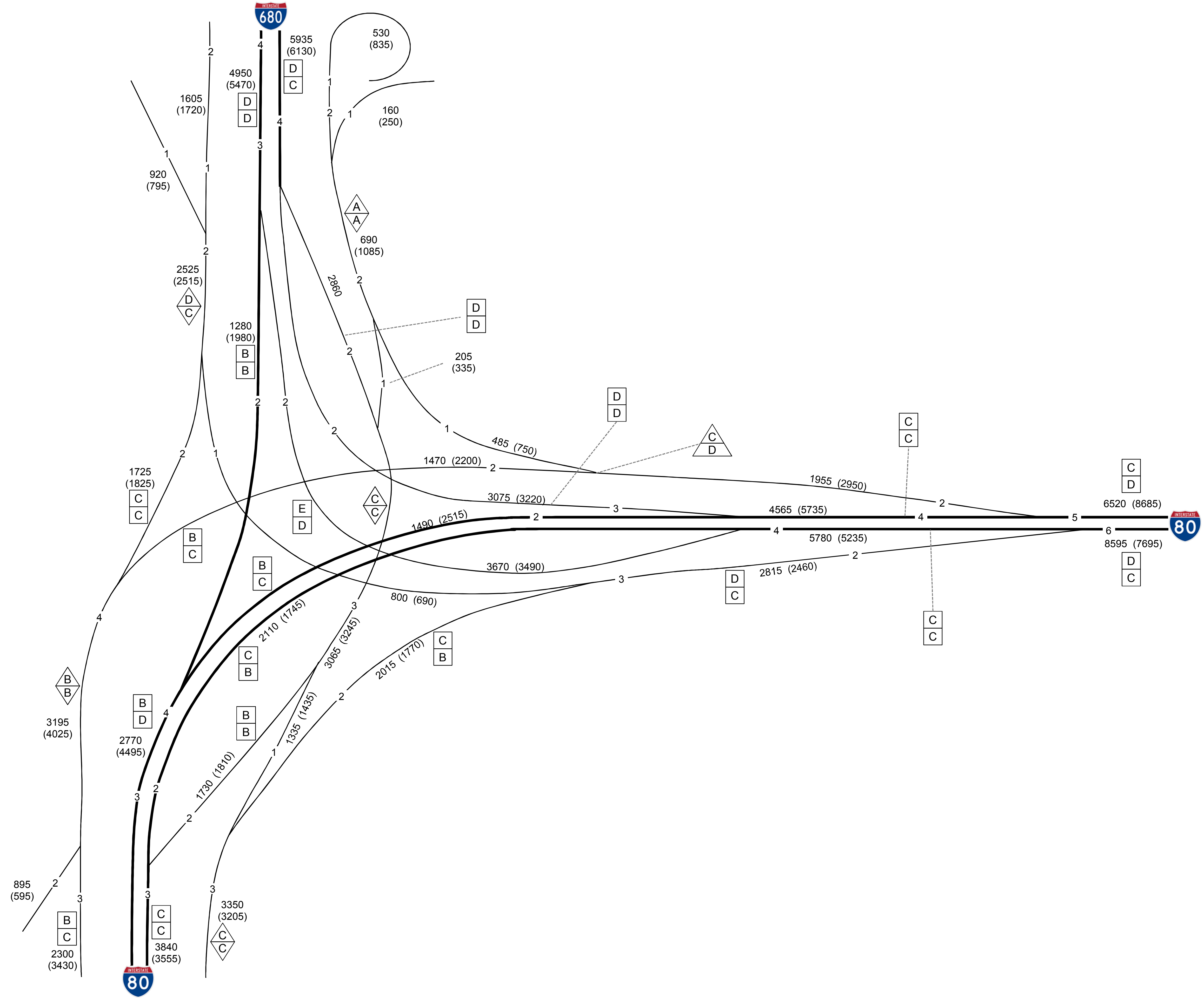


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

I-80 & I-680 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

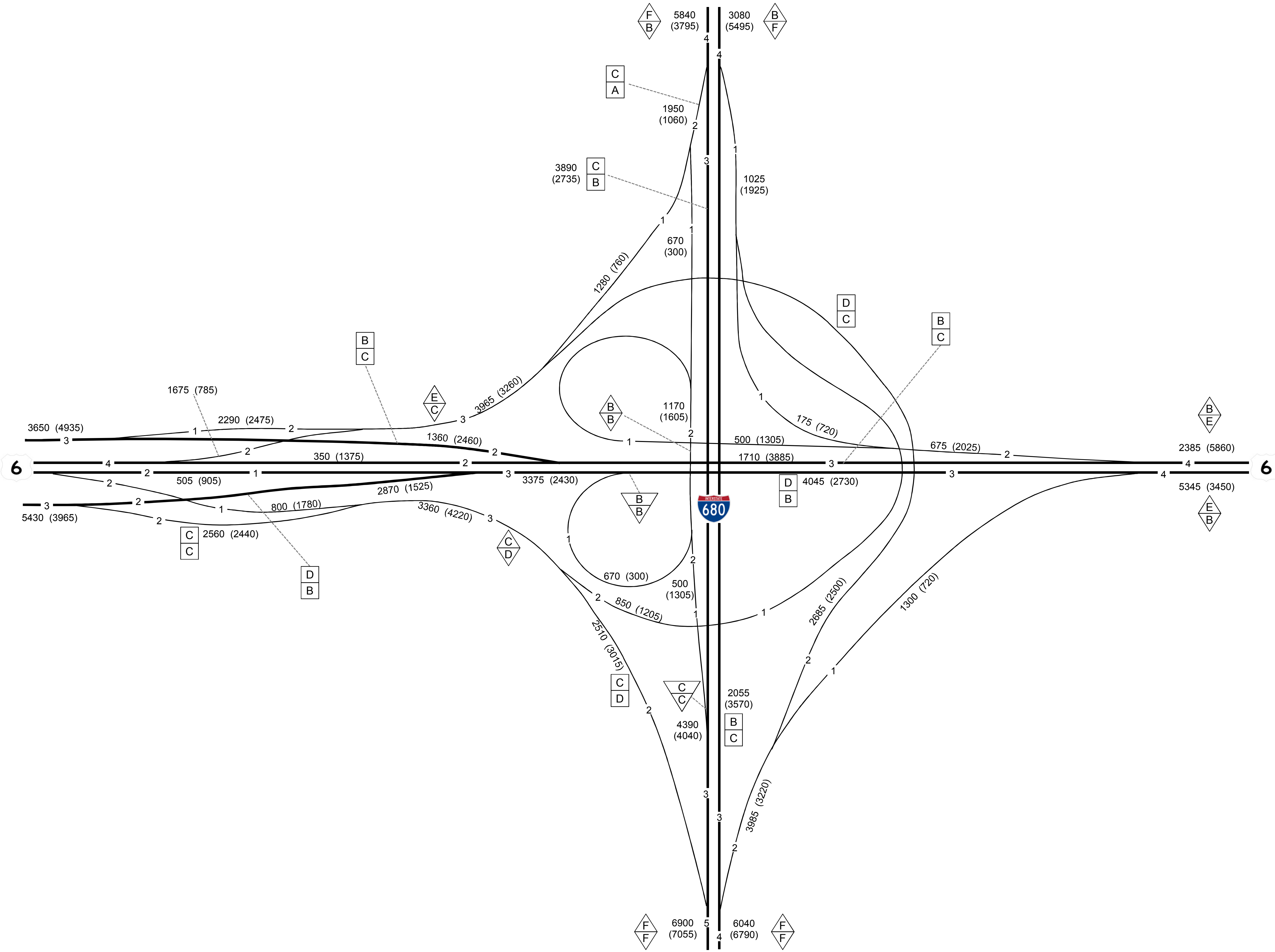


Figure A.1: Existing Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

I-680 & US 6 Interchange

Note:

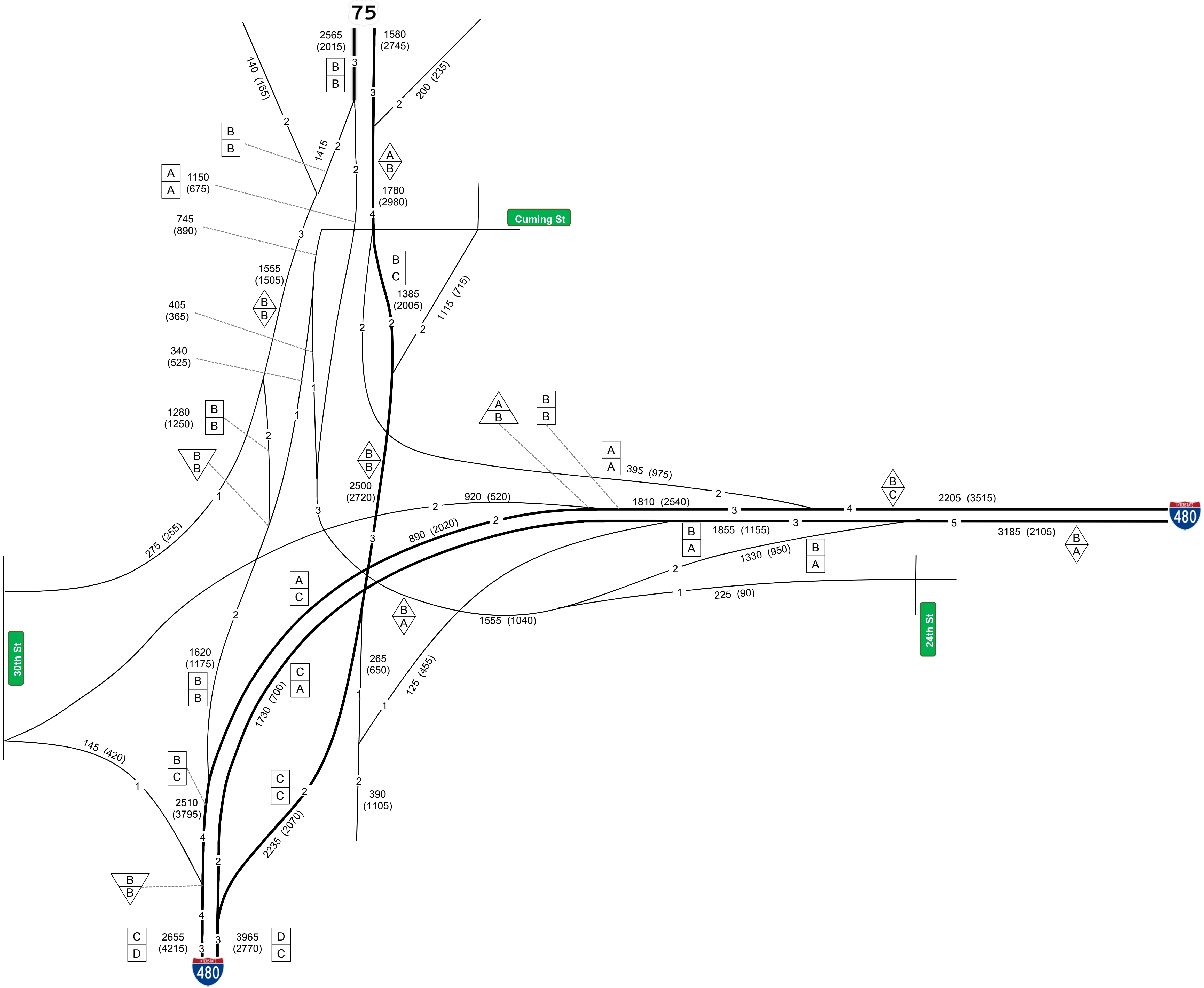
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.1: Existing Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS
X / X — AM Ramp Merge LOS / PM Ramp Merge LOS
X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X — AM Weave LOS / PM Weave LOS

I-480 & US 75 Interchange

Note:

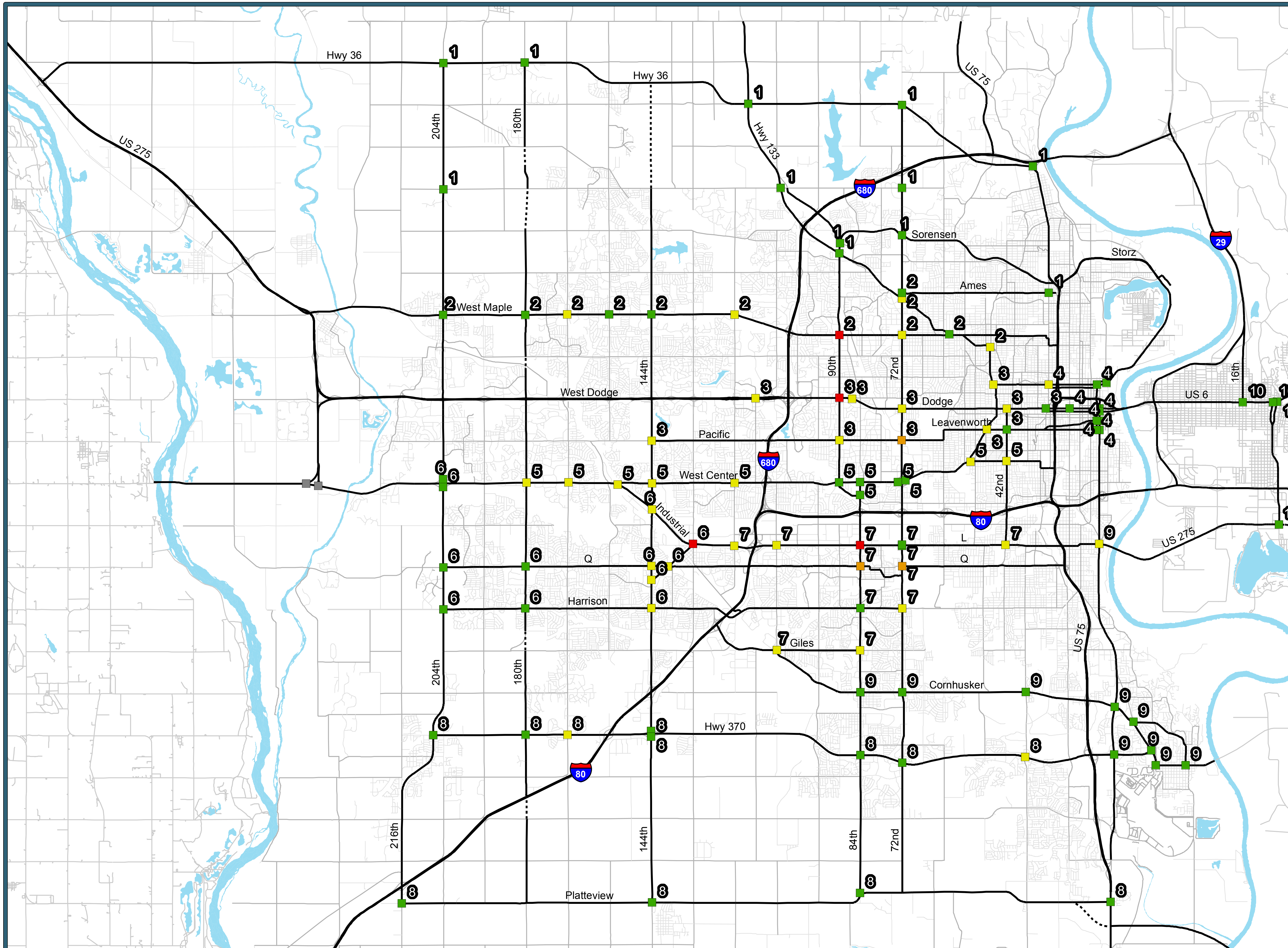
For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

Figure A.2: Existing Non-Freeway Intersection Traffic Operations Key Map



Legend

ICU / Synchro LOS

- A-C
- D
- E
- F
- N/A

Study Roadway

Note:
- Worst case LOS displayed
- Intersection number corresponds to ICU figure on the following pages

N

Metro Area Travel Improvement Study

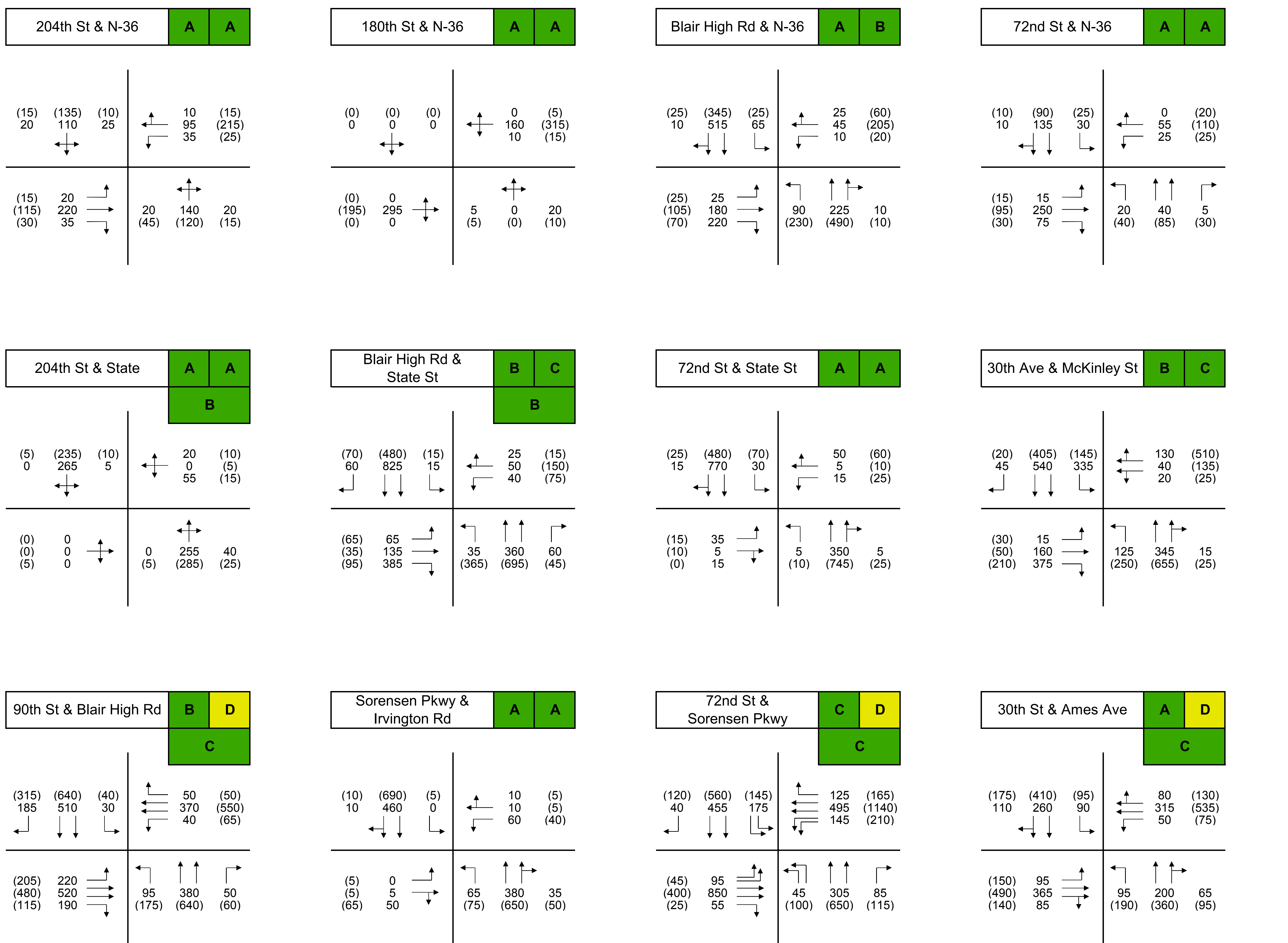


Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A, B, C, D, E, F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

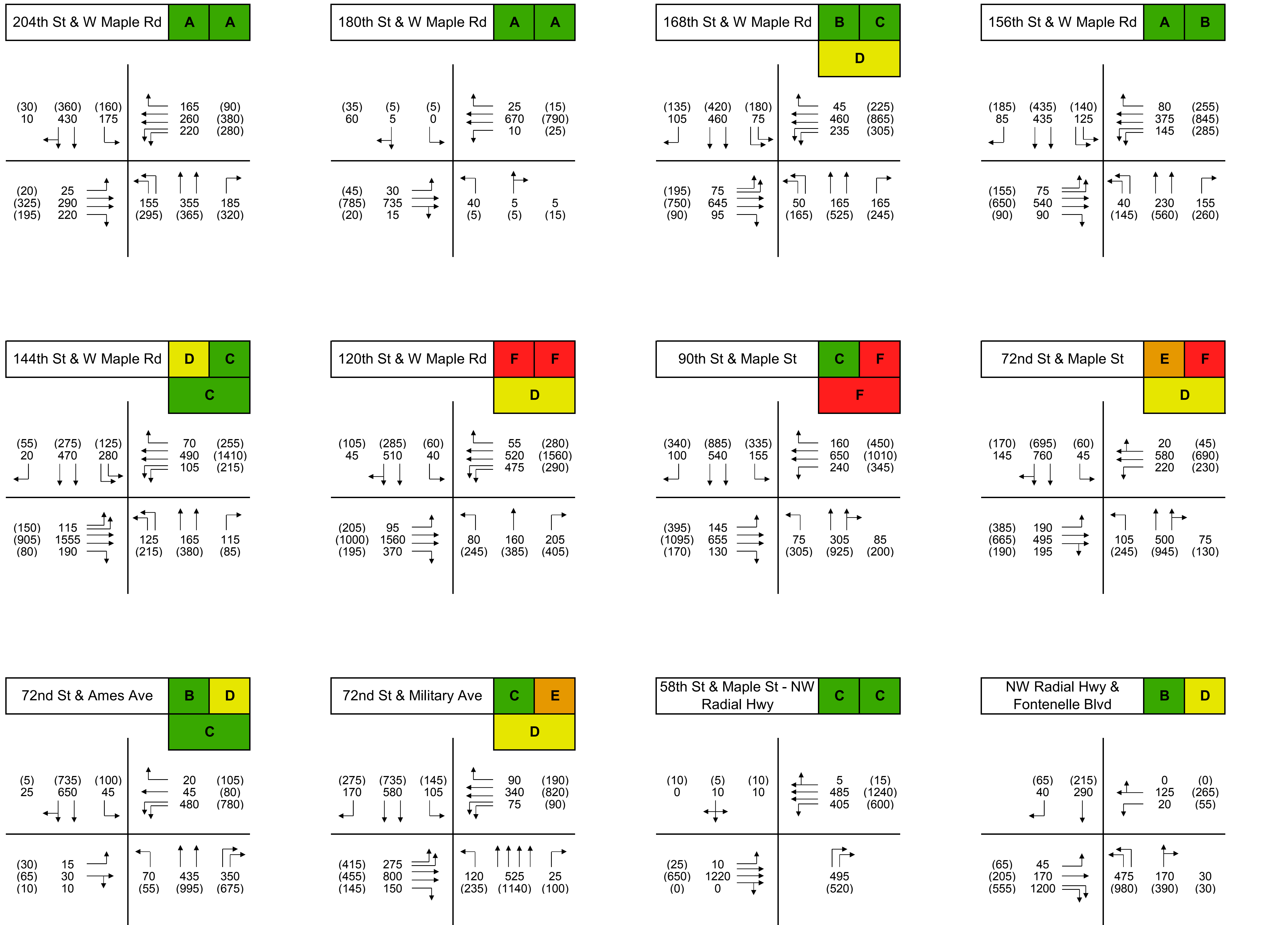


Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
→ Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

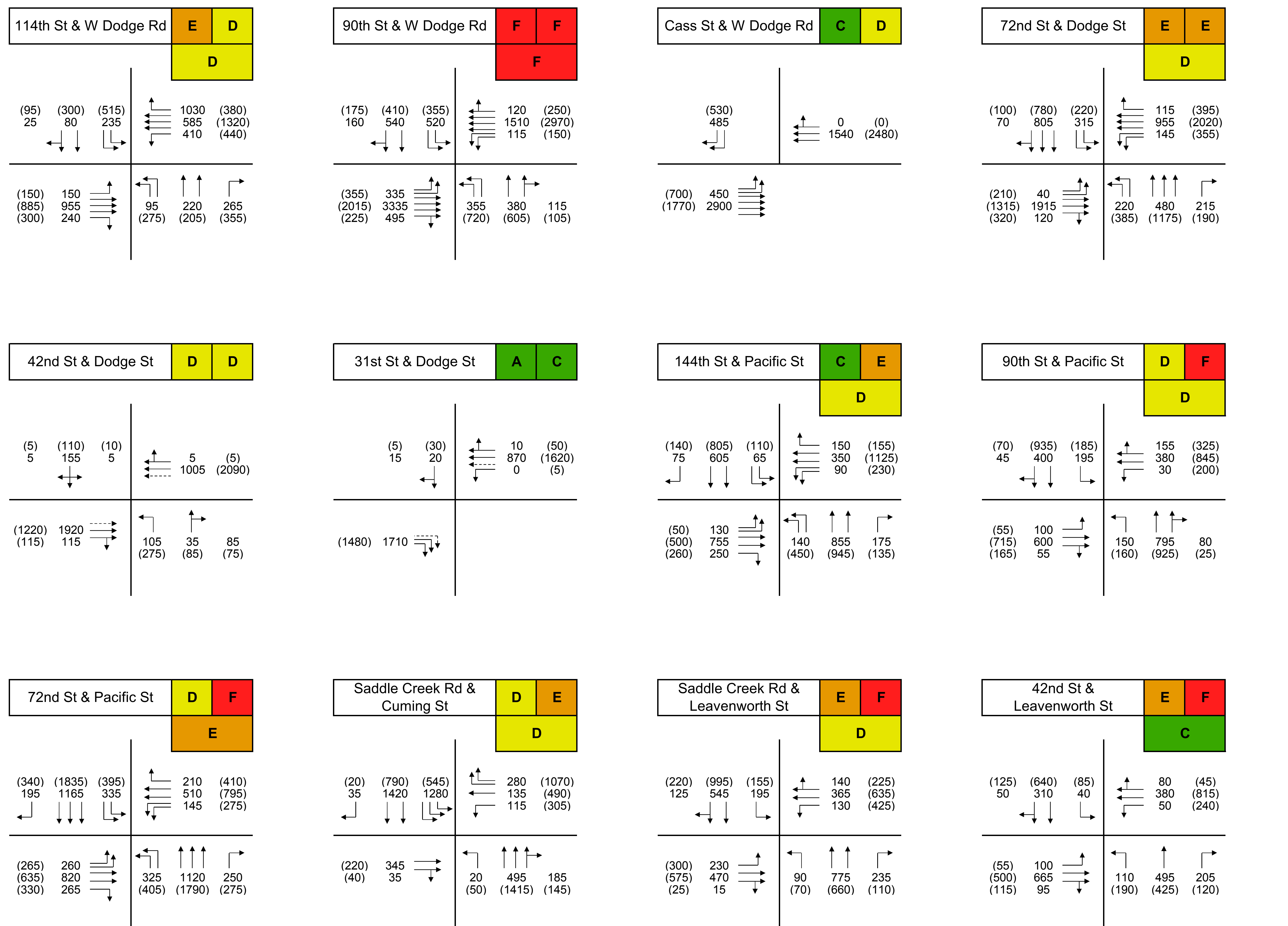


Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Reversible Lane

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

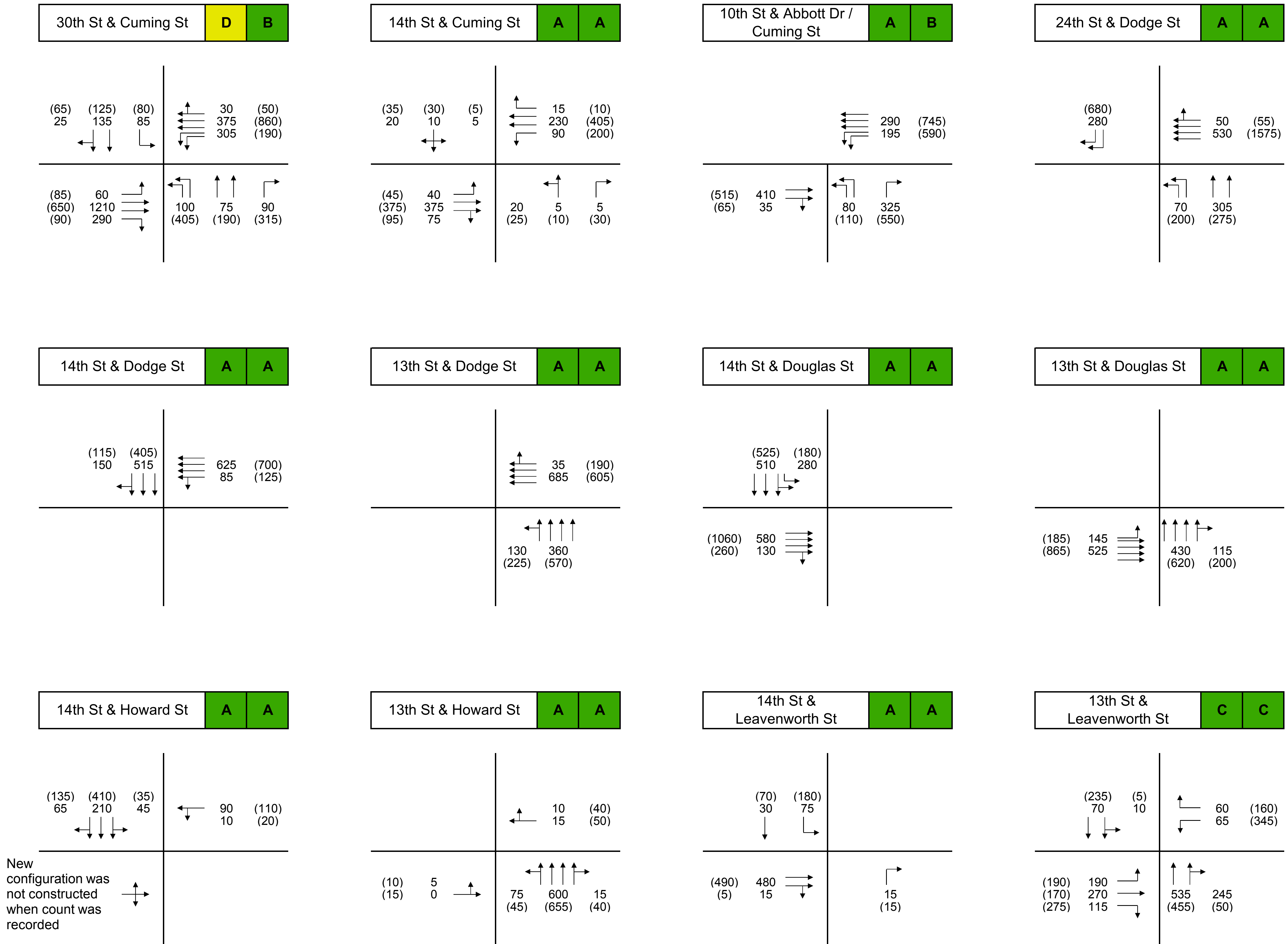


Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

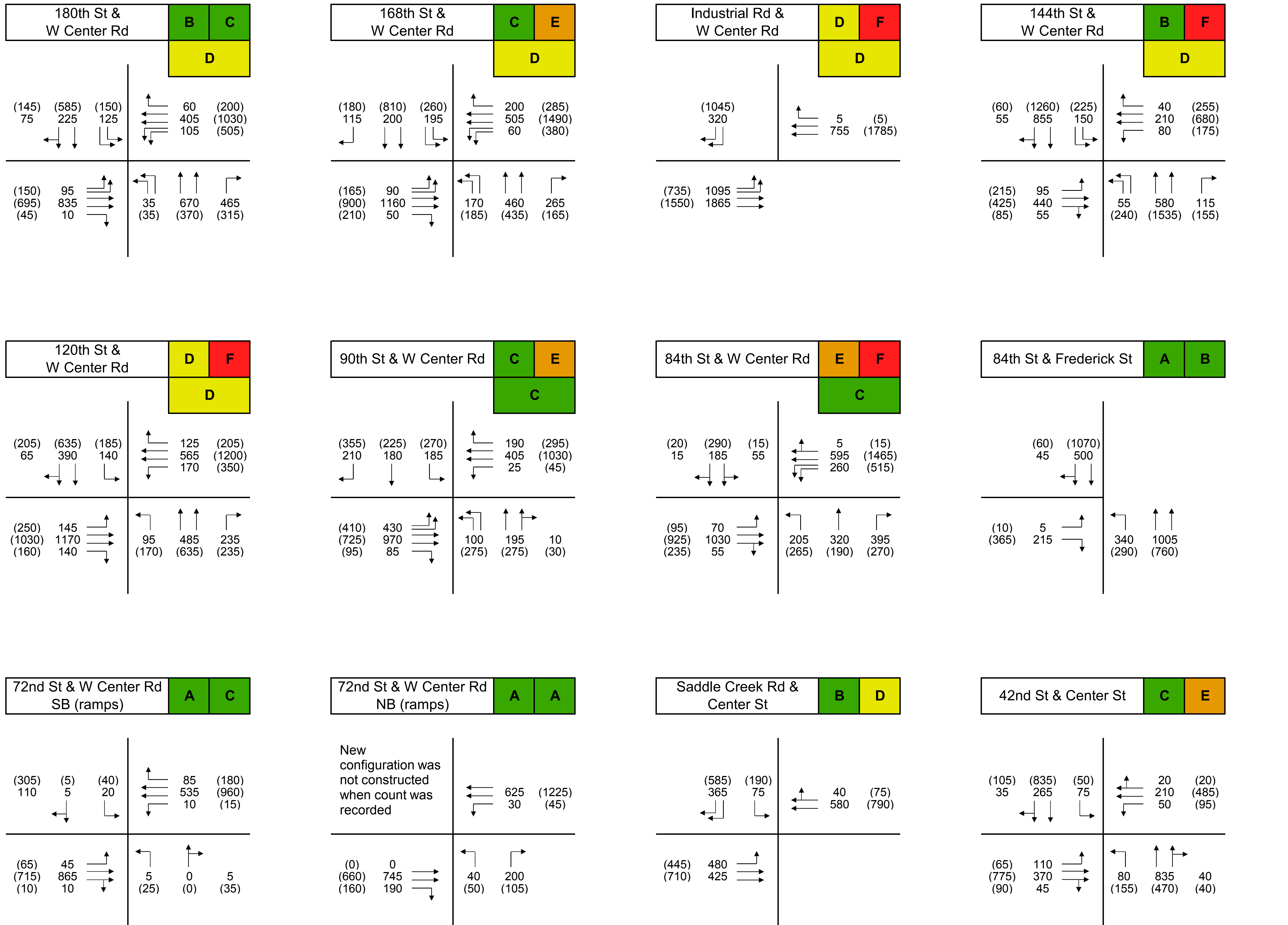


Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
→ Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

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Metro Area Travel Improvement Study

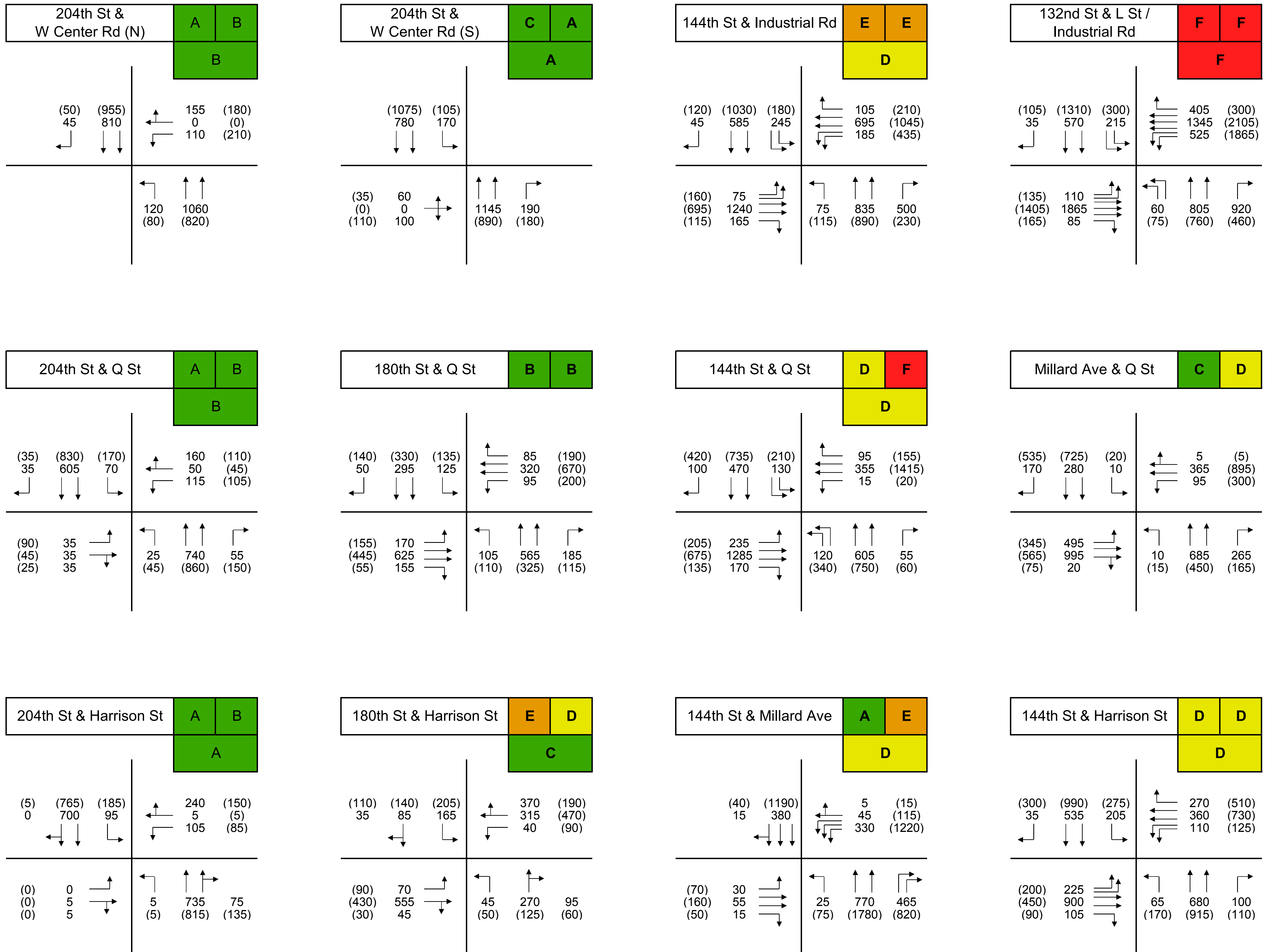

Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A D
B E
C F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

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Metro Area Travel Improvement Study

Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

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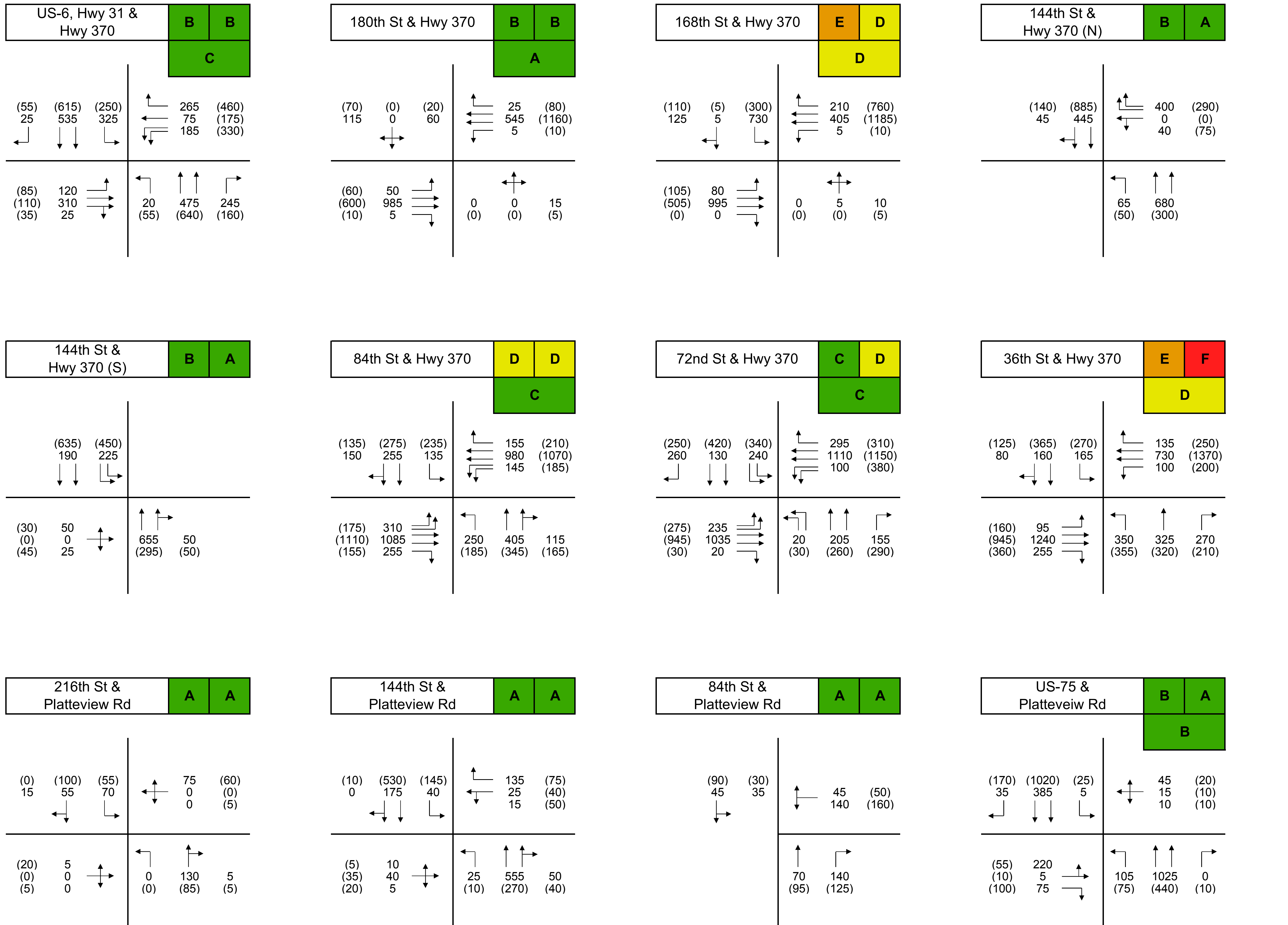

Figure A.3: Existing Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

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Metro Area Travel Improvement Study

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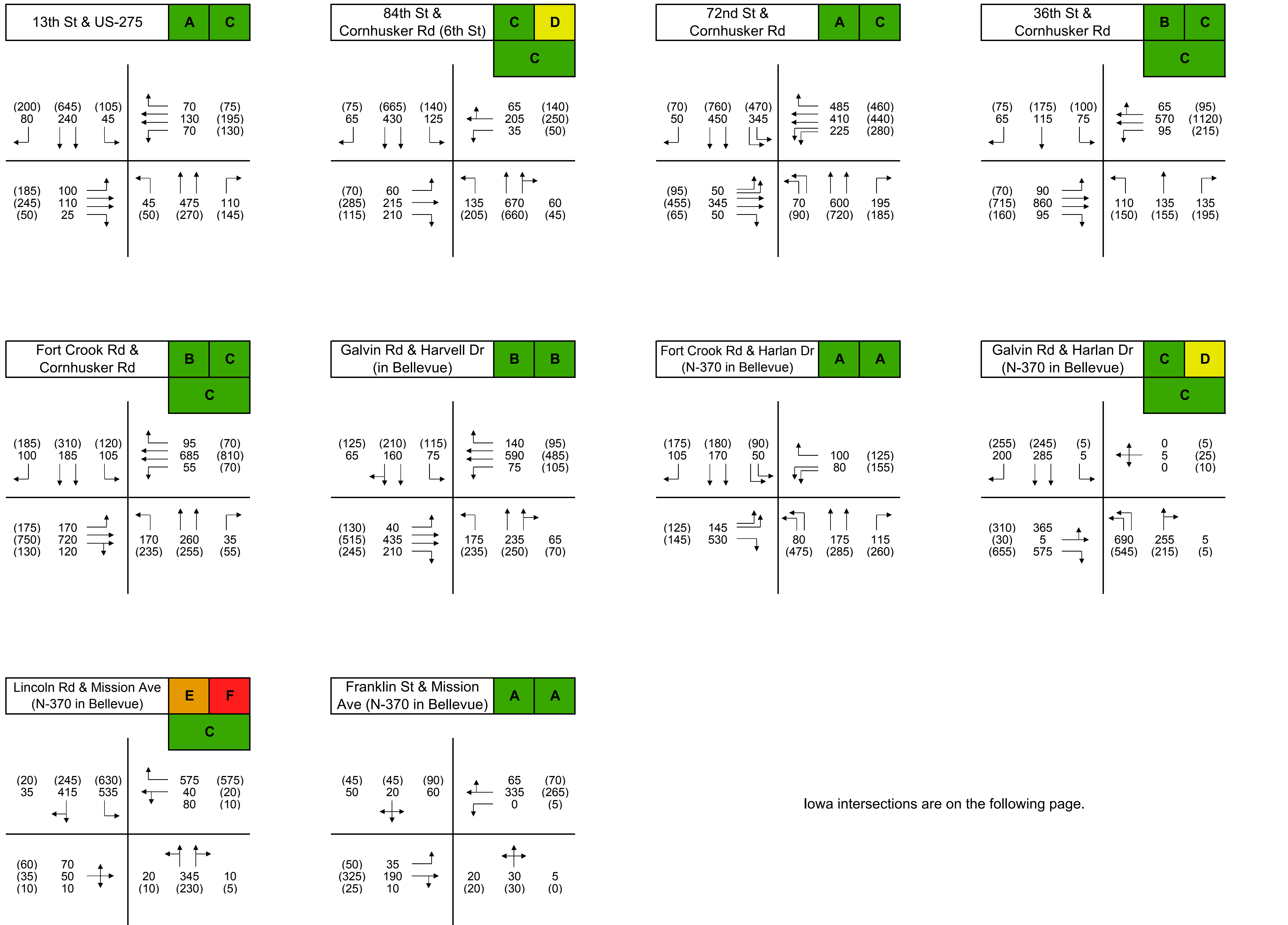

Iowa intersections are on the following page.

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
→ Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

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Metro Area Travel Improvement Study

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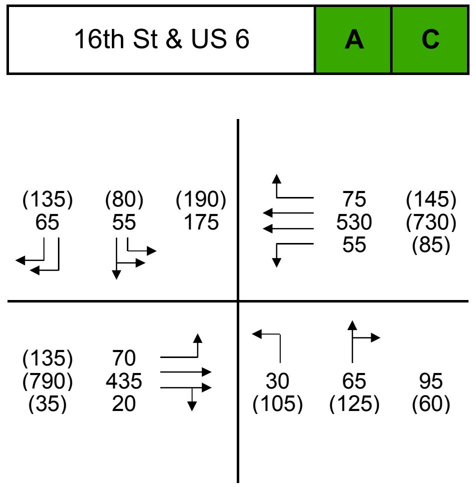

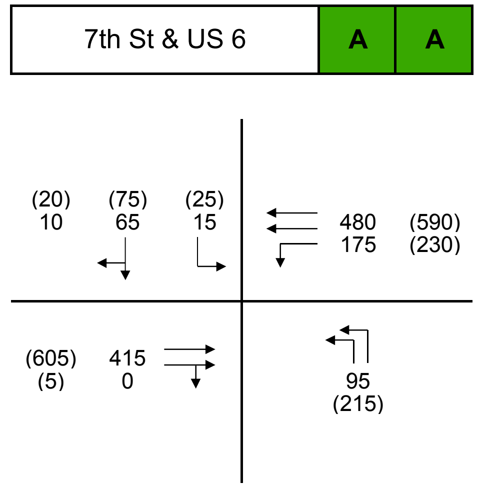

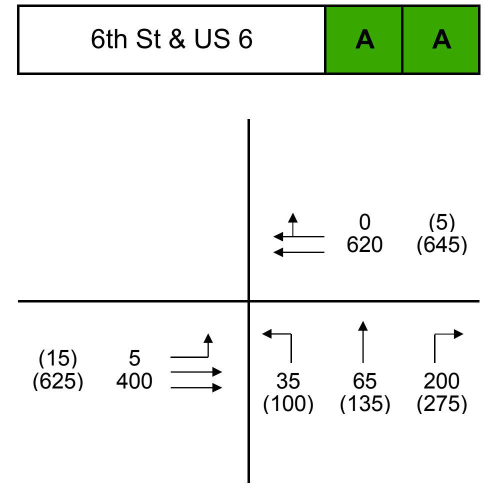

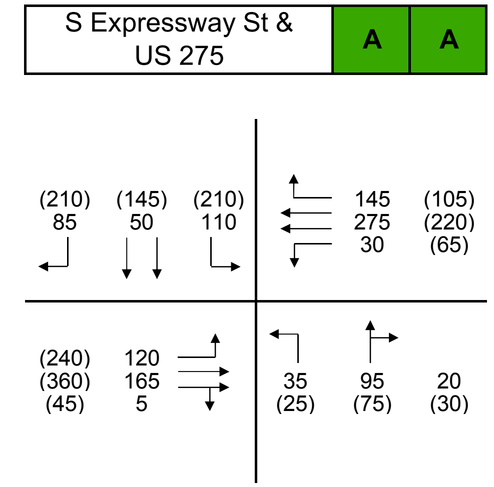

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A D
B E
C F

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Metro Area Travel Improvement Study

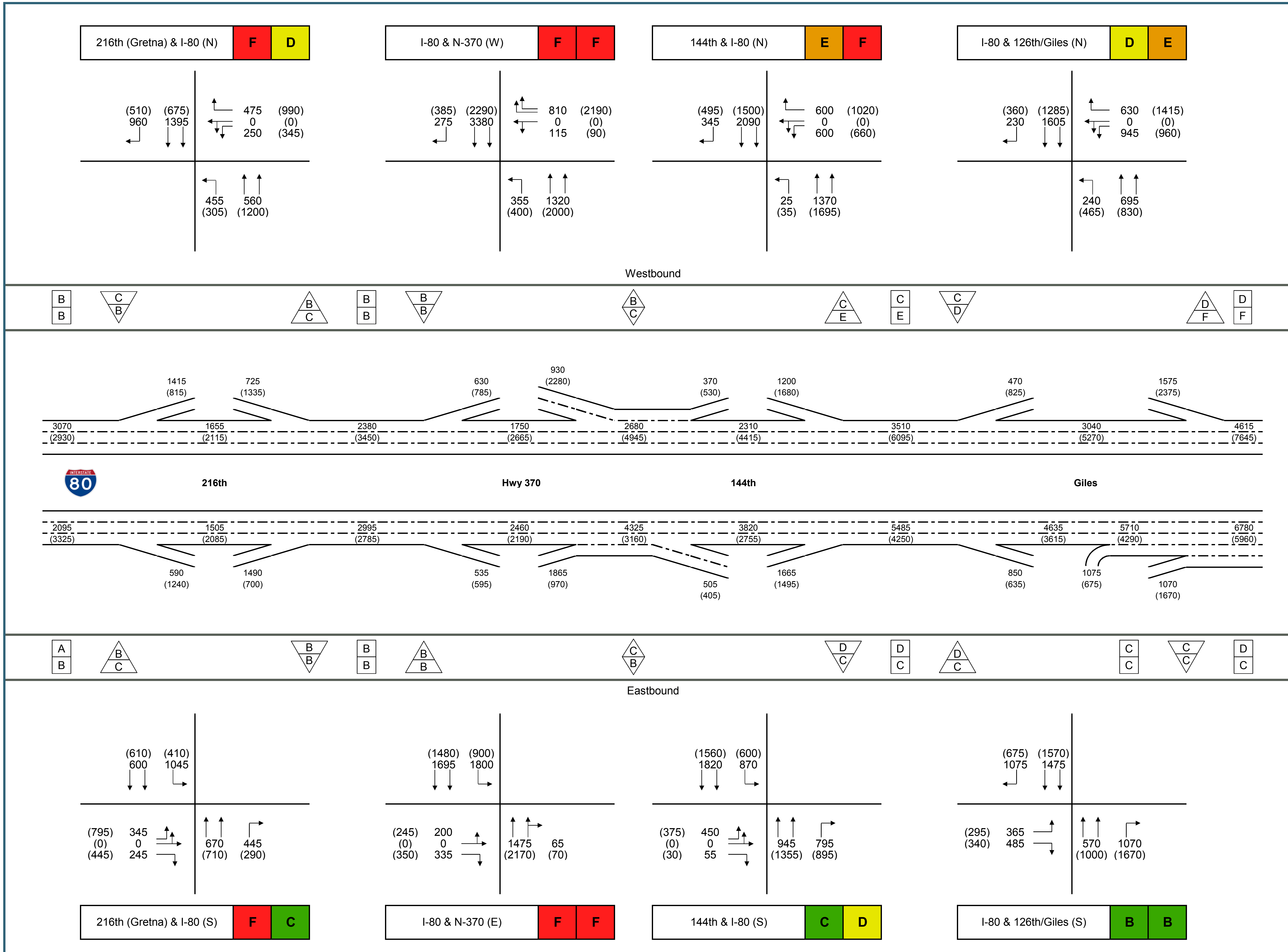

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

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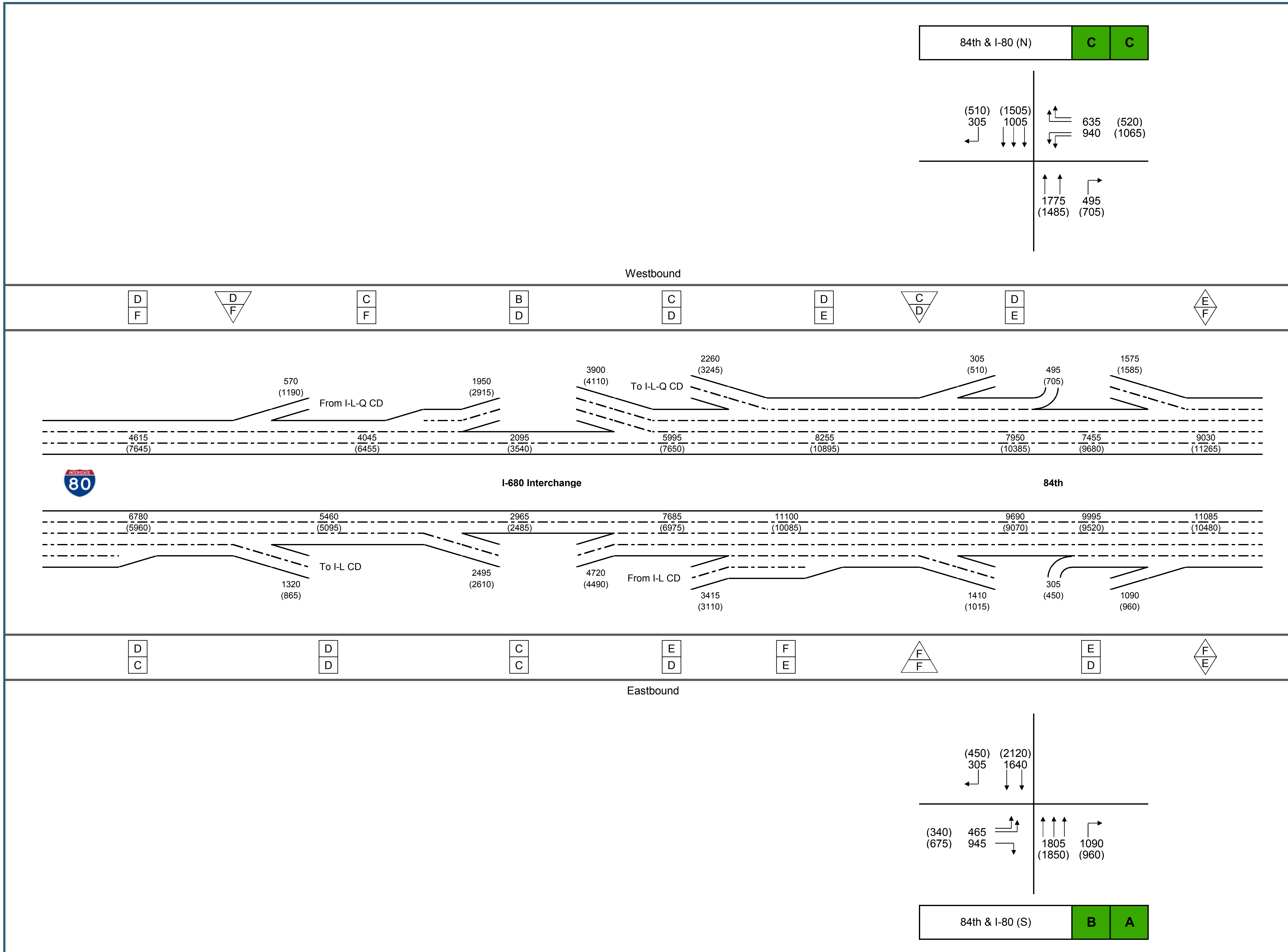

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS
AM Ramp Merge LOS
PM Ramp Merge LOS
AM Ramp Diverge LOS
PM Ramp Diverge LOS
AM Weave LOS
PM Weave LOS

Note:

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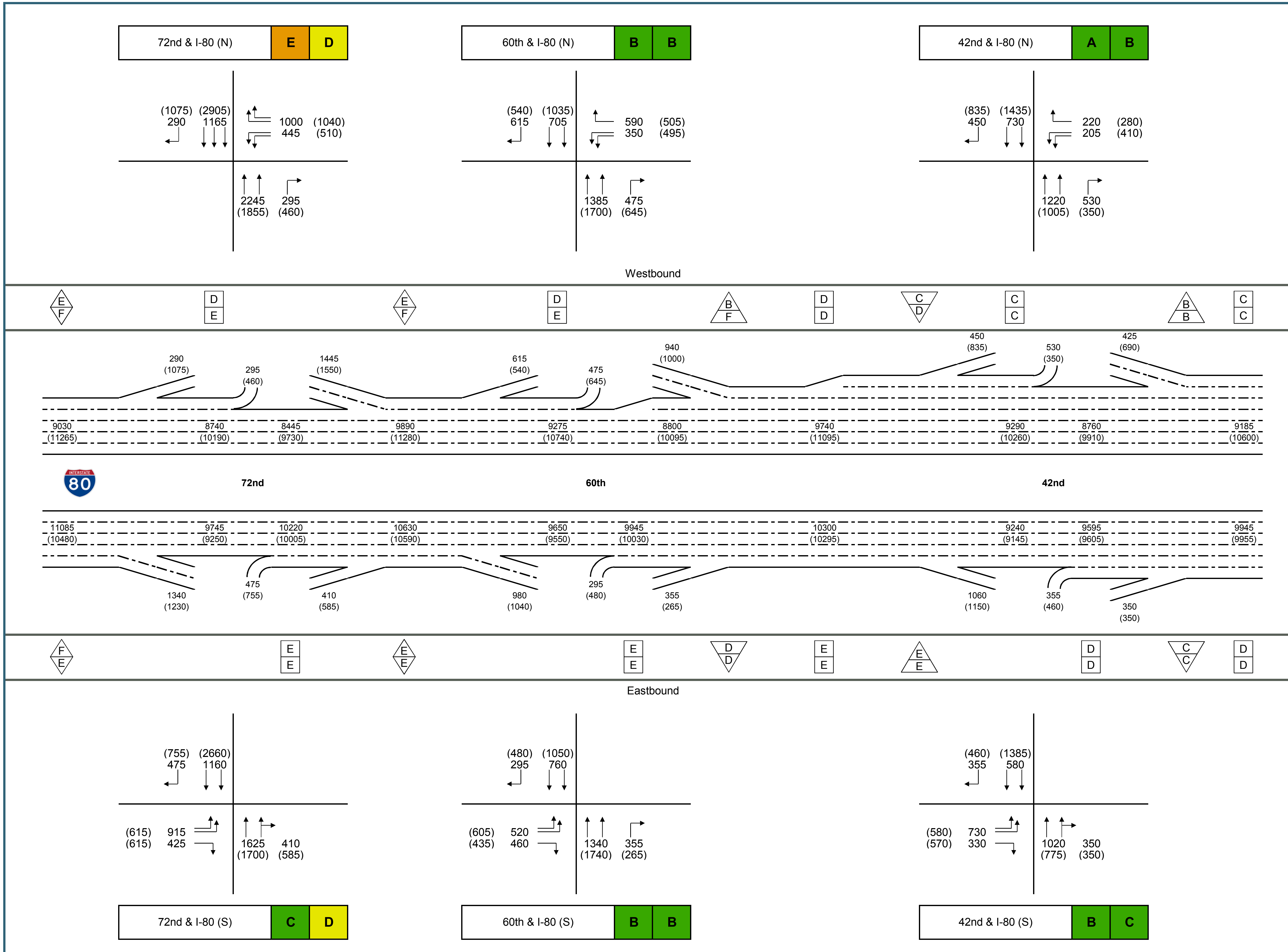

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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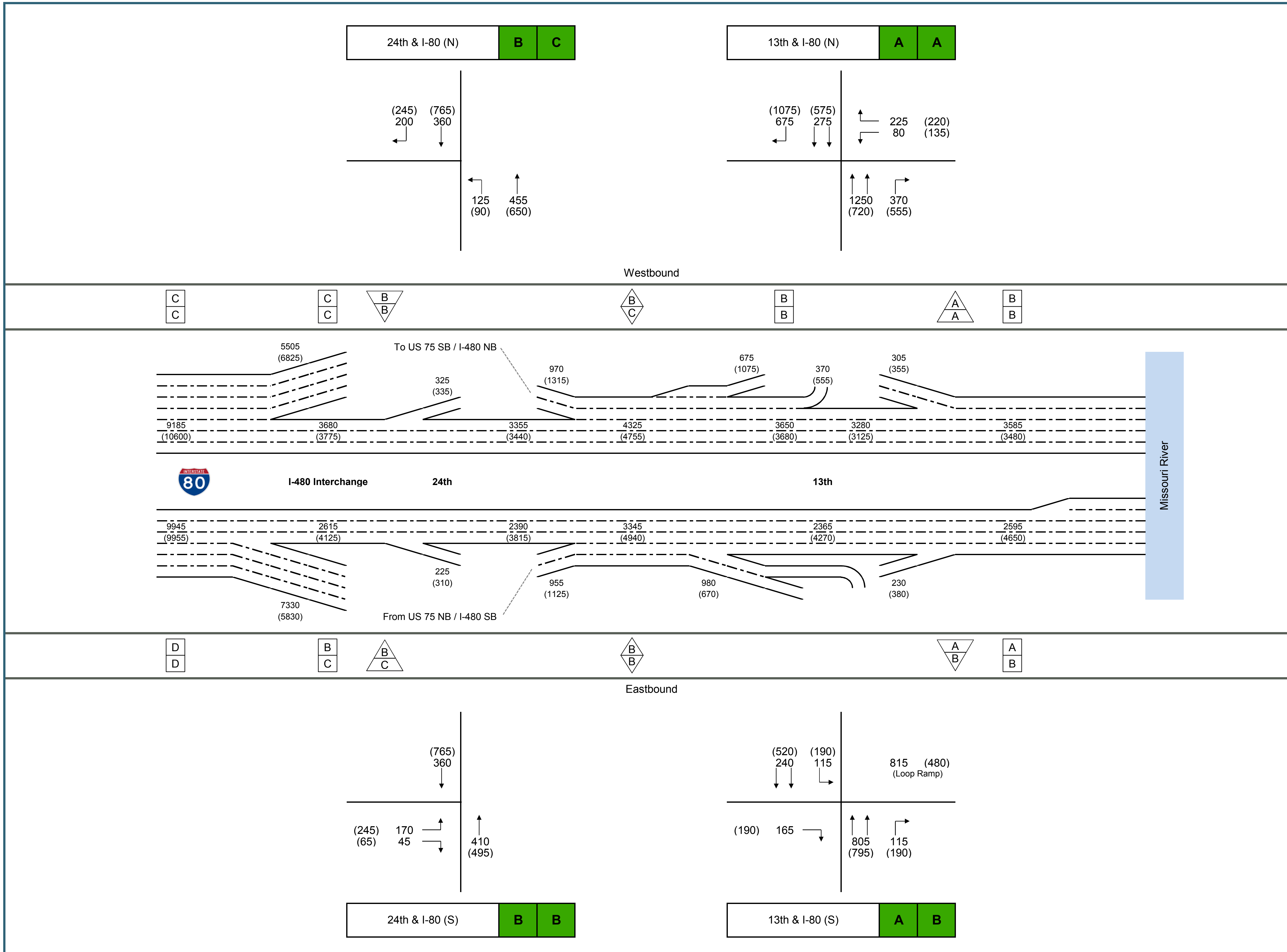

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X: AM Basic Freeway LOS / PM Basic Freeway LOS
X / X: AM Ramp Merge LOS / PM Ramp Merge LOS
X / X: AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X: AM Weave LOS / PM Weave LOS

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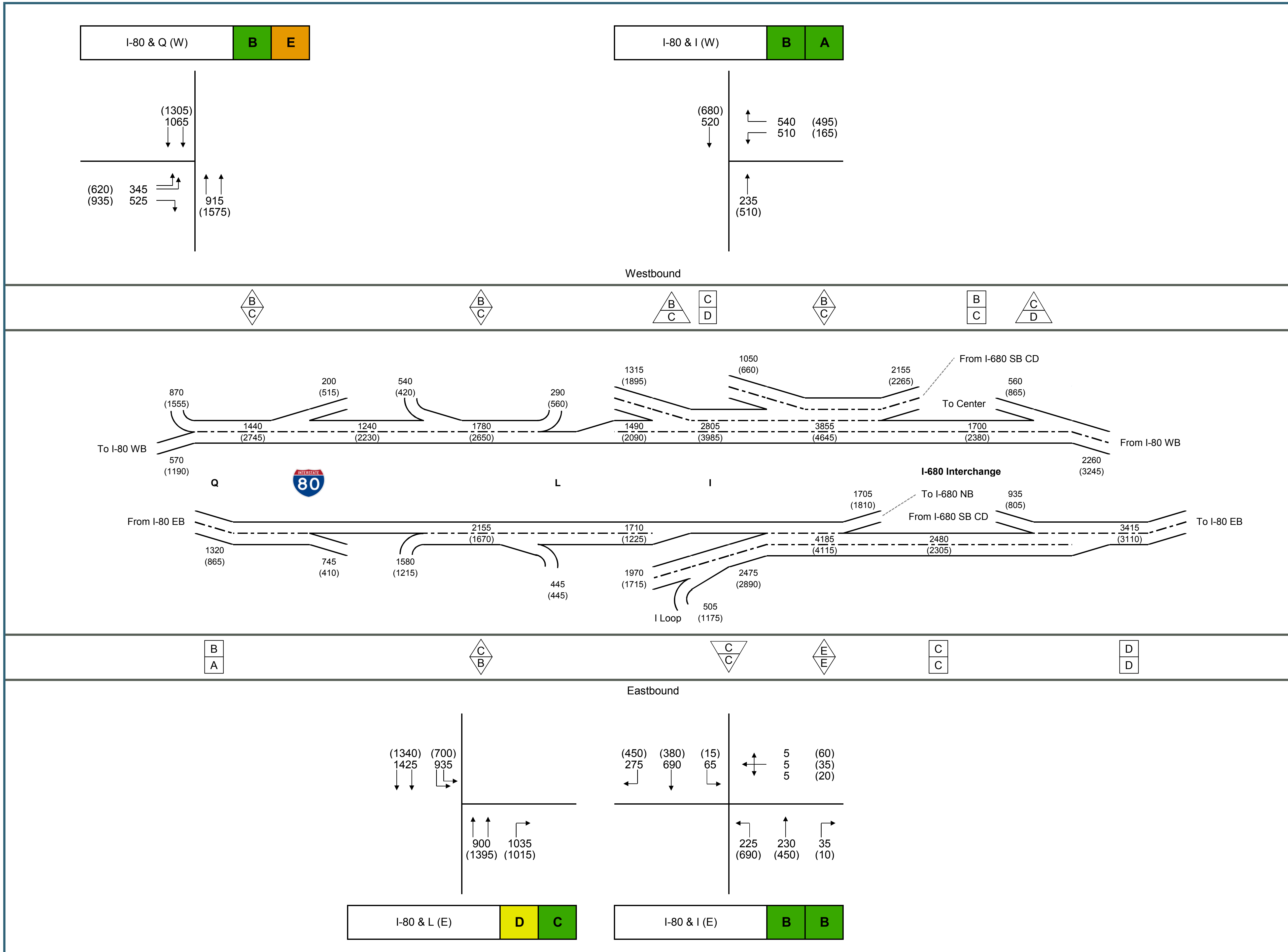

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

I-80 Collector-Distributor Road

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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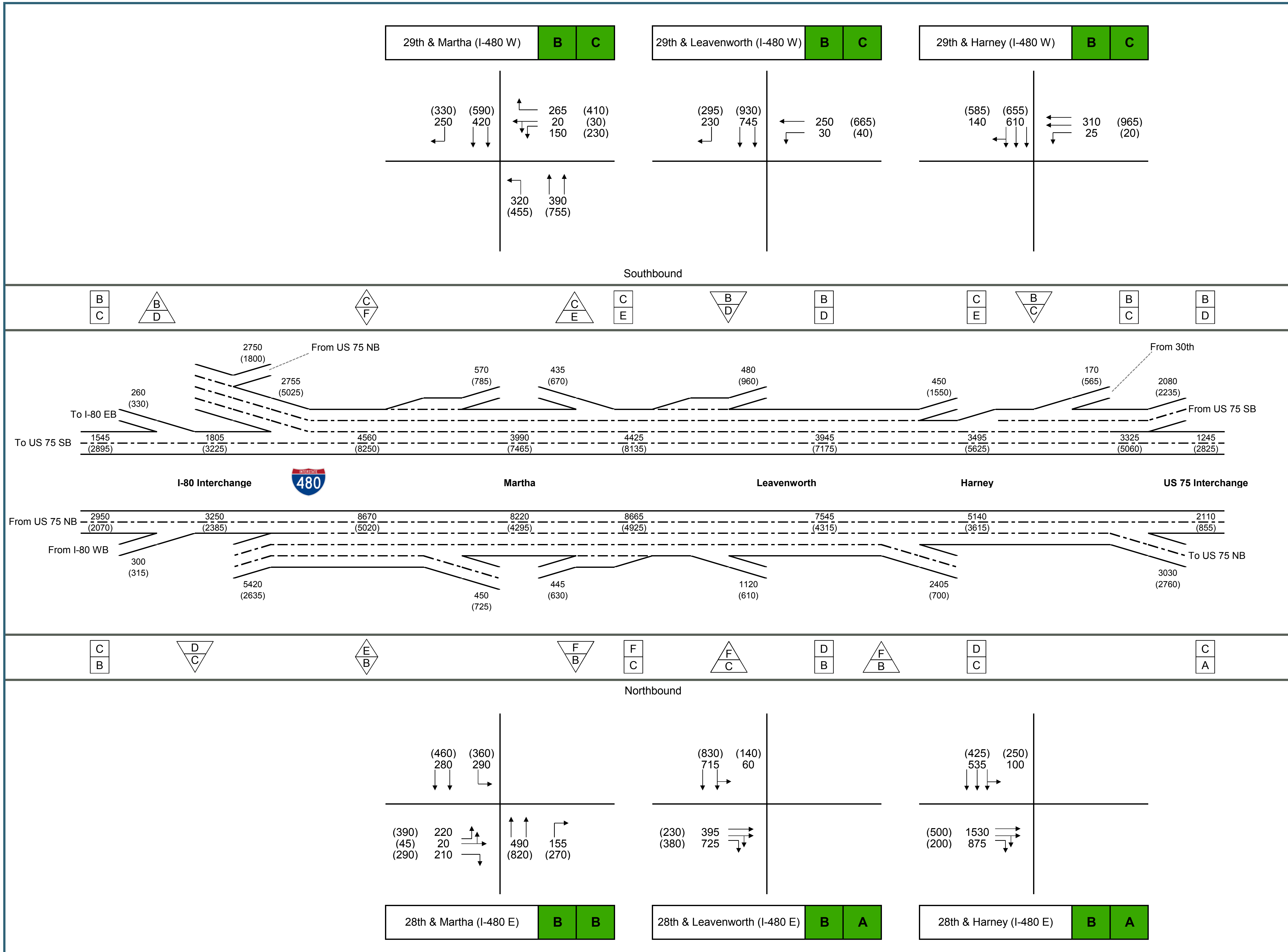
Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS / PM Basic Freeway LOS
AM Ramp Merge LOS / PM Ramp Merge LOS
AM Ramp Diverge LOS / PM Ramp Diverge LOS
AM Weave LOS / PM Weave LOS

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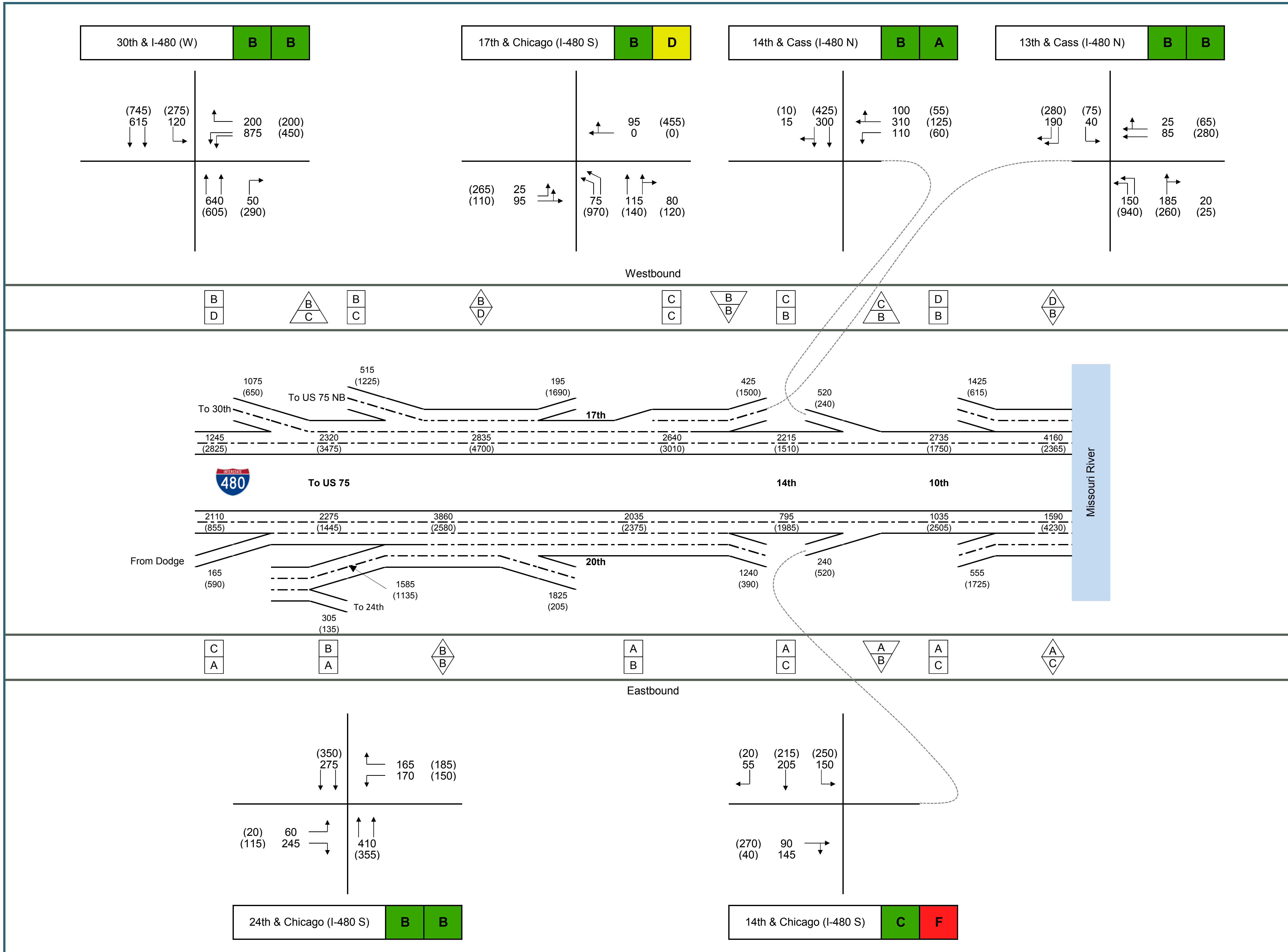

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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

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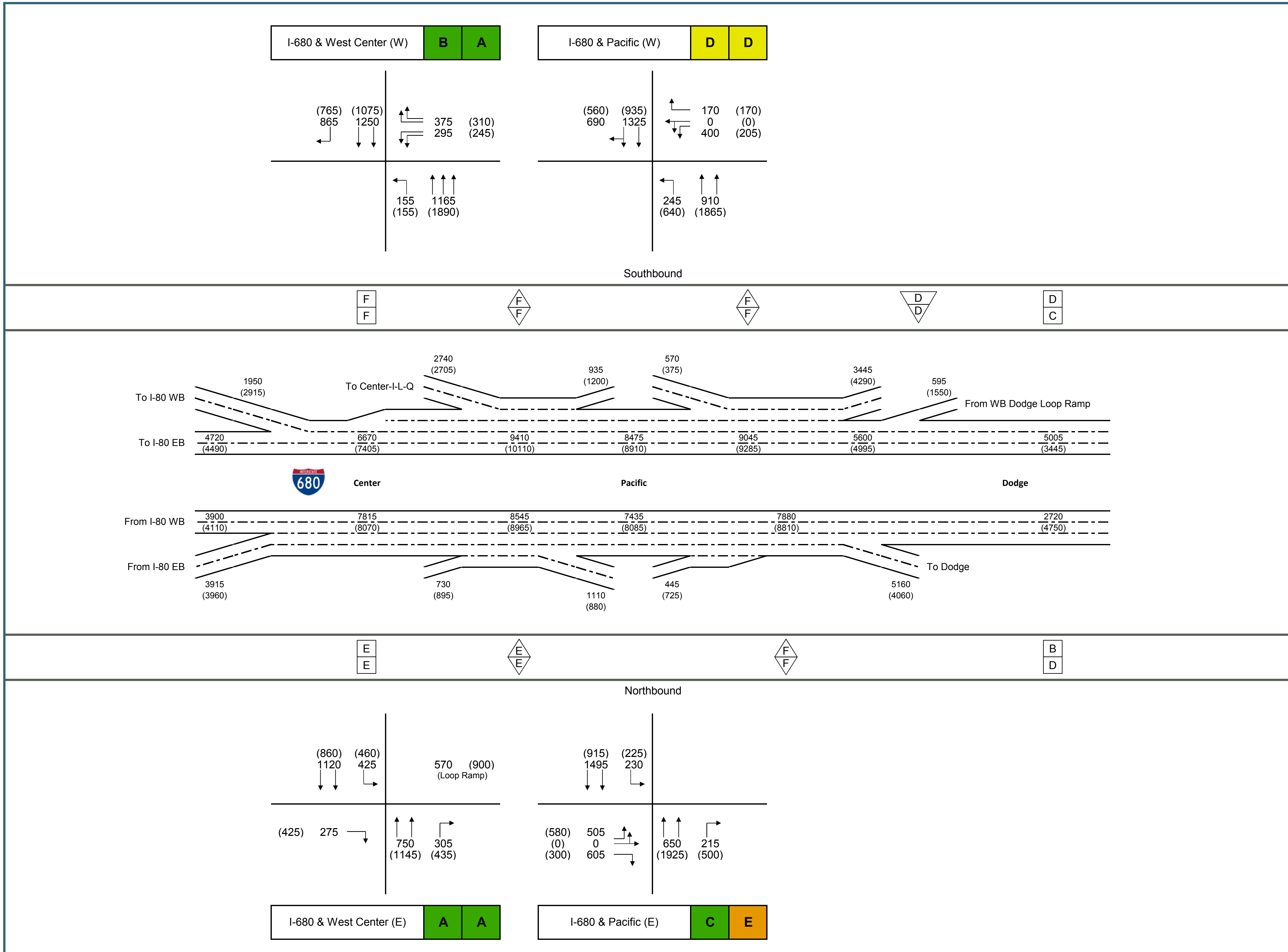
Metro Area Travel Improvement Study



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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

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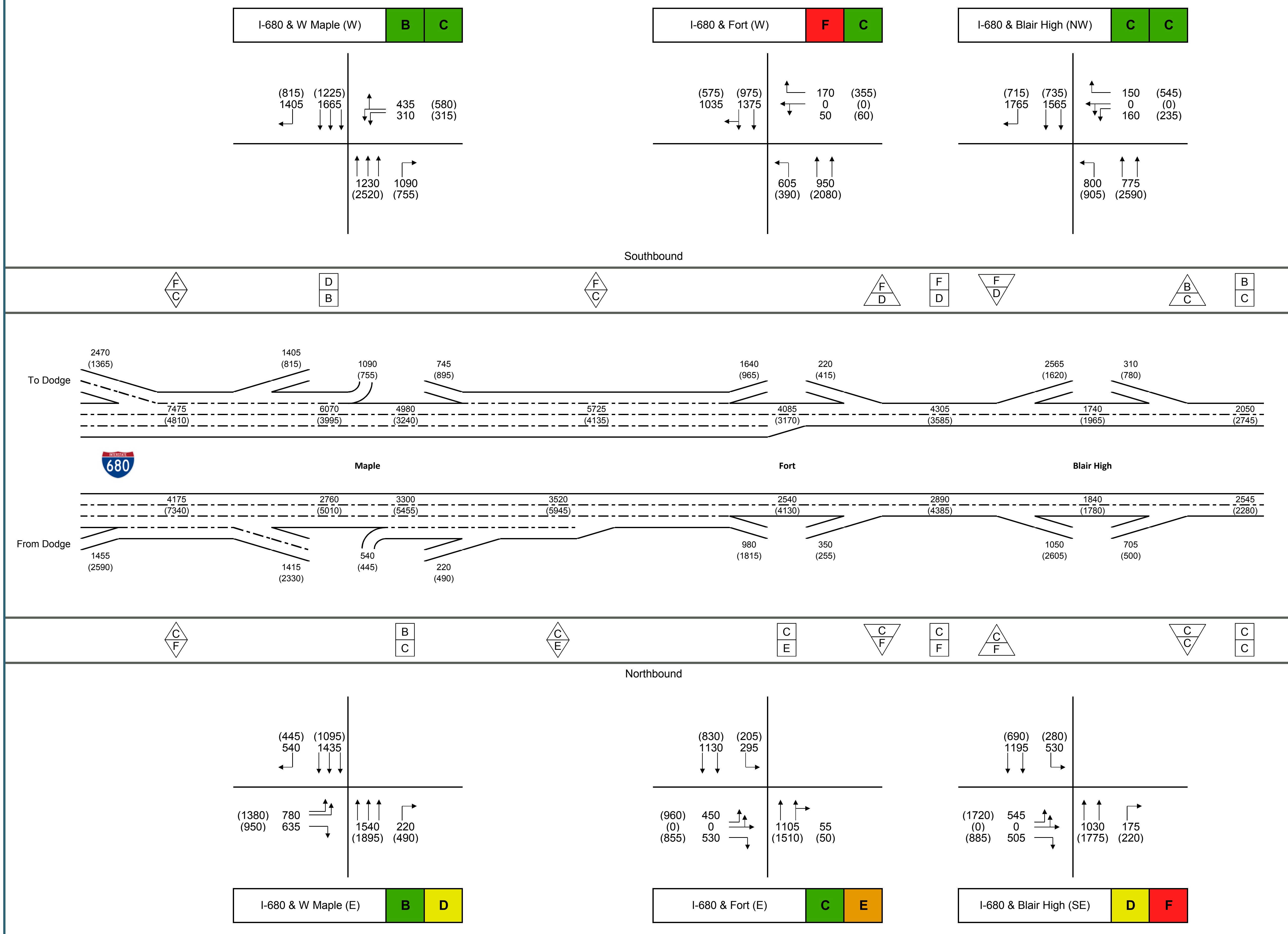
Metro Area Travel Improvement Study



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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

Note:

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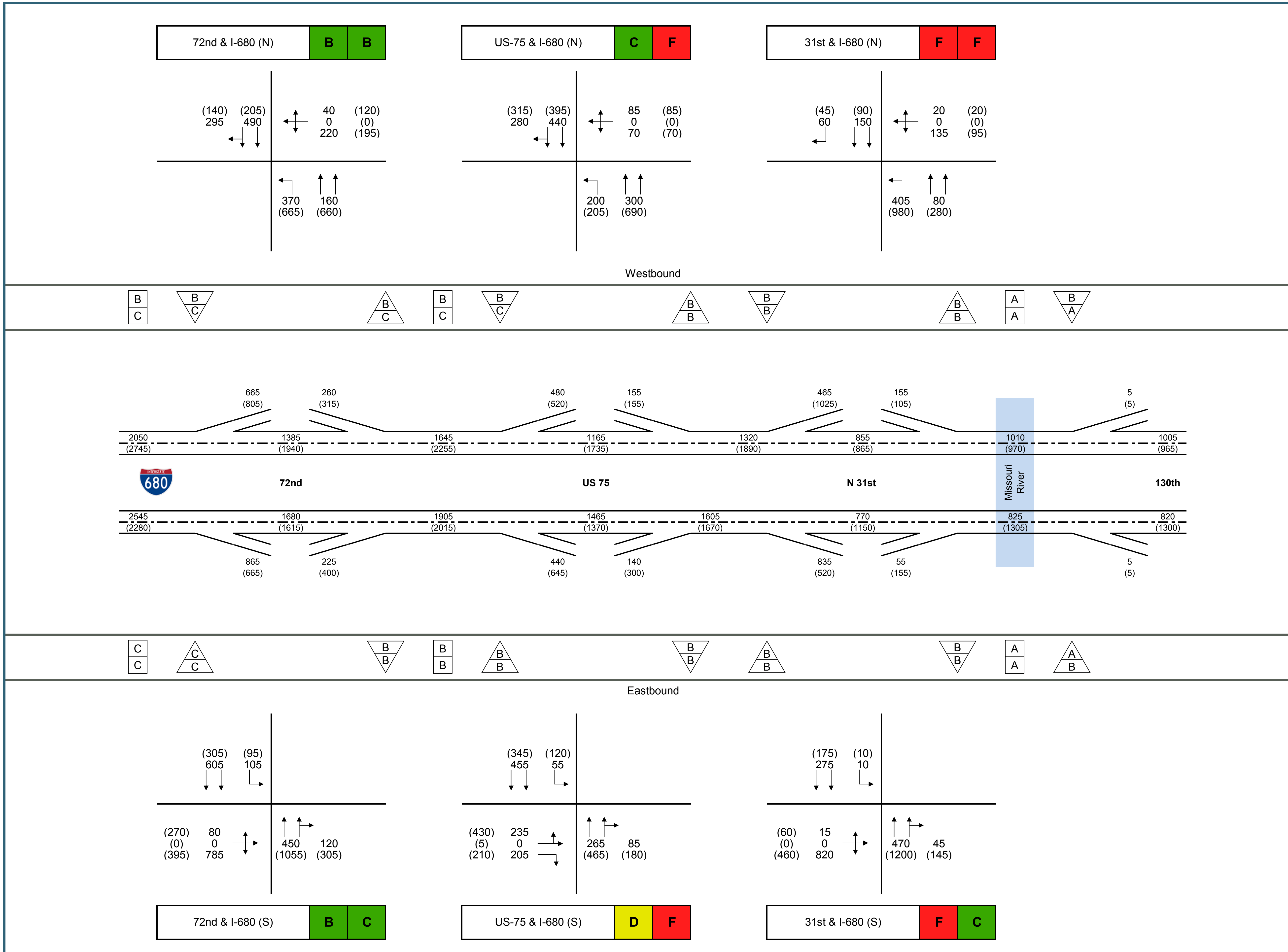

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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

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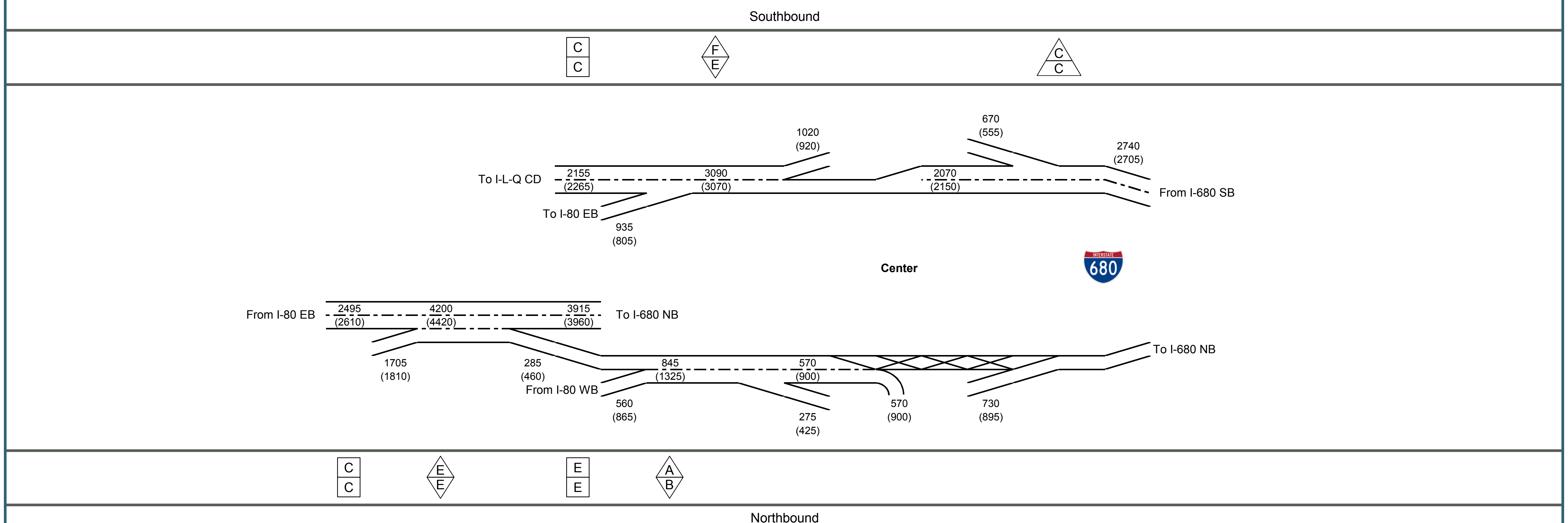
Metro Area Travel Improvement Study

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS / PM Basic Freeway LOS
AM Ramp Merge LOS / PM Ramp Merge LOS
AM Ramp Diverge LOS / PM Ramp Diverge LOS
AM Weave LOS / PM Weave LOS

I-680 Collector-Distributor Road

Note:

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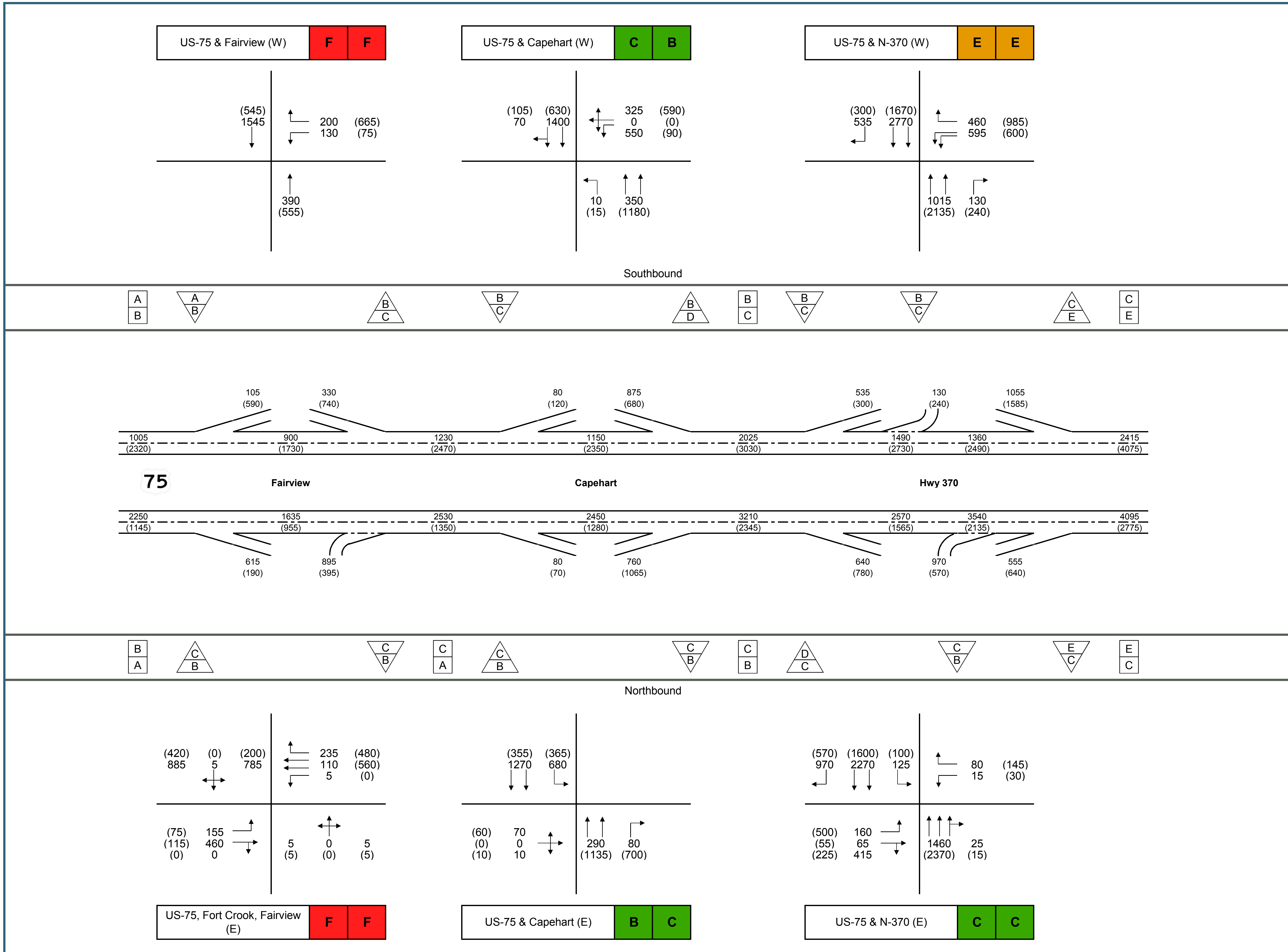
N

Metro Area Travel Improvement Study



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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

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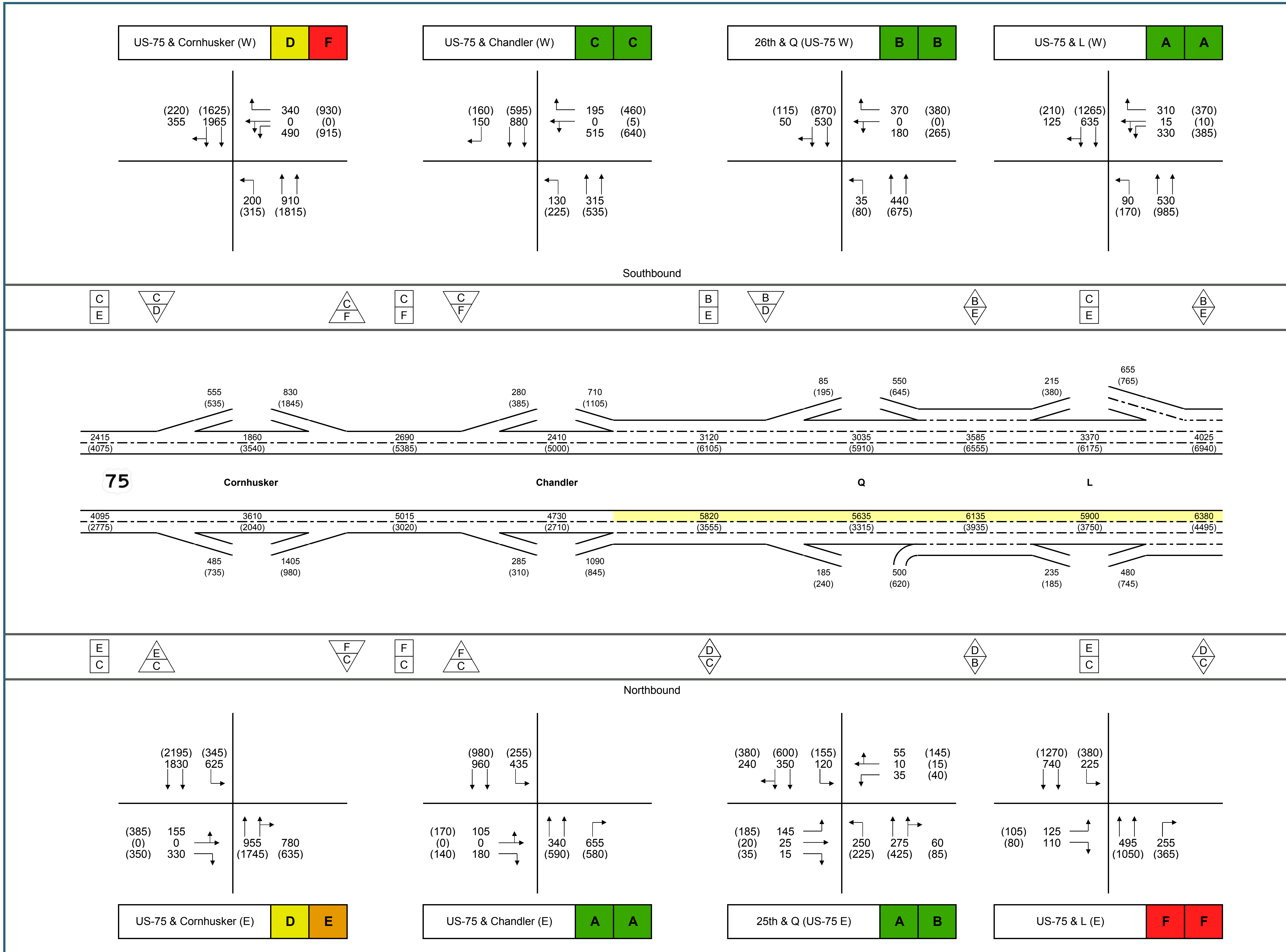

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

2040 E+C Lane Addition

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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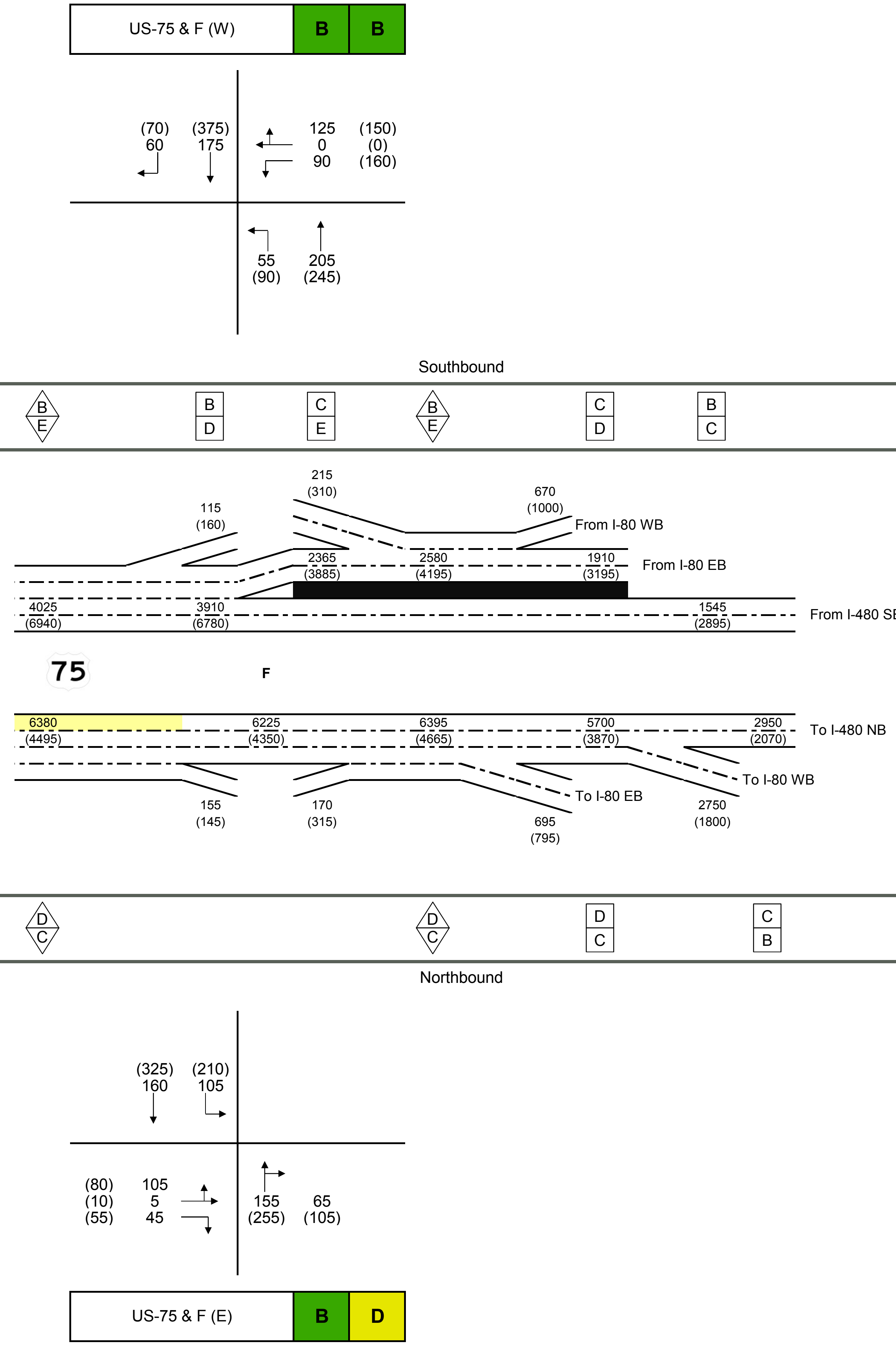

Legend

X,XXX	AM Peak Hour Volume
(X,XXX)	PM Peak Hour Volume
→	Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X (box)	AM Basic Freeway LOS PM Basic Freeway LOS
X / X (inverted triangle)	AM Ramp Merge LOS PM Ramp Merge LOS
X / X (triangle)	AM Ramp Diverge LOS PM Ramp Diverge LOS
X / X (diamond)	AM Weave LOS PM Weave LOS

2040 E+C Lane Addition

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

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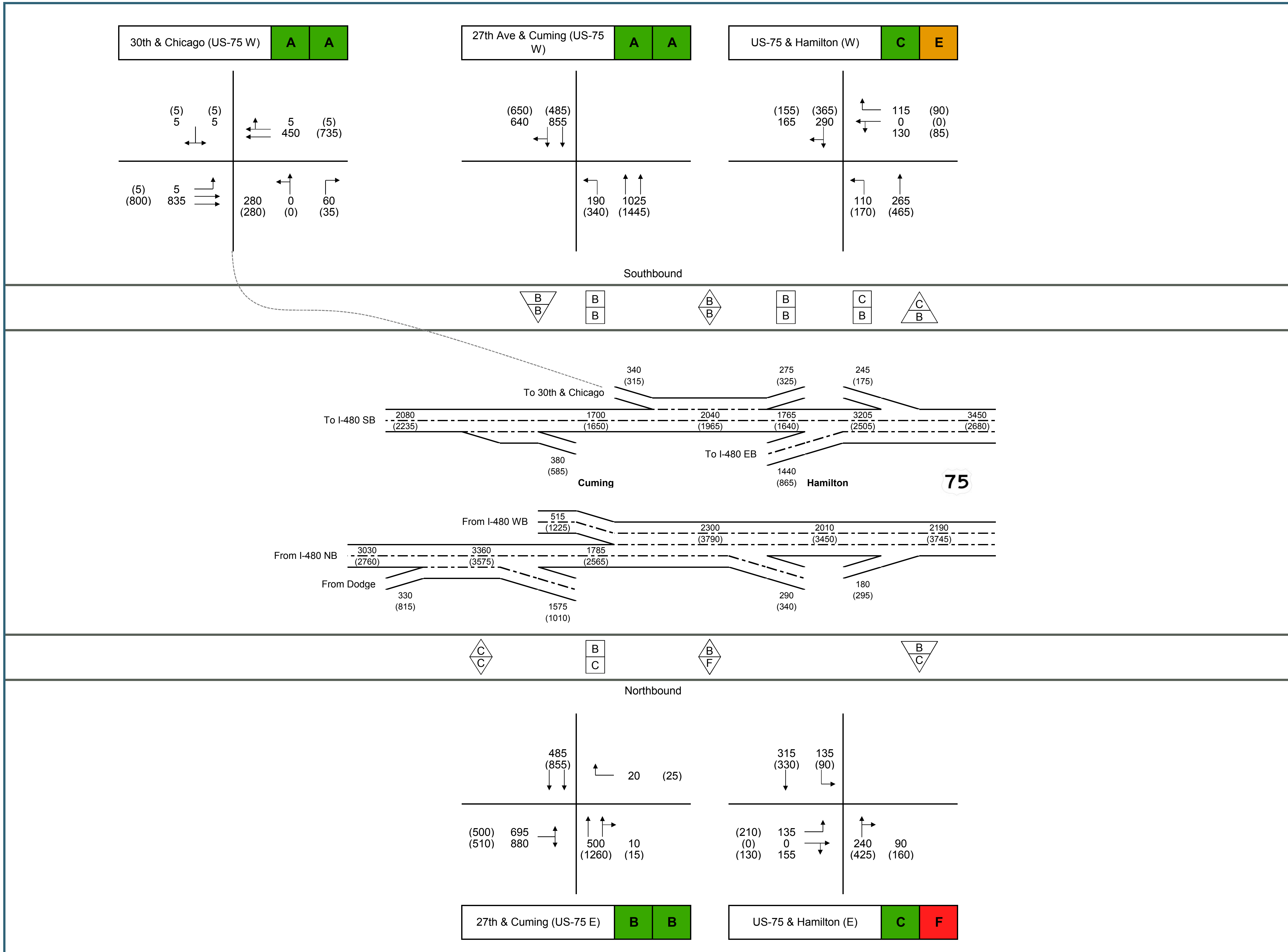

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

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Note:

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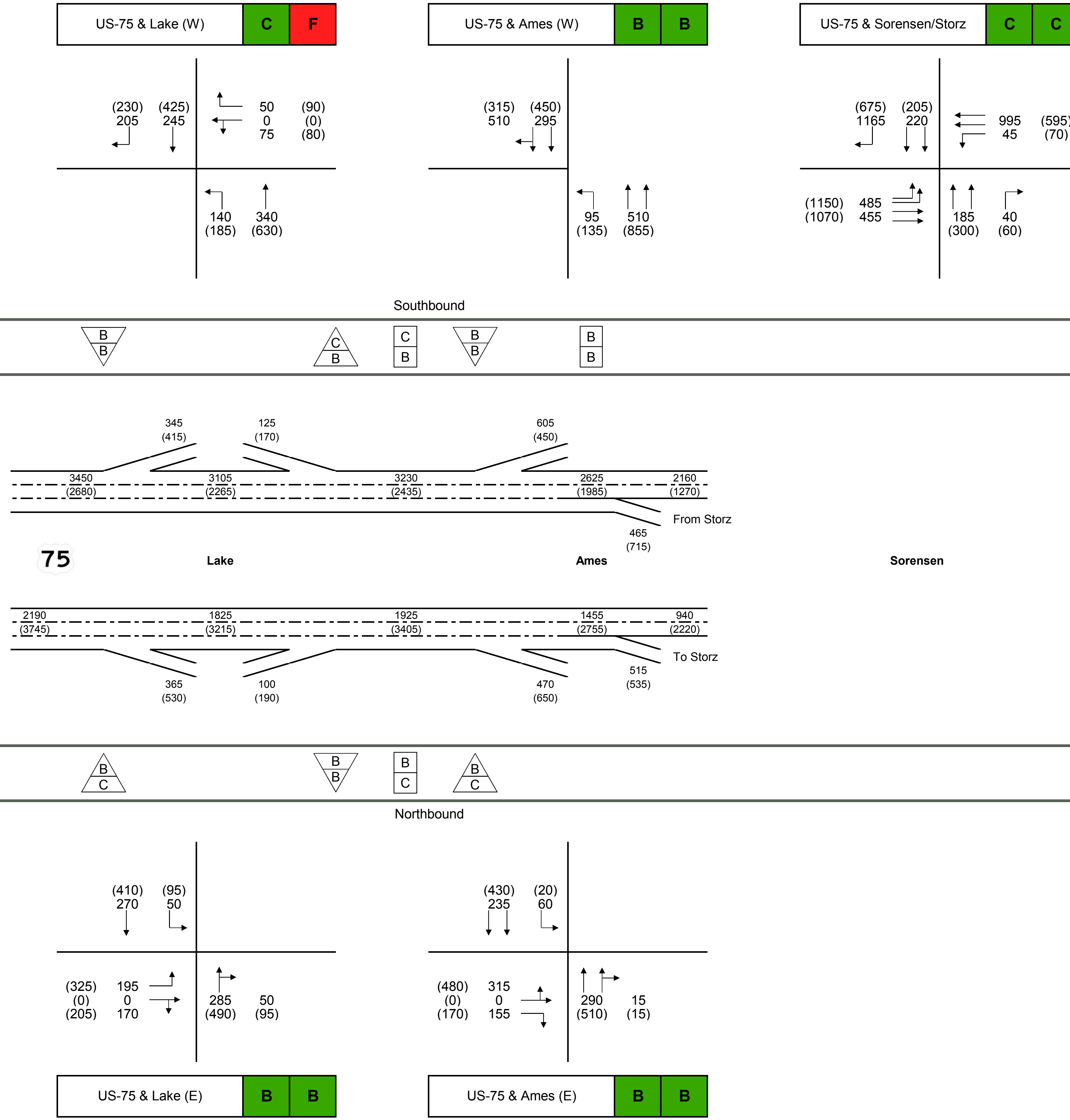

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

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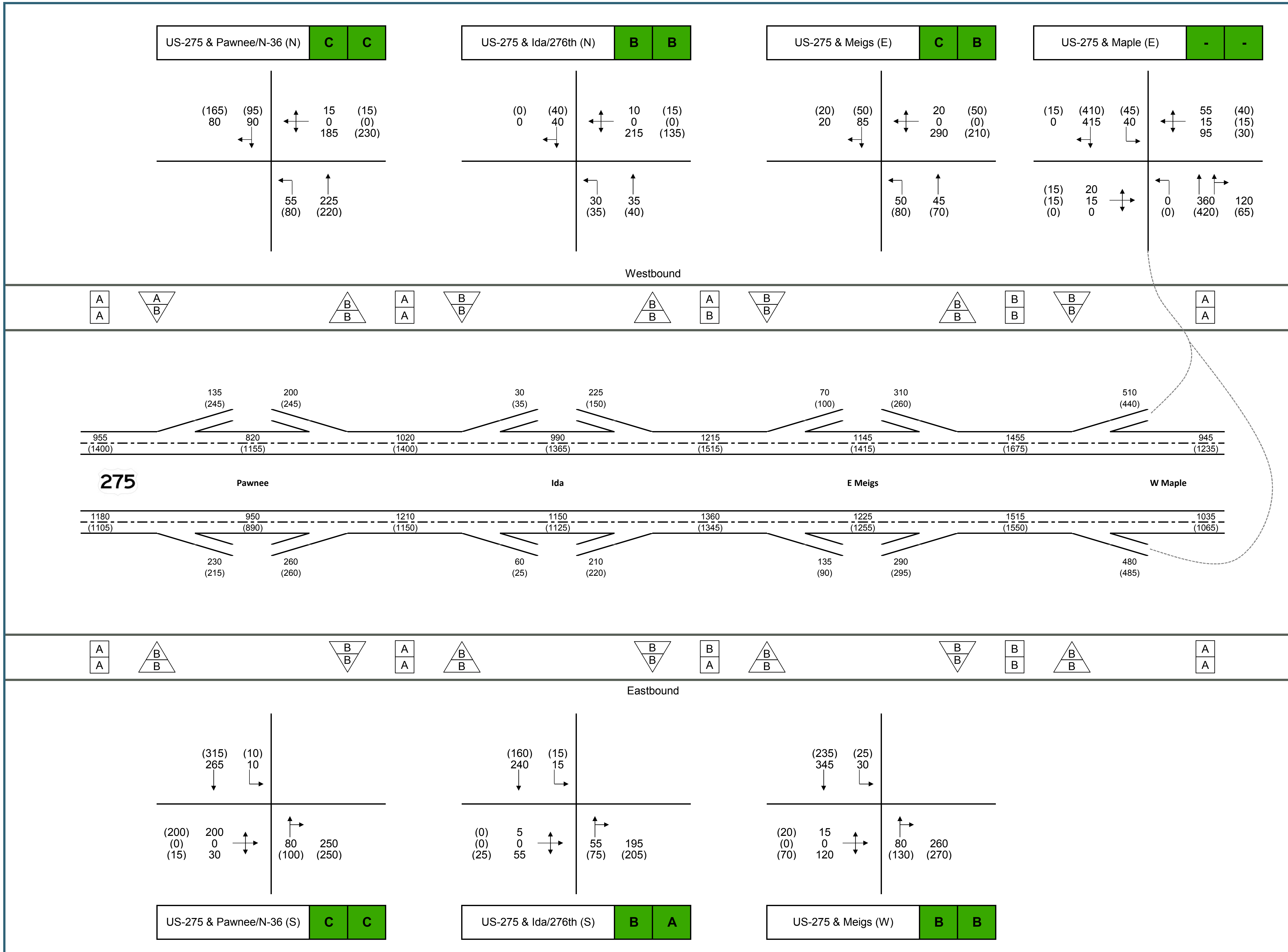
Metro Area Travel Improvement Study



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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X: AM Basic Freeway LOS / PM Basic Freeway LOS

X / X: AM Ramp Merge LOS / PM Ramp Merge LOS

X / X: AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X: AM Weave LOS / PM Weave LOS

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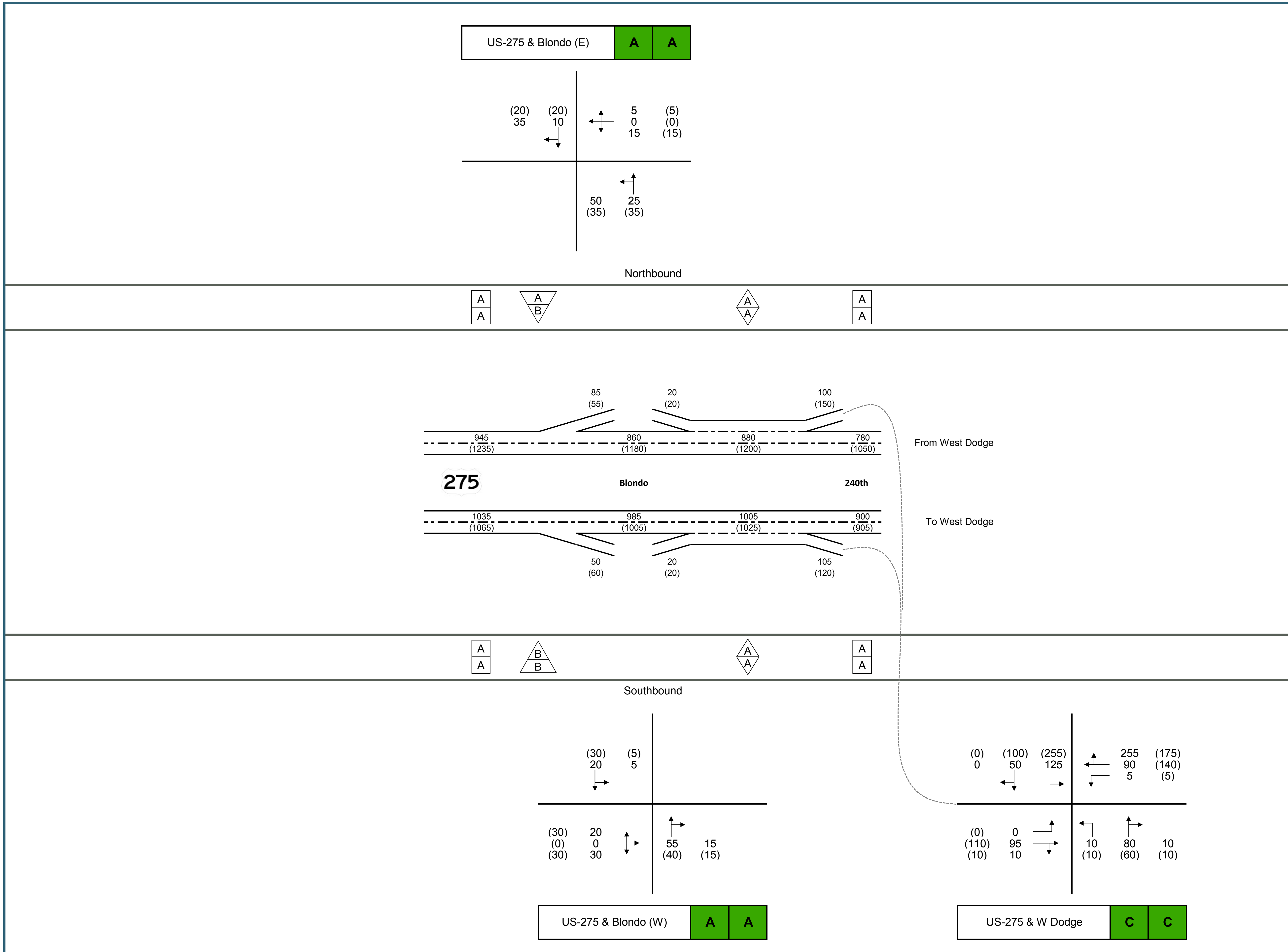

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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS
AM Ramp Merge LOS
PM Ramp Merge LOS
AM Ramp Diverge LOS
PM Ramp Diverge LOS
AM Weave LOS
PM Weave LOS

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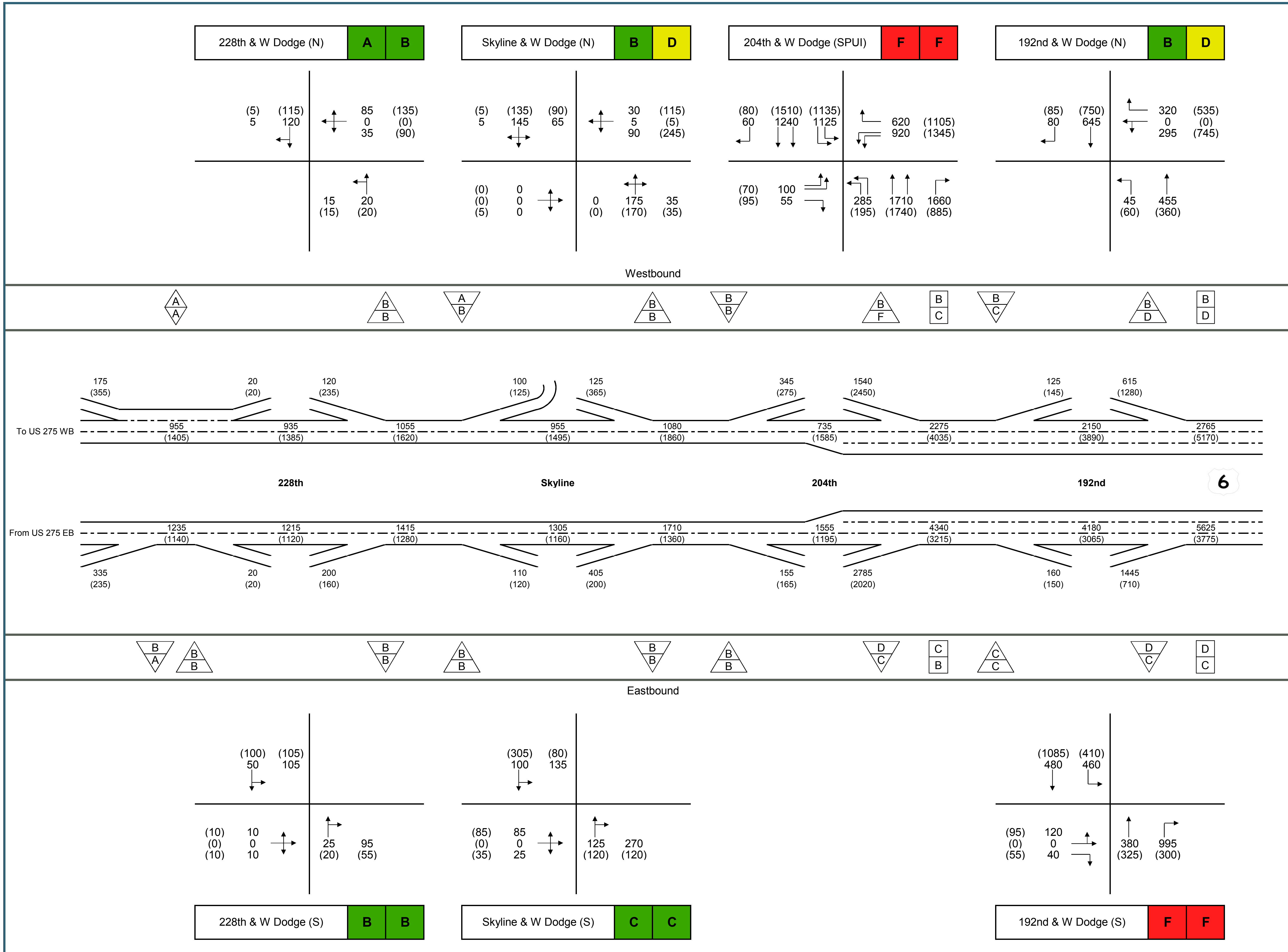
Metro Area Travel Improvement Study



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Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

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X / X AM Weave LOS / PM Weave LOS

Note:

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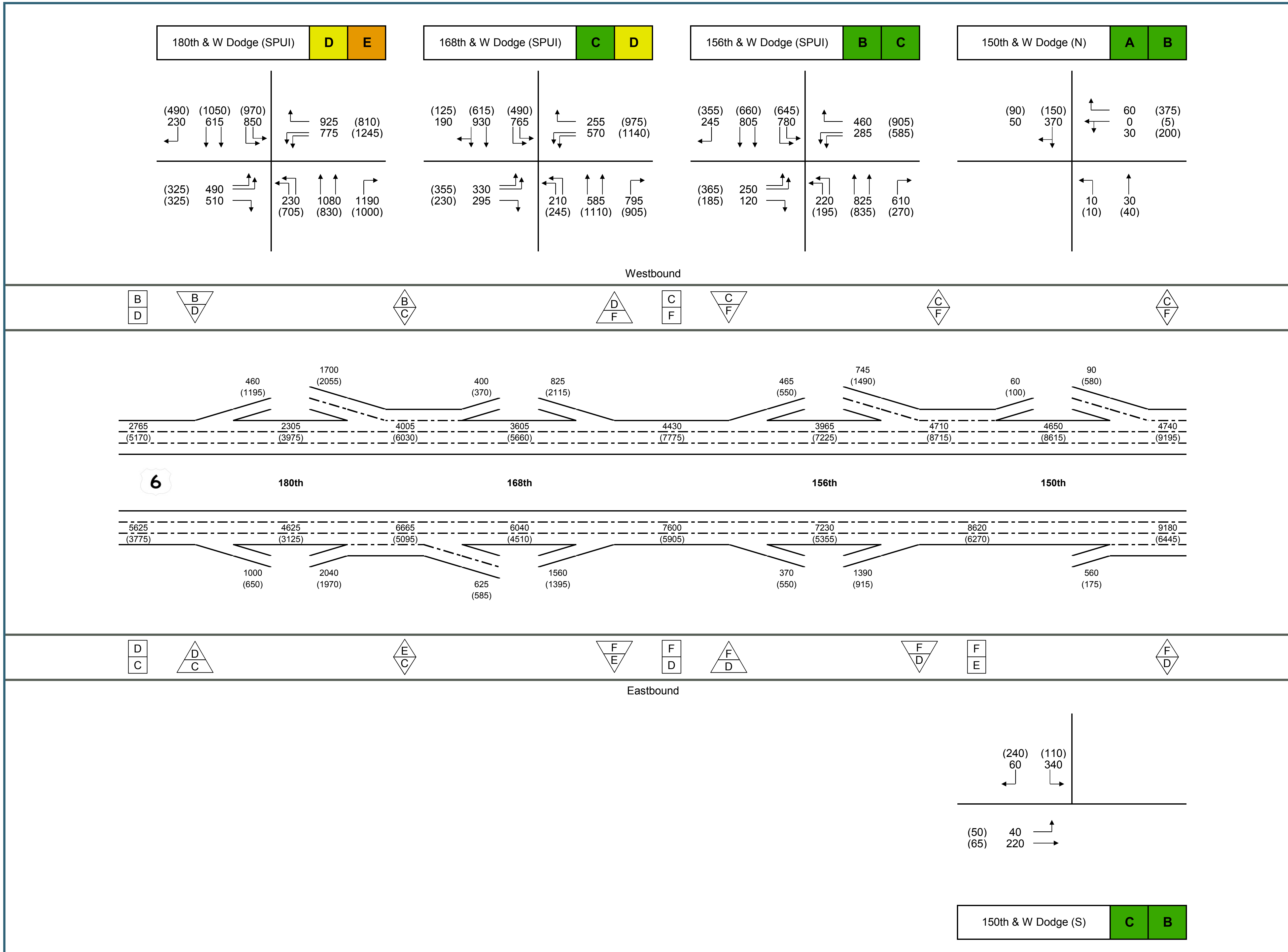

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS
X / X — AM Ramp Merge LOS / PM Ramp Merge LOS
X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X — AM Weave LOS / PM Weave LOS

Note:

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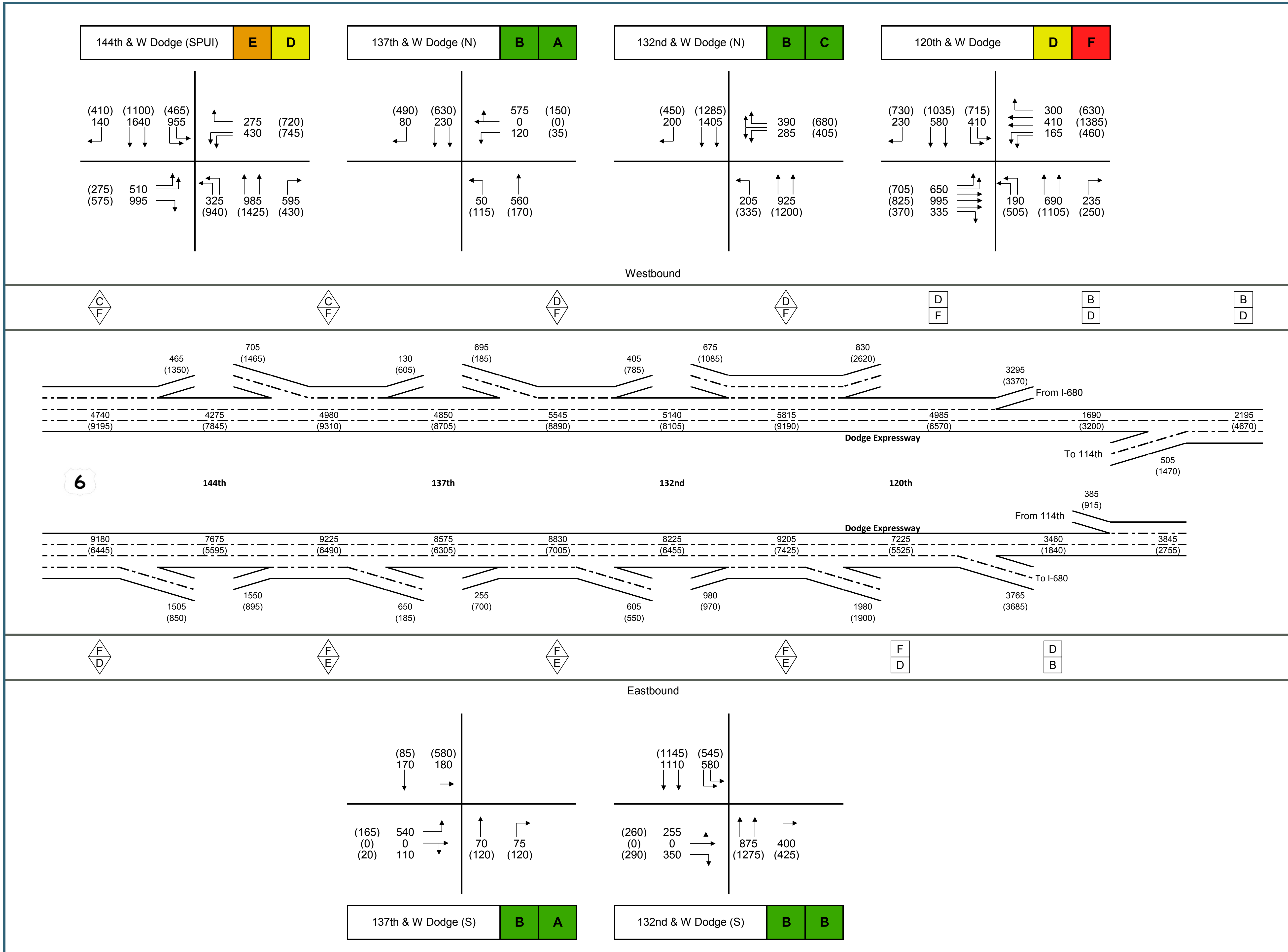

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS
PM Basic Freeway LOS

AM Ramp Merge LOS
PM Ramp Merge LOS

AM Ramp Diverge LOS
PM Ramp Diverge LOS

AM Weave LOS
PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

Metro Area Travel Improvement Study

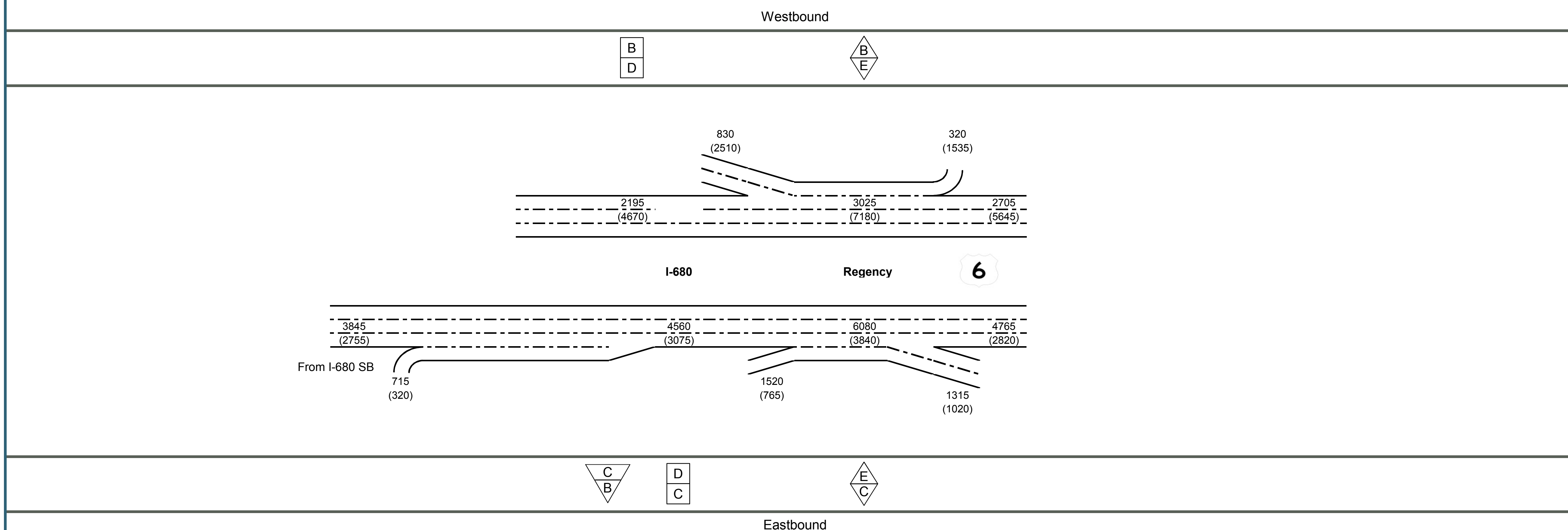

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

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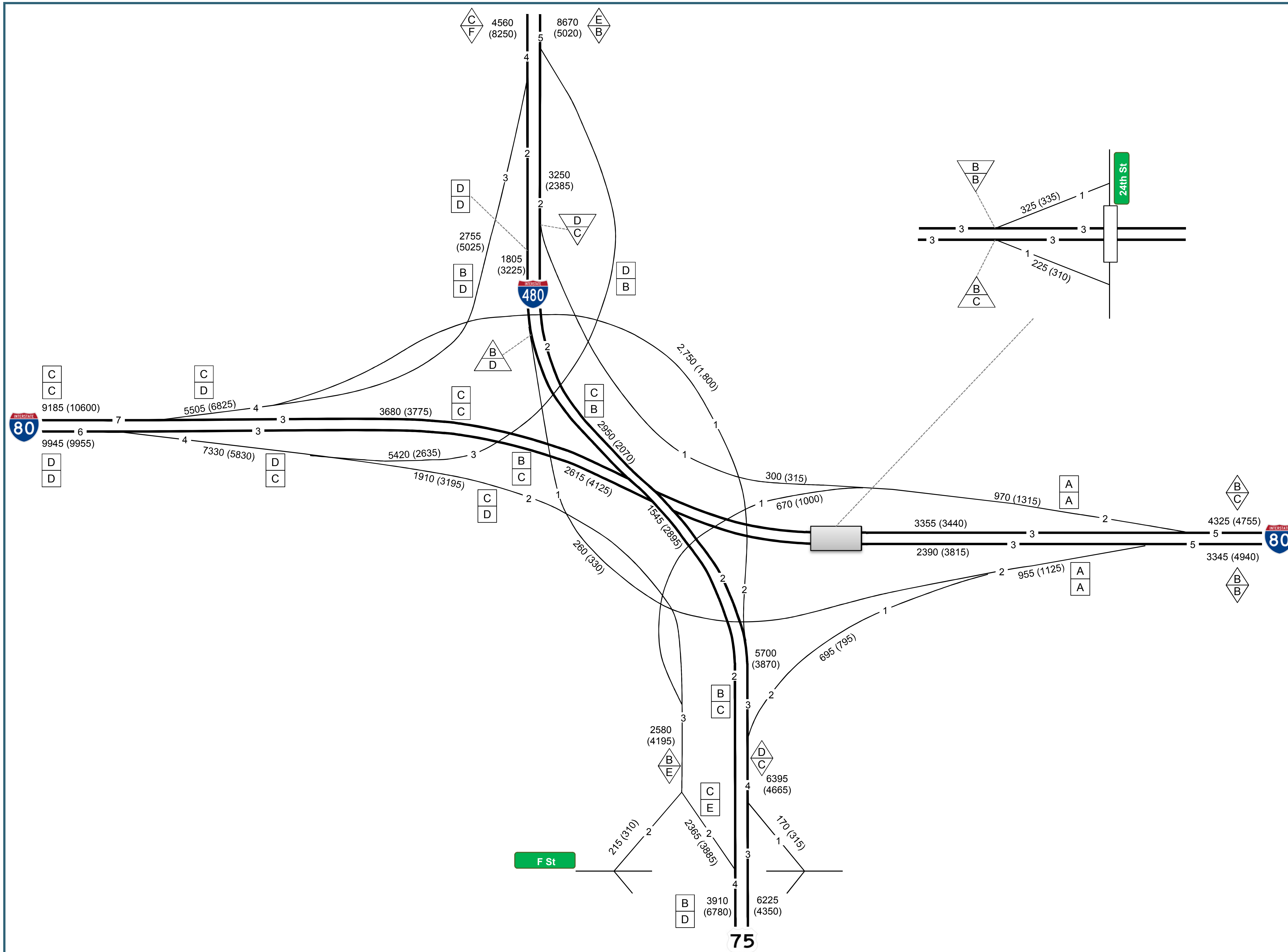
Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

AM Basic Freeway LOS / PM Basic Freeway LOS

AM Ramp Merge LOS / PM Ramp Merge LOS

AM Ramp Diverge LOS / PM Ramp Diverge LOS

AM Weave LOS / PM Weave LOS

I-80 & I-480 / US 75 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

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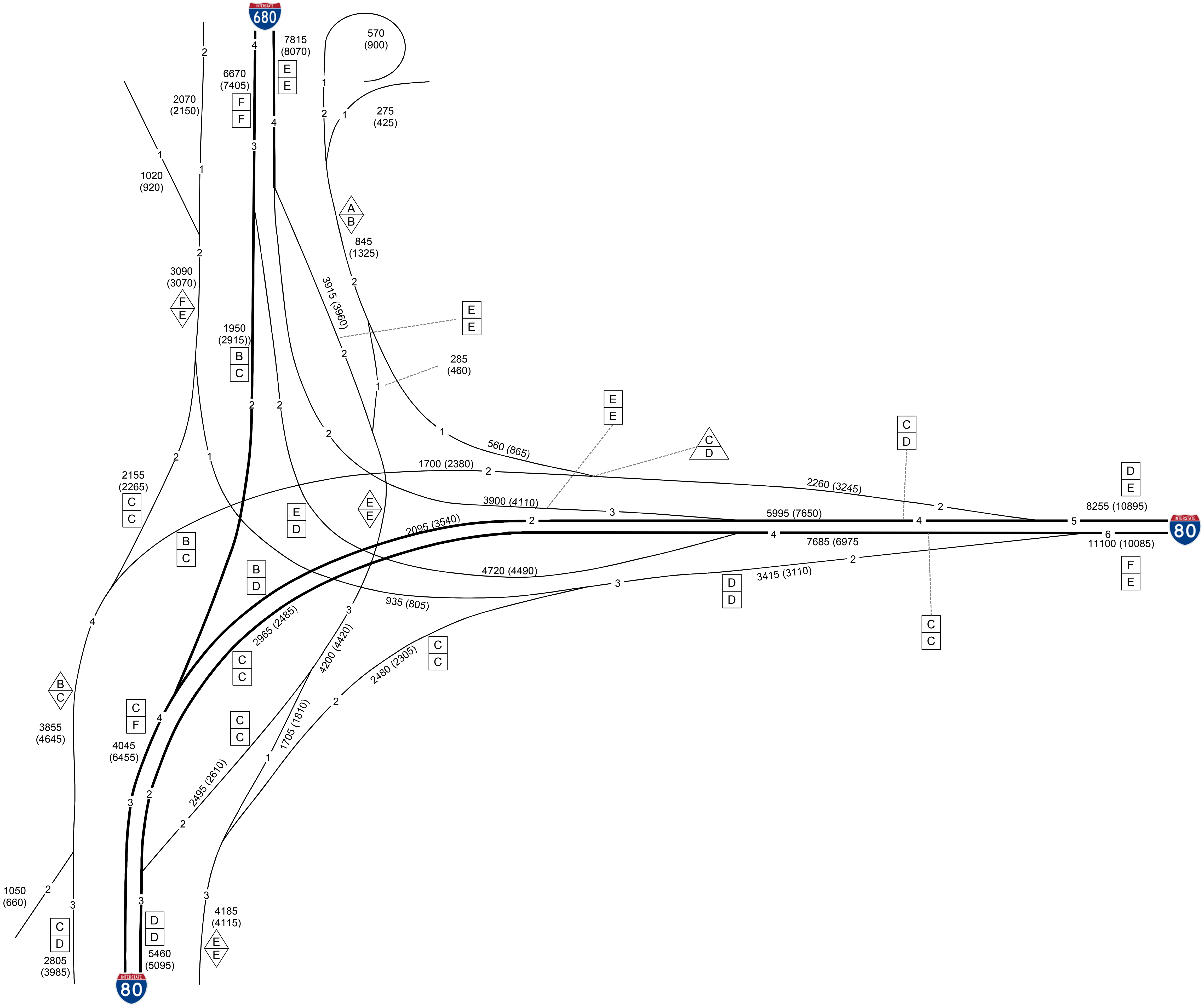

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X — AM Basic Freeway LOS / PM Basic Freeway LOS

X / X — AM Ramp Merge LOS / PM Ramp Merge LOS

X / X — AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X — AM Weave LOS / PM Weave LOS

I-80 & I-680 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

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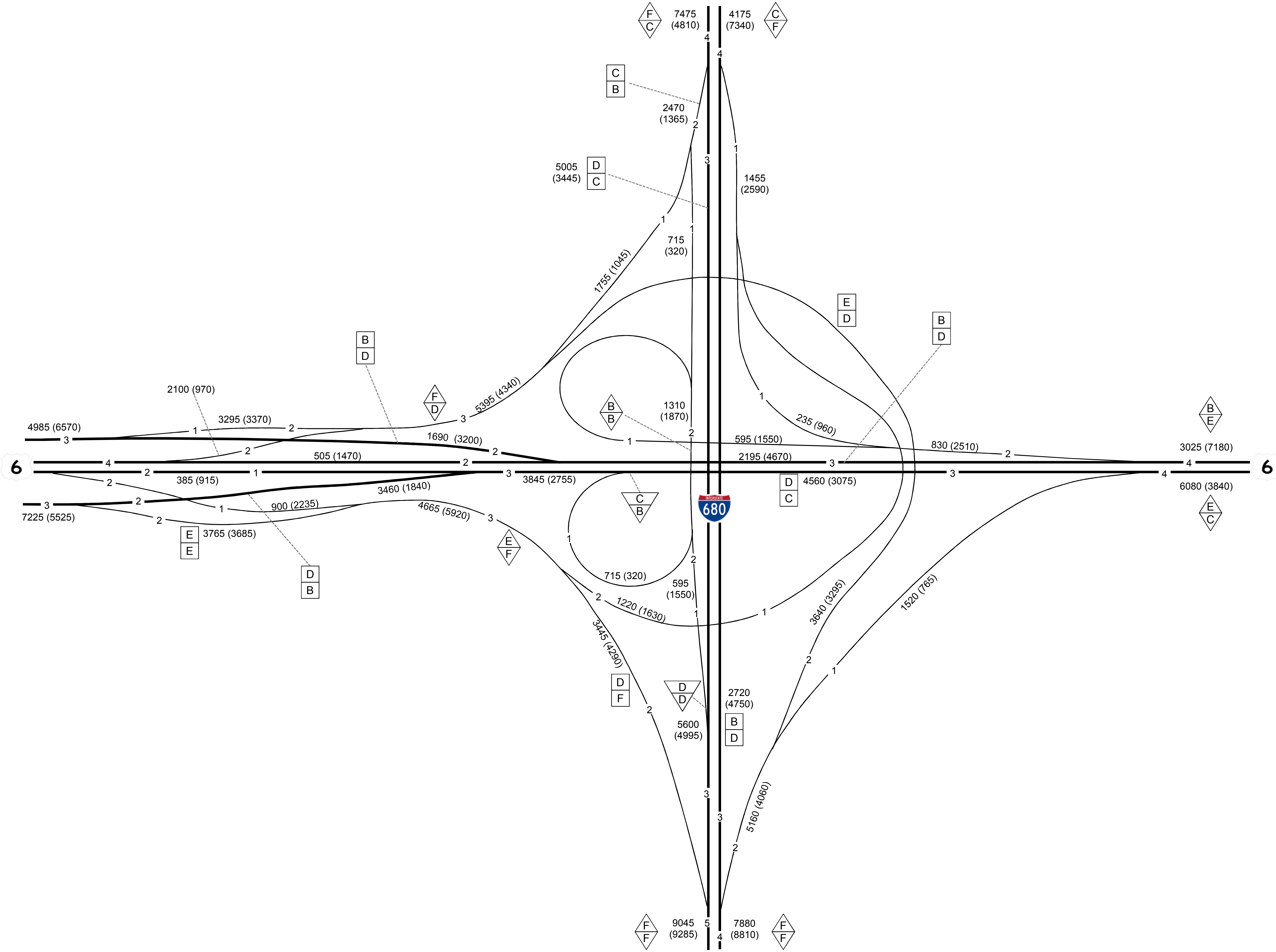

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS
X / X AM Ramp Merge LOS / PM Ramp Merge LOS
X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS
X / X AM Weave LOS / PM Weave LOS

I-680 & US 6 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

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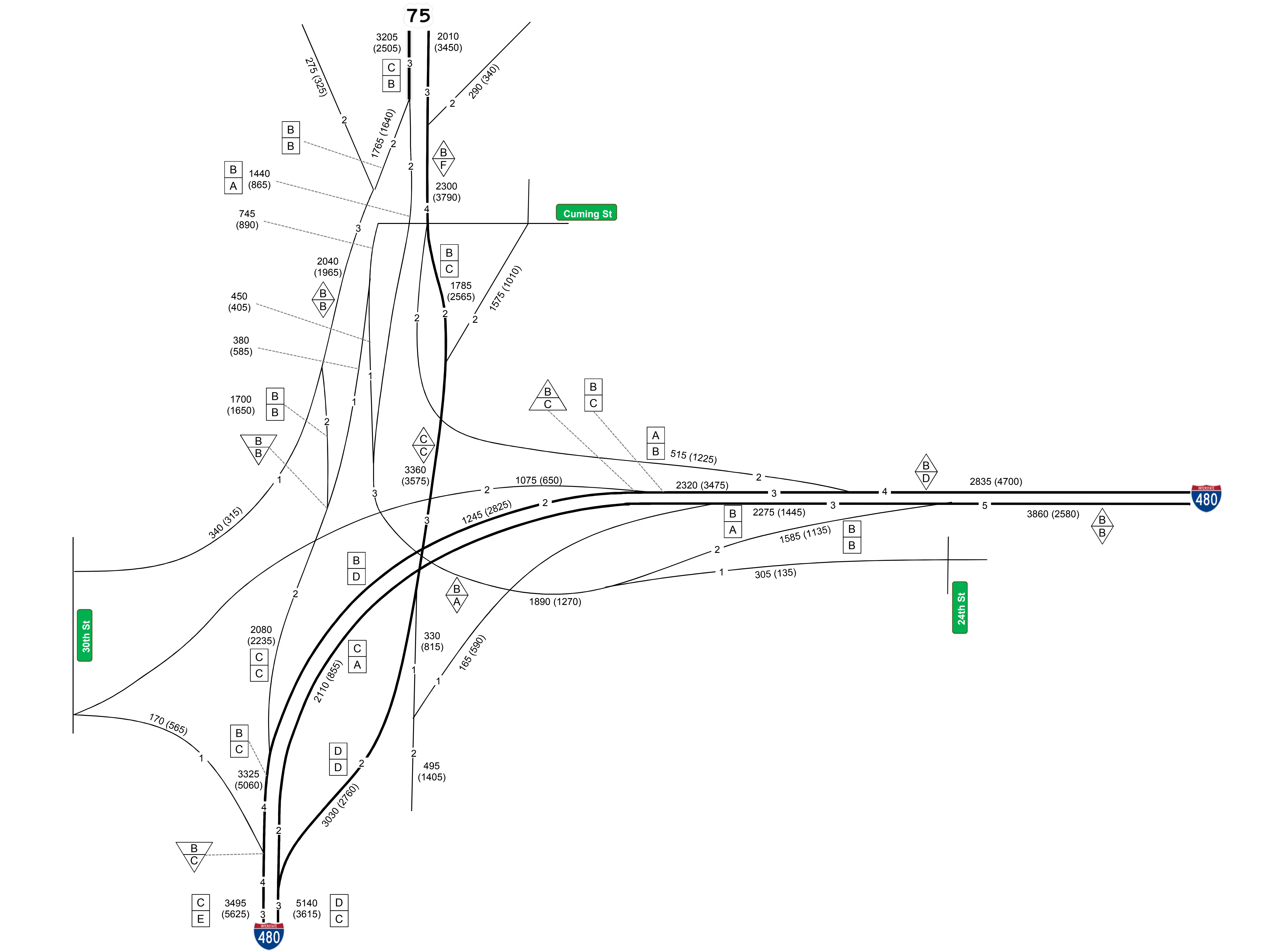

Figure A.4: Future No-Build 2040 E+C Freeway Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume

Intersection Geometrics

N/S Street & E/W Street (Direction)	AM LOS	PM LOS

X / X AM Basic Freeway LOS / PM Basic Freeway LOS

X / X AM Ramp Merge LOS / PM Ramp Merge LOS

X / X AM Ramp Diverge LOS / PM Ramp Diverge LOS

X / X AM Weave LOS / PM Weave LOS

I-480 & US 75 Interchange

Note:

For mainline operational analysis, AM & PM peak hour volumes were balanced between interchanges.

For ramp terminal operational analysis, the worst case AM & PM peak hour volumes were used.

N

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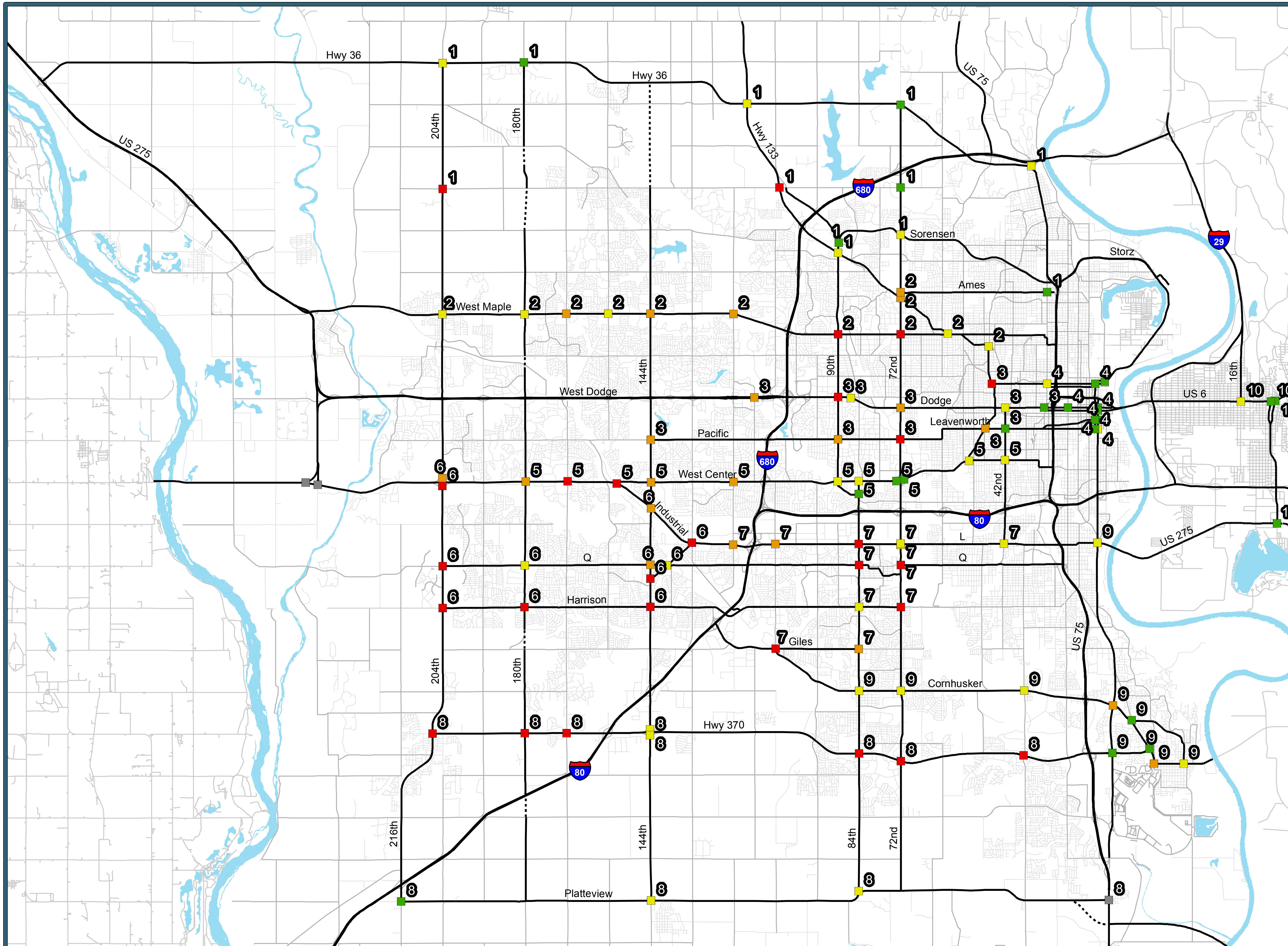

Figure A.5: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations Key Map

Legend

ICU / Synchro LOS

- A-C
- D
- E
- F
- N/A

Study Roadway

Note:
- *Worst case LOS displayed*
- *Intersection number corresponds to ICU figure on the following pages*

N

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Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

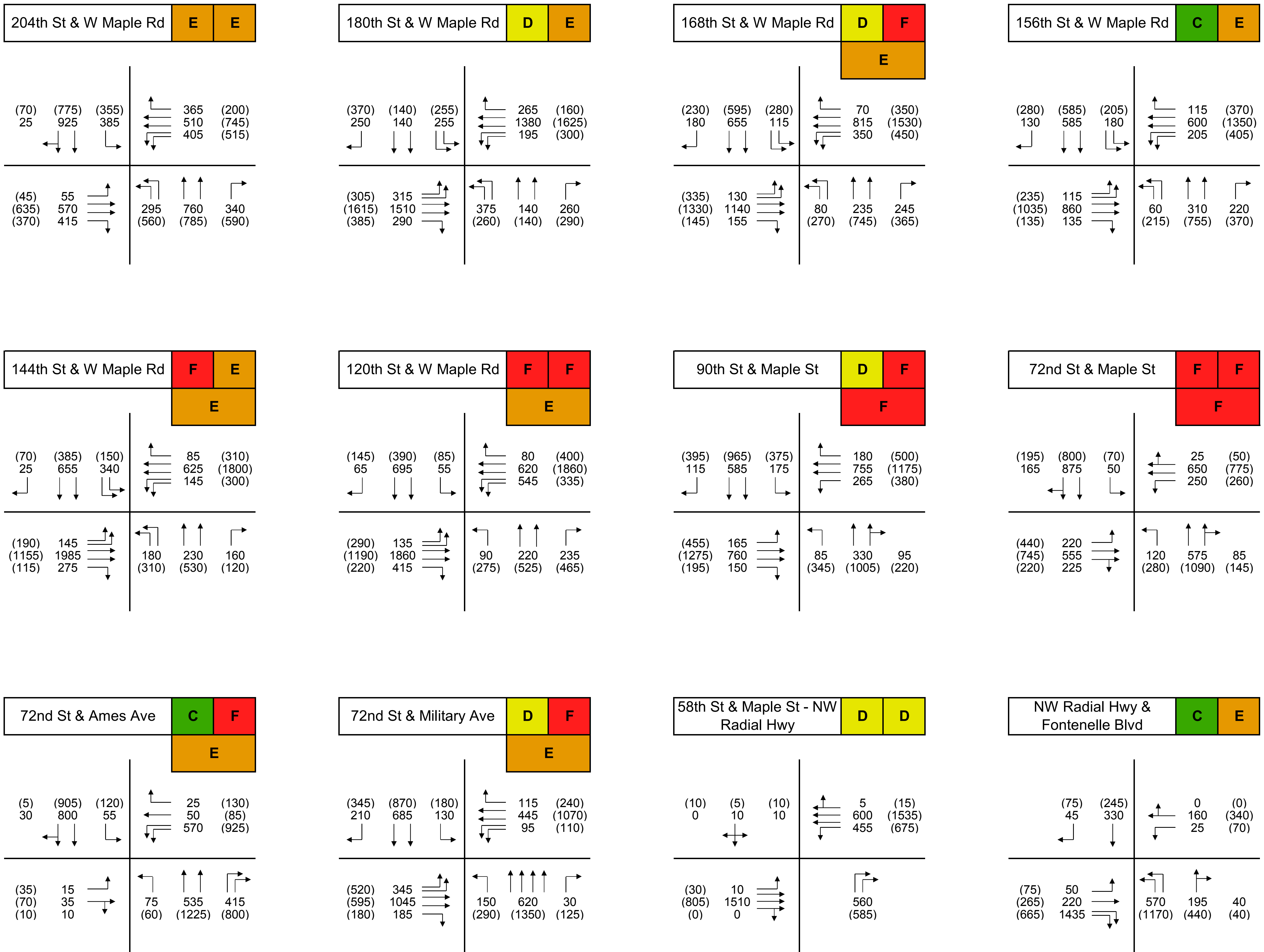

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A D
B E
C F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

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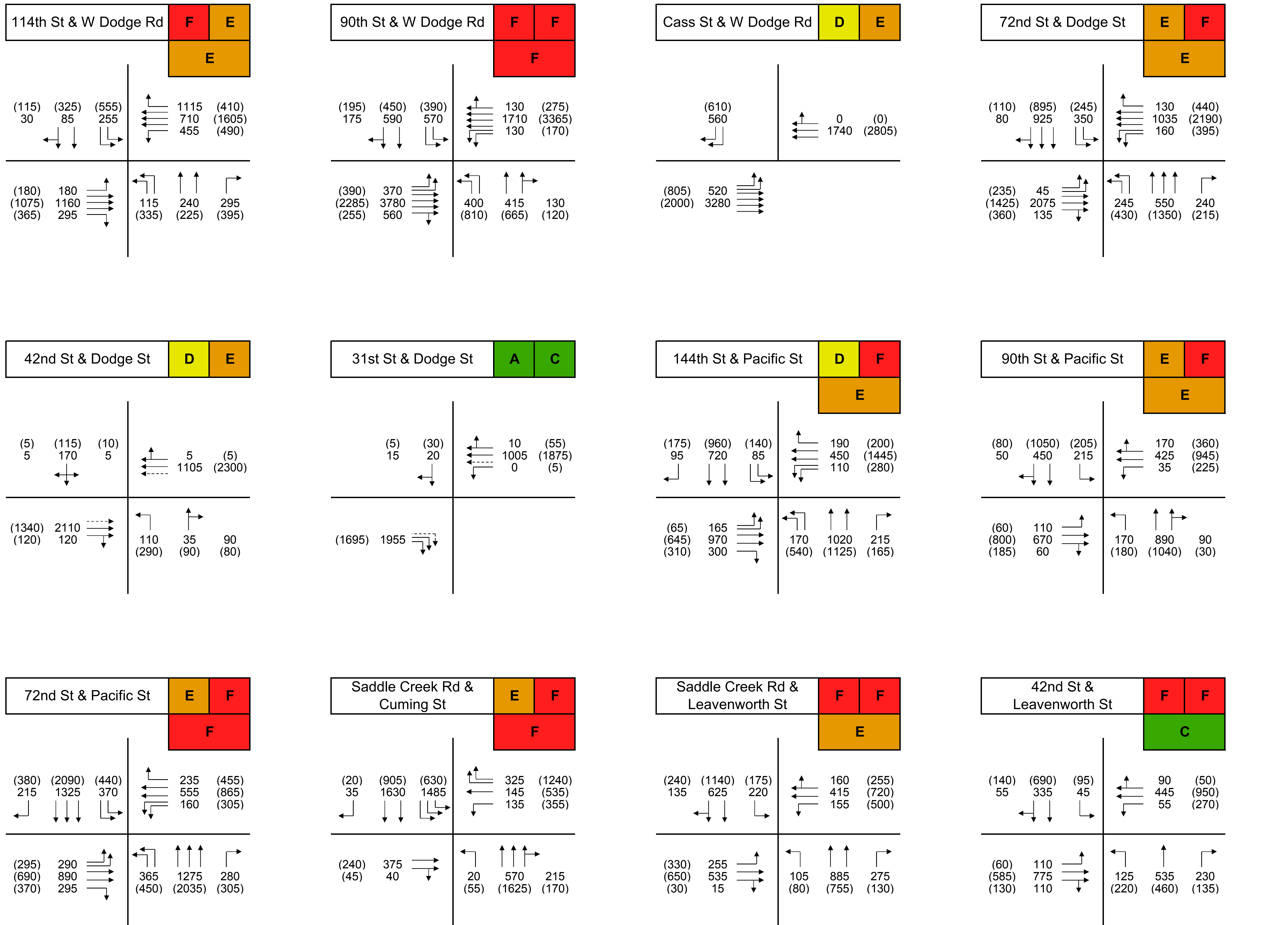

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
→ Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Reversible Lane

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

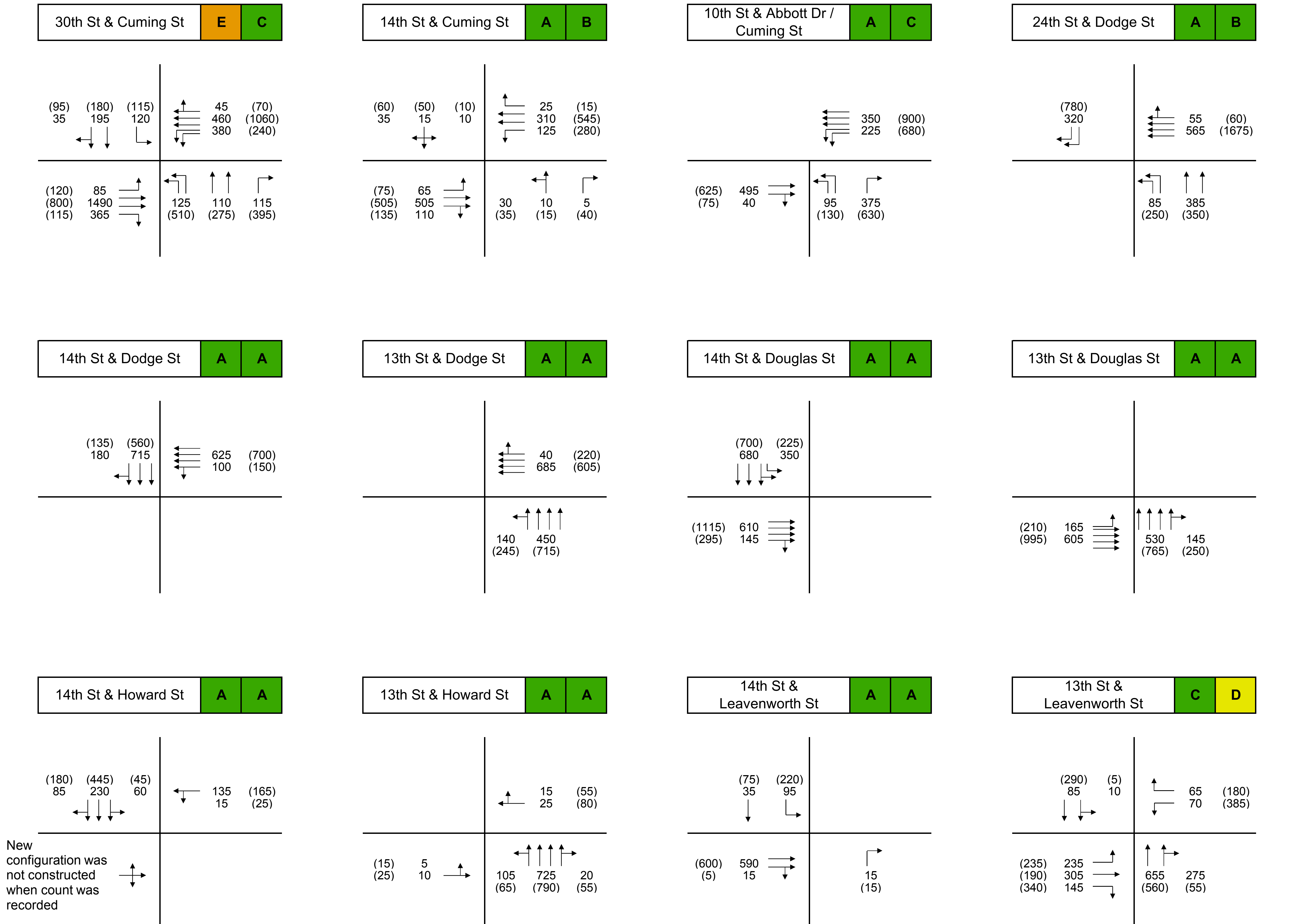

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

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N

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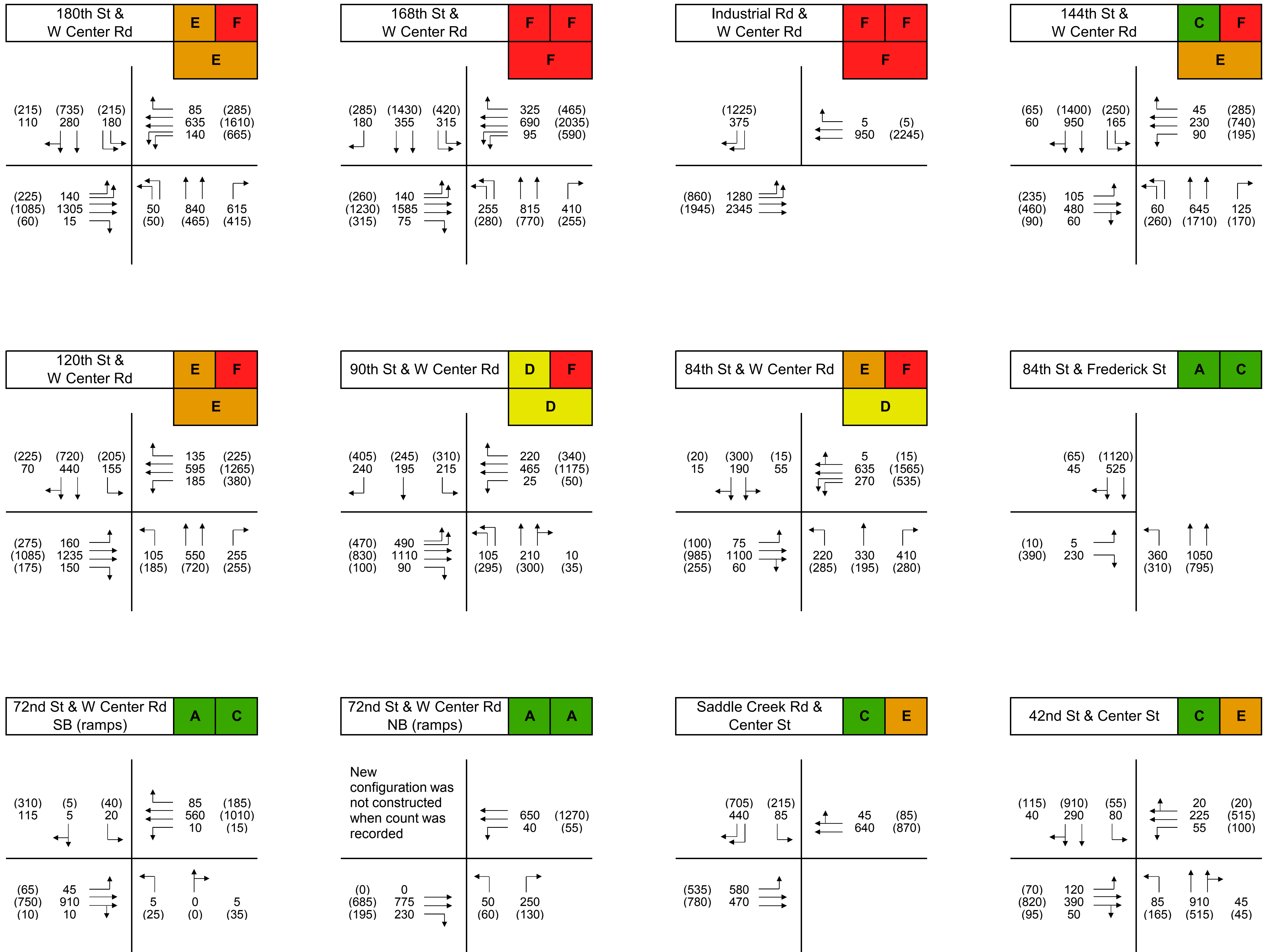


Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

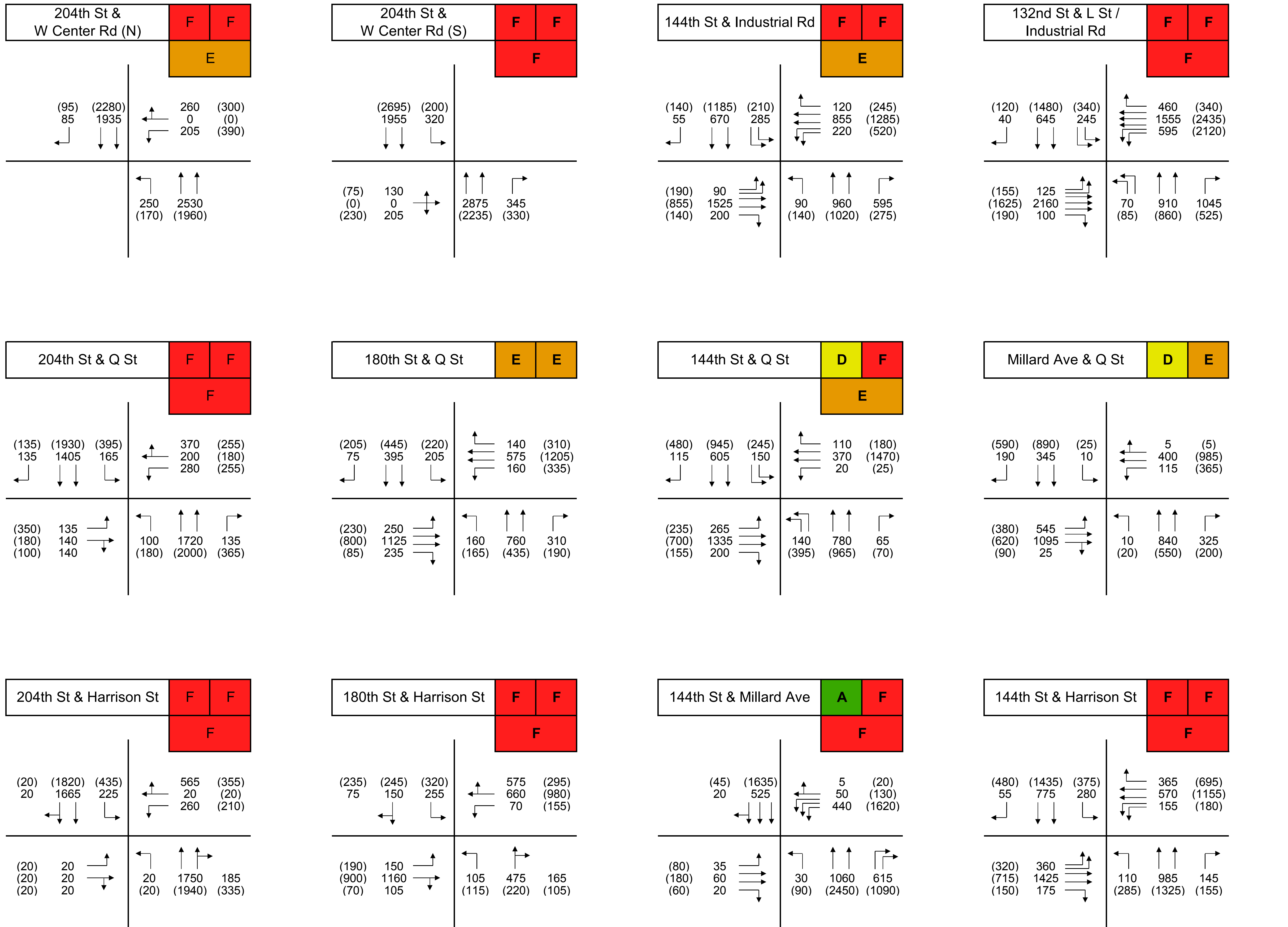
HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Metro Area Travel Improvement Study

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations



Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

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HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

It was assumed ICU LOS E locations would result in an HCM LOS 'D' or better. This is reflected in the operations and needs figures.

N

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A D
B E
C F

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Metro Area Travel Improvement Study

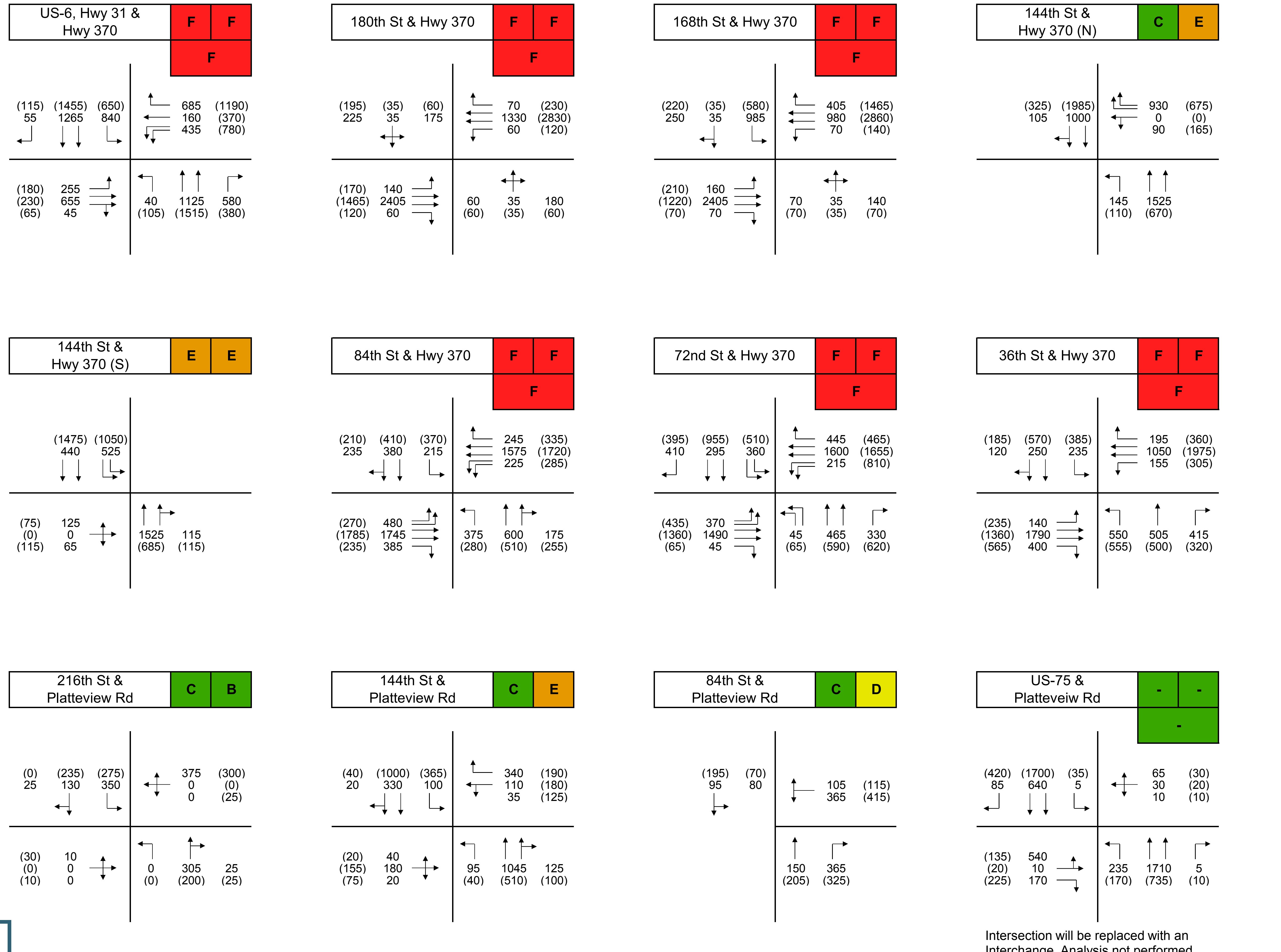

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

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N

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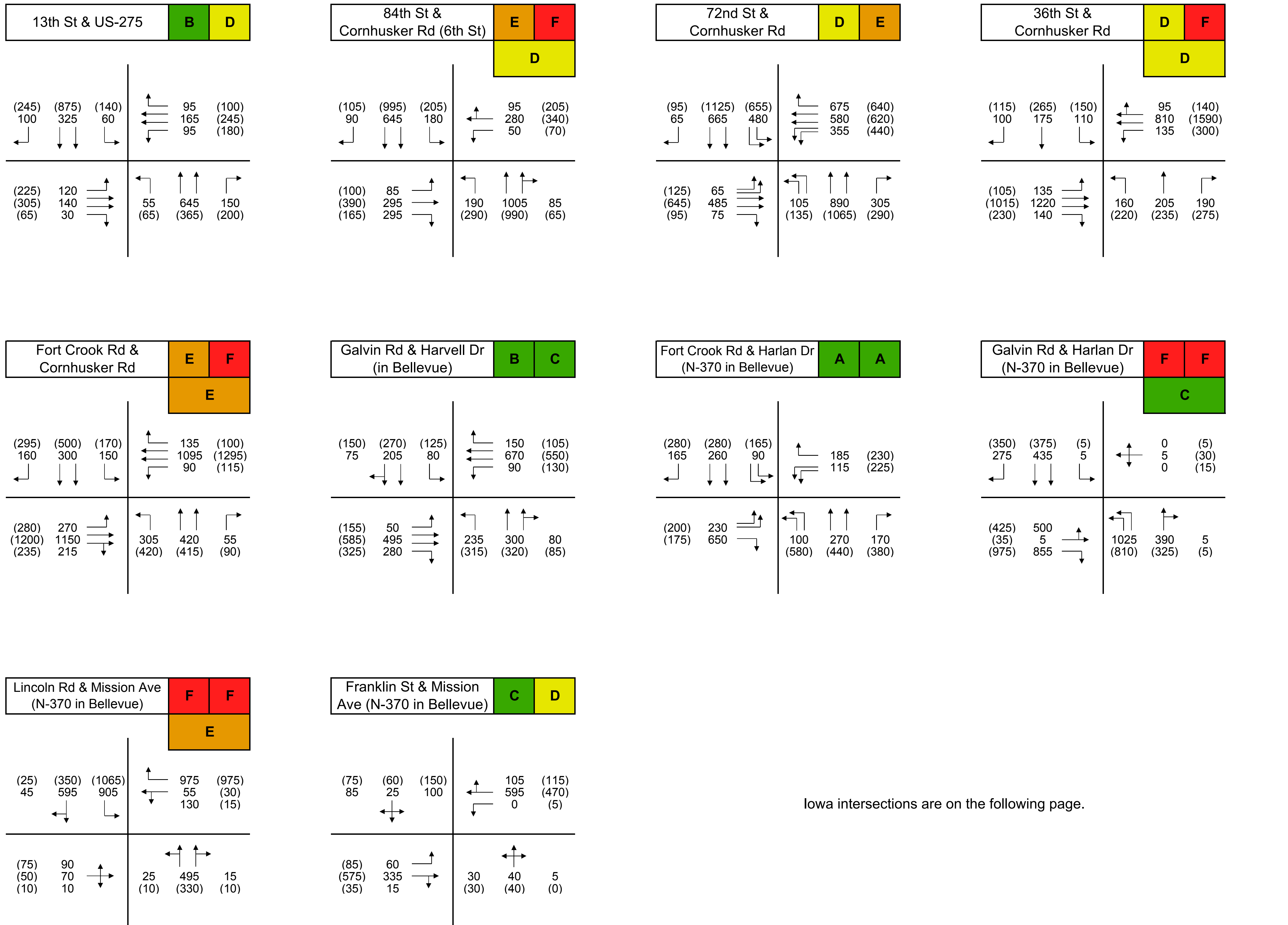

Iowa intersections are on the following page.

Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend

X,XXX AM Peak Hour Volume
(X,XXX) PM Peak Hour Volume
Intersection Geometrics

N/S Street & E/W Street	AM ICU	PM ICU
	HCM LOS	

A B C D E F

Note:

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HCM analysis was performed for the worst case peak period for 2040 E+C locations of ICU LOS F. These 59 intersections were also analyzed for the base year.

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Metro Area Travel Improvement Study

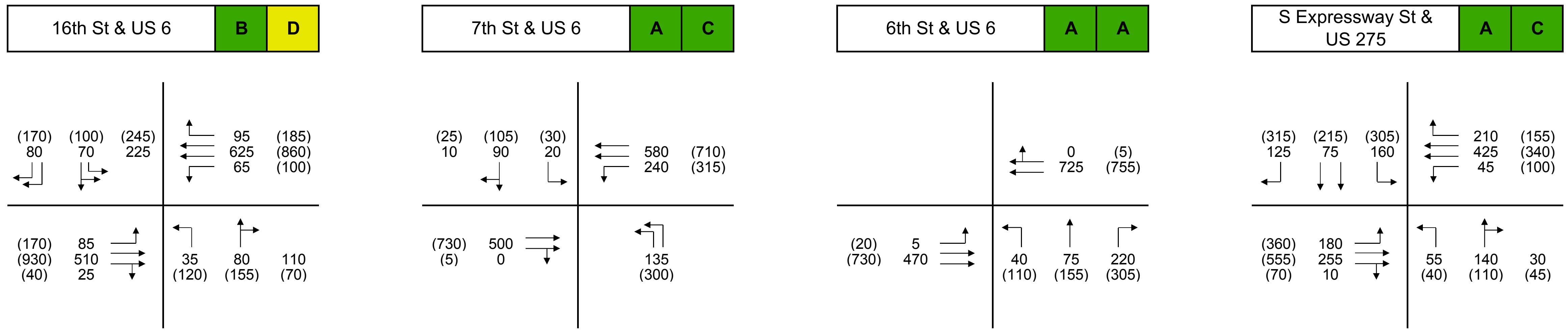
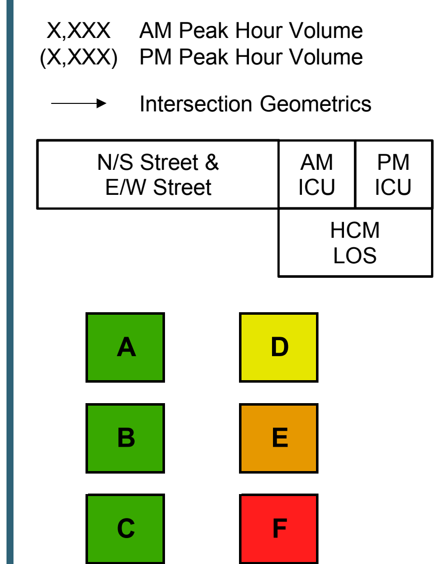


Figure A.6: Future No-Build 2040 E+C Non-Freeway Intersection Traffic Operations

Legend



Note:

HCM LOS was calculated using Synchro 8.0 Software to supplement ICU analysis.

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N

Metro Area Travel Improvement Study