Metro Area Travel Improvement Study

Phase 2 – Strategy/Alternative Development and Evaluation

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NEBRASKA
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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 is utilizing a phased approach. The study phases include:

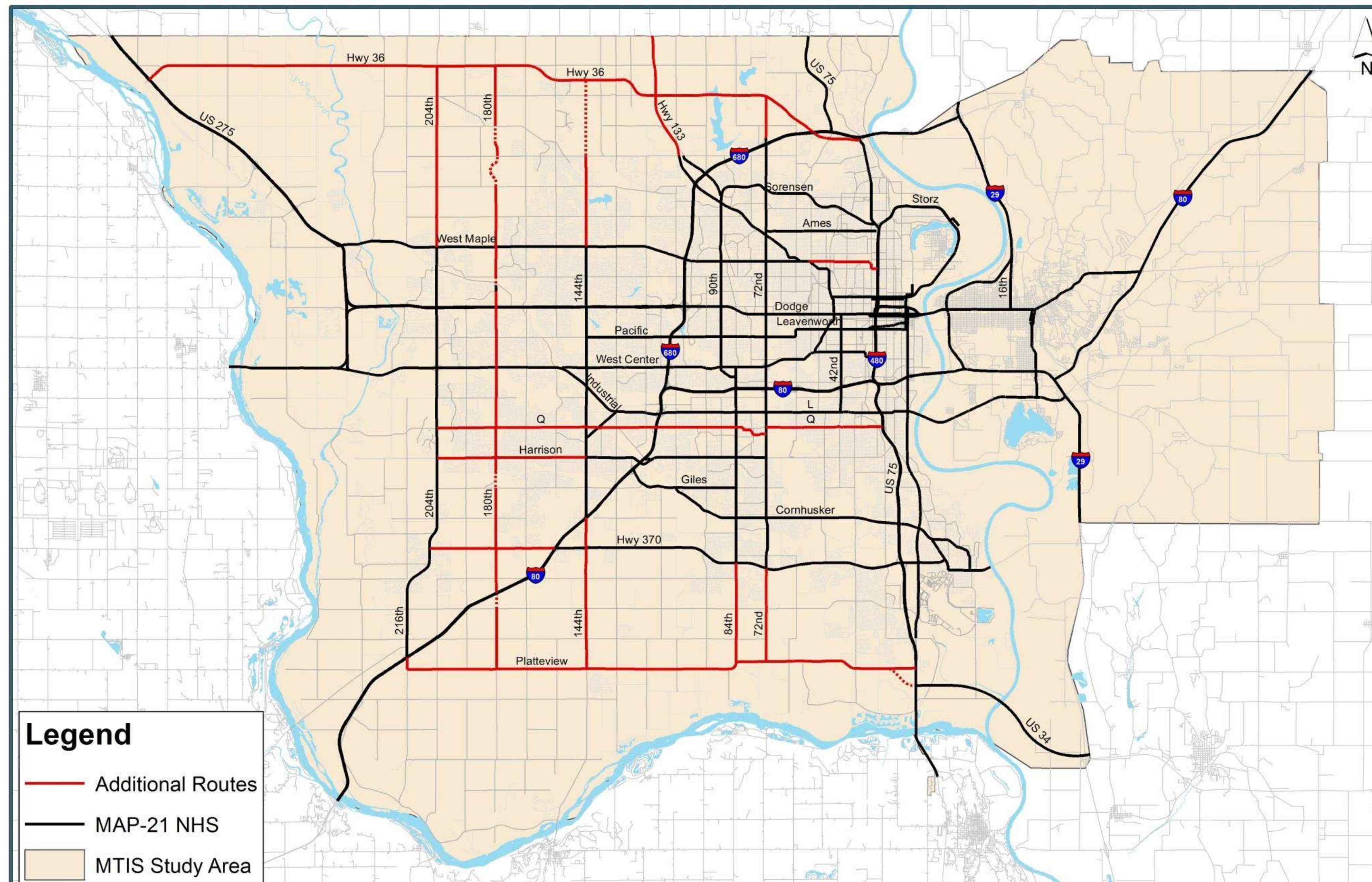
- **Phase 1**: Existing / Future No-Build Conditions Review (companion report)
- **Phase 2**: Strategy / Alternative Development and Evaluation (this report)
- **Phase 3**: Alternative Design and Implementation Plan (future report)

Study Area

The first phase of the study 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 MAP-21 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. The Council Bluffs Interstate projects contained in the current Transportation Improvement Program (TIP) were included in 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



Metro Area Travel Improvement Study

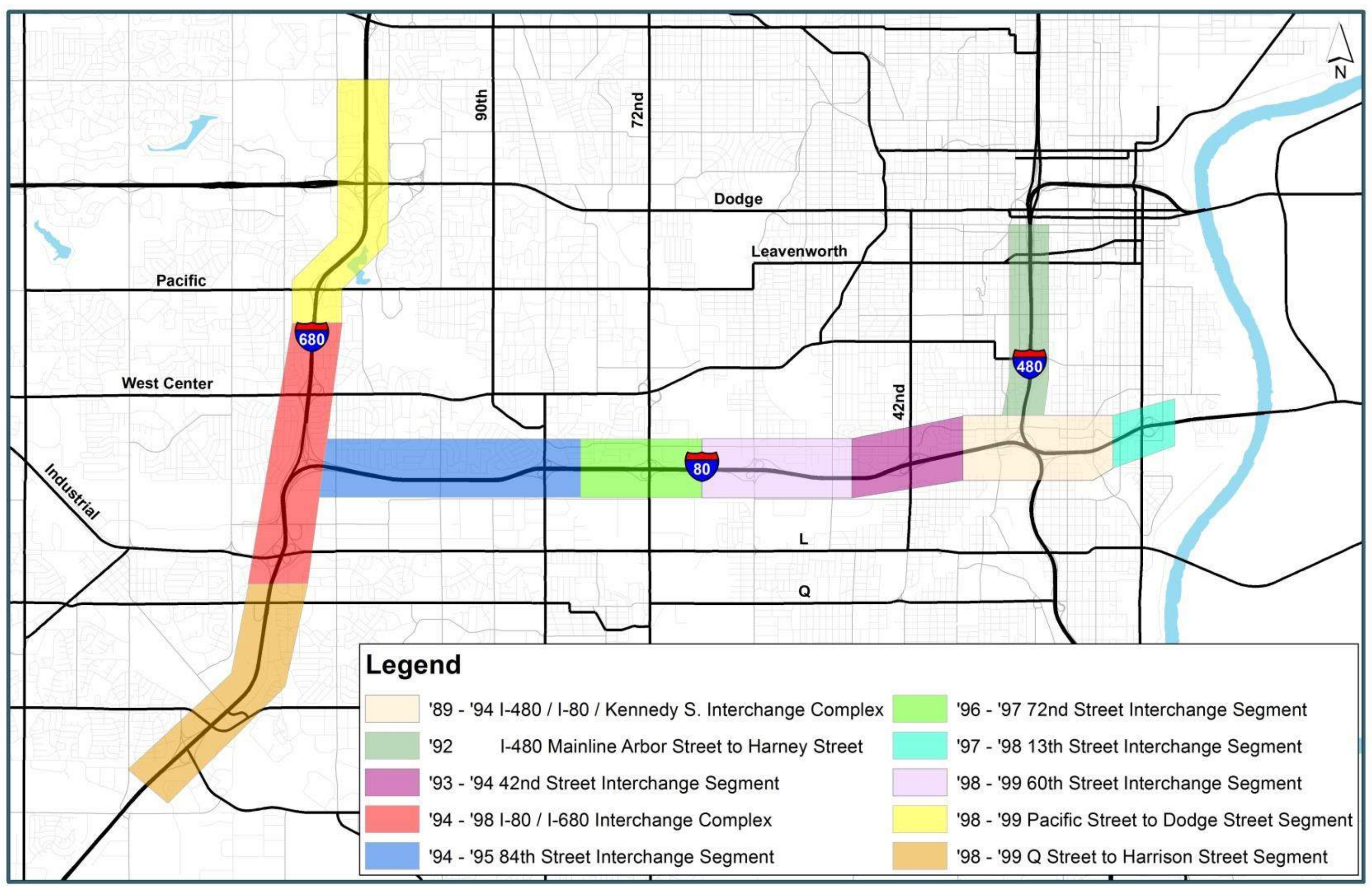
Study Background

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, with a horizon year of 2000. NDOR addressed a series of bottlenecks on the freeway system with a series of construction projects in 2014. These bottleneck-reduction 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. Omaha Interstate Reconstruction Projects (1989 - 1999)



LRTP Process

As part of its role as the Omaha-Council Bluffs metro 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 2040 LRTP, published on October 9, 2015, is considered an interim document that builds off of the products and vision provided by the 2035 LRTP. 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 be a comprehensive plan projecting the transportation needs for the Omaha-Council Bluffs metro area. The purpose of the 2050 LRTP will be to provide a vision for transportation development for the next several decades in order to improve the quality of life for area residents. This plan will take a comprehensive approach to addressing transportation in our area and incorporate elements from the *Heartland 2050 Initiative* as well as the studies MAPA has completed over the past 5 years and will complete prior to publishing the 2050 LRTP, including MTIS. 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 Study 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 Study Team.
- **Stakeholder Committee**: Members include representatives from various jurisdictional agencies within the study area. In Phase 2, this committee convened three times to provide feedback on study methods, findings, and recommendations.

Other Participants / Presentations

During Phase 2, input was also provided during presentations to the MAPA Board of Directors, the MAPA Transportation Technical Advisory Committee (TTAC) and to Sarpy County engineering staff. Public input to MTIS was provided via surveys and meetings conducted by MAPA where the public was asked to prioritize goals and strategies for the region's transportation needs.

Executive Committee

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

Table 1.1. Executive Committee Members

Committee Member	Organization
Kyle Schneweis	NDOR Director
Khalil Jaber	NDOR Deputy Director - Engineering
Moe Jamshidi	NDOR Deputy Director - Operations
Tim Weander	NDOR District 2
Jim Knott	NDOR Roadway Design
Dan Waddle	NDOR Traffic
Robert Stubbe	City of Omaha
Greg Youell	MAPA
Michael Helgerson	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
Doug Atkin	FHWA
Justin Luther	FHWA

Management Committee

Management Committee members are shown 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 Helgerson	MAPA
Michael Felschow	MAPA
Josh Corrigan	MAPA

Stakeholder Committee

Stakeholder Committee participants are shown in **Table 1.3**. Note that the table includes any person that attended at least one Stakeholder Committee meeting during Phase 2 of MTIS.

Table 1.3. 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 Intermodal Planning
Mick Syslo	NDOR Materials and Research
Mark Traynowicz	NDOR Bridge
Joel Rossman	NDOR Bridge
Greg Youell	MAPA
Michael Helgerson	MAPA
Megan Walker	MAPA
Courtney Fuhrer	MAPA
Michael Felschow	MAPA
Curt Simon	Metro
Justin Luther	FHWA
Greg Reeder	City of Council Bluffs
Derek Miller	City of Omaha
Murthy Koti	City of Omaha
Todd Pfitzer	City of Omaha
Bryan Guy	City of Omaha
Stephen Osberg	City of Omaha
Dean Dunn	City of Bellevue
Dan Kutilek	Douglas County
Denny Wilson	Sarpy County
Marco Floreani	Greater Omaha Chamber

Coordination with Other Studies and Projects

Numerous on-going and past regionally-significant studies have relevance to MTIS. The Study Team reviewed the progress and scope of each of these studies to determine 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 1.4**, and a summary of past relevant studies is provided in **Table 1.5**.

Table 1.4. Summary of On-Going Relevant Regional Studies / Programs

	Study	Owner	Study Status	Data Relevance / Coordination for MTIS
Ongoing Studies	Heartland 2050 Action Plan	MAPA	Ongoing	Study developed regional growth scenarios - applicable to MTIS & MAPA Regional Model. This plan also includes the Close the Gap campaign started by MAPA.
	Metro! Rideshare / Air Quality / CMAQ	MAPA	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), 2017-2022	MAPA	Occasionally amended, updated annually	All programmed regional transportation projects that have funding sources identified through 2022 are included in TIP.
	MAPA 2050 Long Range Transportation Plan (LRTP)	MAPA	Ongoing	Results from MTIS will be used in the development of the 2050 LRTP.
	Omaha Streetcar	Metro & City of Omaha	Ongoing. Financial Assessment complete. Advanced Conceptual Engineering (ACE) started.	Includes alignments, stations, vehicle maintenance facility, ridership forecasts, and governance.
	Bus Rapid Transit (BRT)	Metro & City of Omaha	Preliminary Design/NEPA (Environmental) phase complete. Final Design phase started.	Dodge BRT alignment is included in Existing plus Committed transit network.
	New I-80 Interchanges (Sarpy County) Planning Studies	NDOR & Sarpy County	Ongoing	Potential locations, forecasts, regional benefits
	Major Redevelopment Projects (Boystown, 192nd/Dodge)	Developers	Ongoing	Land use intensities, access, circulation
	Sarpy County Comprehensive Plan	Sarpy County	Draft Final Report Complete	Update of the Sarpy County Comprehensive Plan, Zoning Ordinance, and Zoning Map.
	Sarpy County Trails Master Plan - Phase 2	Sarpy County	Incorporating into Sarpy County Comp Plan	Bike / pedestrian corridor recommendations
	Build Nebraska Act	NDOR	Ongoing	NDOR Selected projects were incorporated in all Strategy Packages.

Table 1.5. Summary of Past / Completed Relevant Regional Studies / Programs

	Study	Owner	Completion Date	Data Relevance / Coordination for MTIS
Past / Completed Studies	Sarpy County Transit Study	MAPA & Sarpy County	2017	Transit recommendations to consider for inclusion in MTIS.
	Nebraska Strategic Highway Safety Plan	NDOR	Completed for 2017-2021	Strategic plan for meeting statewide traffic safety goals. Includes safety goals, objectives, strategies and performance measures.
	Platteview Road Corridor Study	MAPA & Sarpy County	2016	Analyzed transportation and land use options for the corridor in order to assess potential future development options and to identify transportation strategies.
	Heartland Connections Bicycle-Pedestrian Plan	MAPA & NDOR	2015	Data include bike / pedestrian short and long term recommendations, bicycle level of service, and goals / strategies.
	MAPA Long Range Transportation Plan	MAPA	2040 LRTP (2015) 2035 LRTP (2010)	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.
	Heartland 2050 Vision	MAPA	2014	Provides updated land use scenarios for the MAPA travel demand model
	Heartland Connections Regional Transit Vision	MAPA	2013	Data include travel market analysis, transit service plans, on-board ridership survey and a financial analysis.
	External-to External O-D Survey	MAPA, NDOR, & Iowa DOT	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.
	Omaha Traffic Signal System Master Plan	City of Omaha	2013	Includes recommended system upgrades over a 10-year period, estimated costs, and other key recommendations
	Omaha Master Plan - Transportation Element	City of Omaha	2012	TMP includes some performance measure approaches to consider for inclusion in MTIS. Follow progress of any updates to TMP. Not a multi-jurisdictional plan.
	Statewide LRTP / Vision 2032	NDOR	2012	Provides NDOR's system planning vision, goals, objectives and performance measures. Statewide summary data on travel, freight and transit.
	Beltway Study	MAPA	2010	Regional alternatives / scenarios / land use options to consider for inclusion in MTIS.
	Omaha Master Plan - Environmental Element	City of Omaha	2010	City of Omaha document that provides some goals / objectives that relate to transportation. These goals / objectives are consistent with MTIS. Not a multi-jurisdictional plan.
	Council Bluffs Interstate System Improvement Program	Iowa DOT	Design Completed. Ongoing construction.	Cross-section and plans for Council Bluffs interstate system.
	Transportation Funding Study	MAPA	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	Douglas County	2004	Trails plan map. Likely will be superseded by Heartland Connections Bicycle-Pedestrian Plan.
	Northwest Douglas County Arterial Streets Study	MAPA & Douglas County	2003	Cross-section plans / alignments for corridors north of Omaha (120th/132nd/144th/180th/State/Rainbow Rd). All projects included in LRTP.
	Kennedy Freeway Planning Study	NDOR	2002	Cross-section needs for the Kennedy Freeway through 2030.
	Omaha Area Freeway Leisch Study	NDOR	1985	Study recommended projects have been completed over last 20+ years.

Chapter 2 - Needs Identified in Phase 1

Phase 1 of MTIS included a comprehensive assessment of existing and future no-build conditions in the study area and identified the areas/components of the study area that do not the meet the evaluation criteria or performance measure targets that were developed for MTIS. These "needs" were determined to be worthy of further study in Phase 2 but were not necessarily characterized as areas that "must" be addressed or mitigated.

In some cases, the identified needs might be better described as "wants" or "opportunities for improvement". For example, the crash assessment identified "locations with the greatest potential for safety improvement" while the pavement/bridge assessment identified "current short/near-term recommendations". In the Phase 1 Report it was further noted that the alternatives and strategies to be evaluated in Phase 2 would primarily be evaluated against system or regional performance measures and that it was possible that the regional plan ultimately recommended would meet regional performance measure targets without addressing all of the needs identified in Phase 1.

The following Phase 1 assessments were used to identify the study area needs that were considered in Phase 2:

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

Note that the Phase 1 assessment of the freeway geometry and operational features in the study area was not directly used to identify needs. Rather, the freeway segments within the study area that were identified as "poor" relative to various geometric criteria were 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 sub-standard horizontal curve be a contributing factor to congestion or crashes?).

Pavement and Bridge Needs

Existing pavement conditions in the study area were 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. Notable findings from the assessment included 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.

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 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. Findings from this analysis included:

- 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 not 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.

Similar to the pavement analysis, the Phase 1 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. The analysis of the current bridge conditions found that 76% of bridges in the MTIS study area are in satisfactory/good condition, 20% in fair condition, and the remaining 4% are in poor condition. 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%).

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. 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.

Pavement and bridge needs as of 2014 are shown graphically in **Figure 2.1** and summarized in tabular format in **Table 2.1**. Pavement and bridge that are in poor condition are considered "needs".

Table 2.1. Summary of Pavement & Bridge Needs (Existing)

Type	Percent of Study Area Roadways with Preservation Needs
Pavement	9.7%
Bridge	3.5%

Traffic Operations Needs

Existing and Future No-Build traffic operational analysis were conducted in Phase 1 to compare traffic operations to performance measure targets established for the MTIS study area. The threshold for acceptable Highway Capacity Manual (HCM) operations is Level of Service (LOS) 'D' or better. Methodologies from the HCM were utilized for the freeway system. Two (2) capacity-based methods were utilized 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.

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 were included at the following locations:

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

The existing conditions analysis in Phase 1 found that the majority of freeway facilities are generally operating at LOS 'D' or better during the peak hours. The non-freeway existing conditions traffic analysis results from Phase 1 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.

The Future No-Build 2040 E+C analysis found that a number of freeway facilities will not meet the threshold of LOS 'D' or better during peak hours. E+C analysis allows the MTIS Study Team to assess how the roadway system would perform if no additional investment in the transportation system was made, aside from committed short-term projects within the region. The non-freeway Future No-Build 2040 E+C conditions traffic analysis results are summarized below.

- 35% of non-freeway study roadways will be approaching capacity or over capacity (V/C > 0.9)
- 59 of the 112 studied intersections will be over capacity (LOS 'F') during their AM or PM peak hours.

Traffic operational needs are shown graphically in **Figure 2.2** and summarized in tabular format in **Table 2.2**. A traffic operation need is defined as any roadway segment or intersection that falls into either of the following categories:

- HCM LOS 'E' or 'F'
- V/C ratios > 0.9

Table 2.2. Summary of Traffic Operational Needs (Future No-Build 2040 E+C)

Facility Type	Percent of Study Area Roadways / Intersections with Operational Needs
Freeway Segments	34%
Ramp Terminals	29%
Arterial Segments	35%
Arterial Intersections	43%

Discontinuities / Access Gaps

Roadway system discontinuities and access gaps were identified in coordination with the Management Committee. These discontinuities and access gaps represent opportunities to provide continuous corridors where they do not exist today (e.g., 180th Street) and/or to provide new regionally significant corridors in the suburban areas of the study area. Discontinuities and access gaps are shown graphically in **Figure 2.3**.

Safety

A crash assessment of all study area roadways and intersections was performed in Phase 1. Varying methodologies were used depending on the facility type. Study area roadways were stratified into the following categories:

- Freeway Mainline and Ramp Segments
- Freeway Ramp Terminal Intersections
- Non-Freeway Roadway Segments
- Non-Freeway Intersections
- Pedestrian Corridors

Crash data was 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, multi-vehicle, pedestrian related); crash severity (e.g., fatal, injury, property damage); and other circumstances of the crash (e.g., road conditions, driver condition).

Predicted crashes were estimated to assess future conditions. The concept of predicted crashes recognizes that roadways with traffic will (over time) experience crashes. Methods from the Highway Safety Manual were used to predict crashes as a function of the type of facility. The expected crash frequency for any facility is a function of the following:

- **Average Daily Traffic (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).

Screening criteria were then established 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 needs (i.e. locations for 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. 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.

Locations with the potential for safety improvements are shown graphically in **Figure 2.4** and summarized in tabular format in **Table 2.3**.

Table 2.3. Summary of Safety Needs (Existing)

Facility Type	Percent of Study Area Roadways / Intersections with Safety Needs
Freeway Segments	12%
Ramps (Interchanges)	34%
Ramp Terminals	12%
Arterial Segments	18%
Arterial Intersections	22%

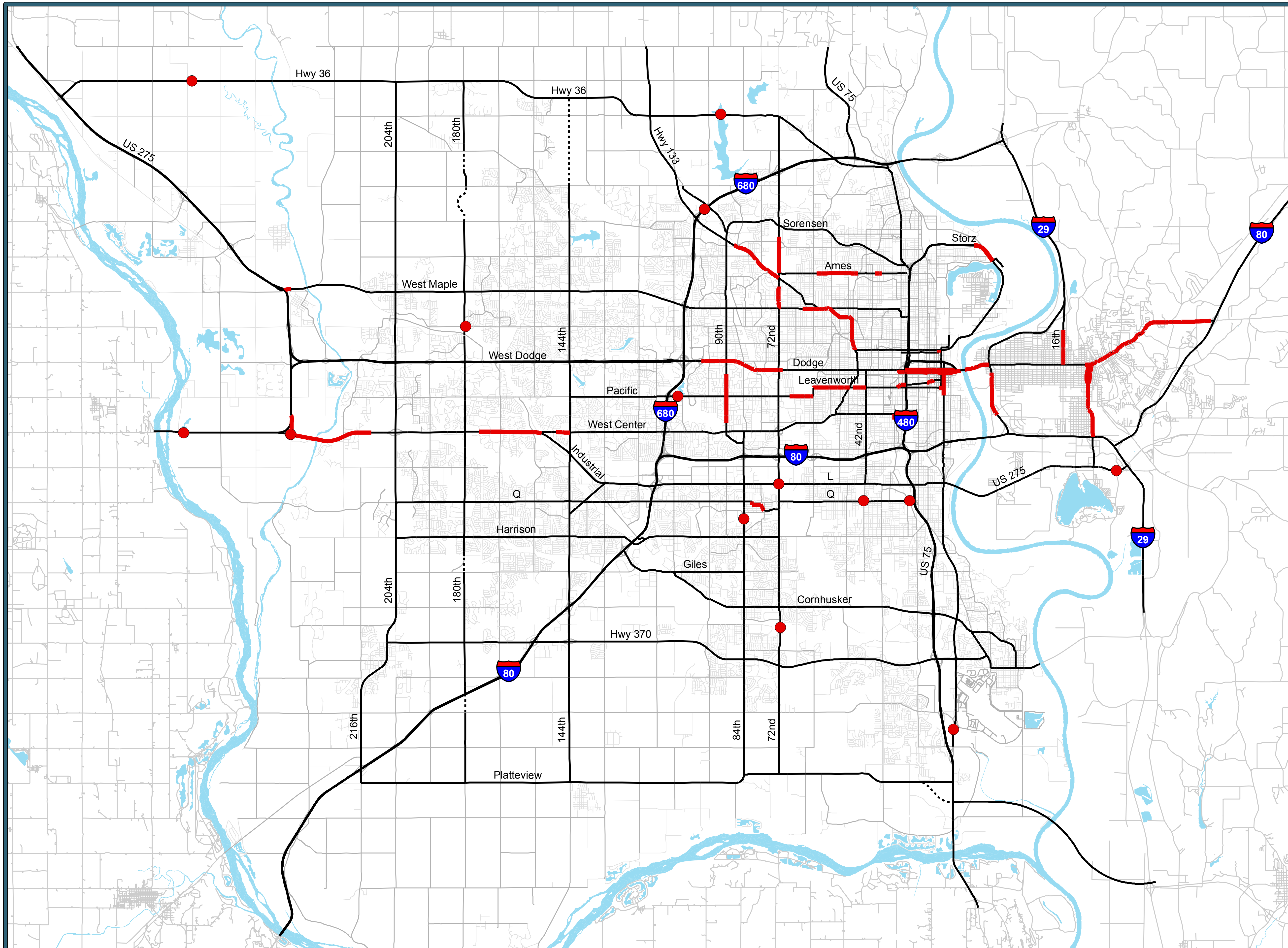


Figure 2.1: Pavement & Bridge Needs (Existing)

Legend

- Bridge Needs
- Pavement Needs

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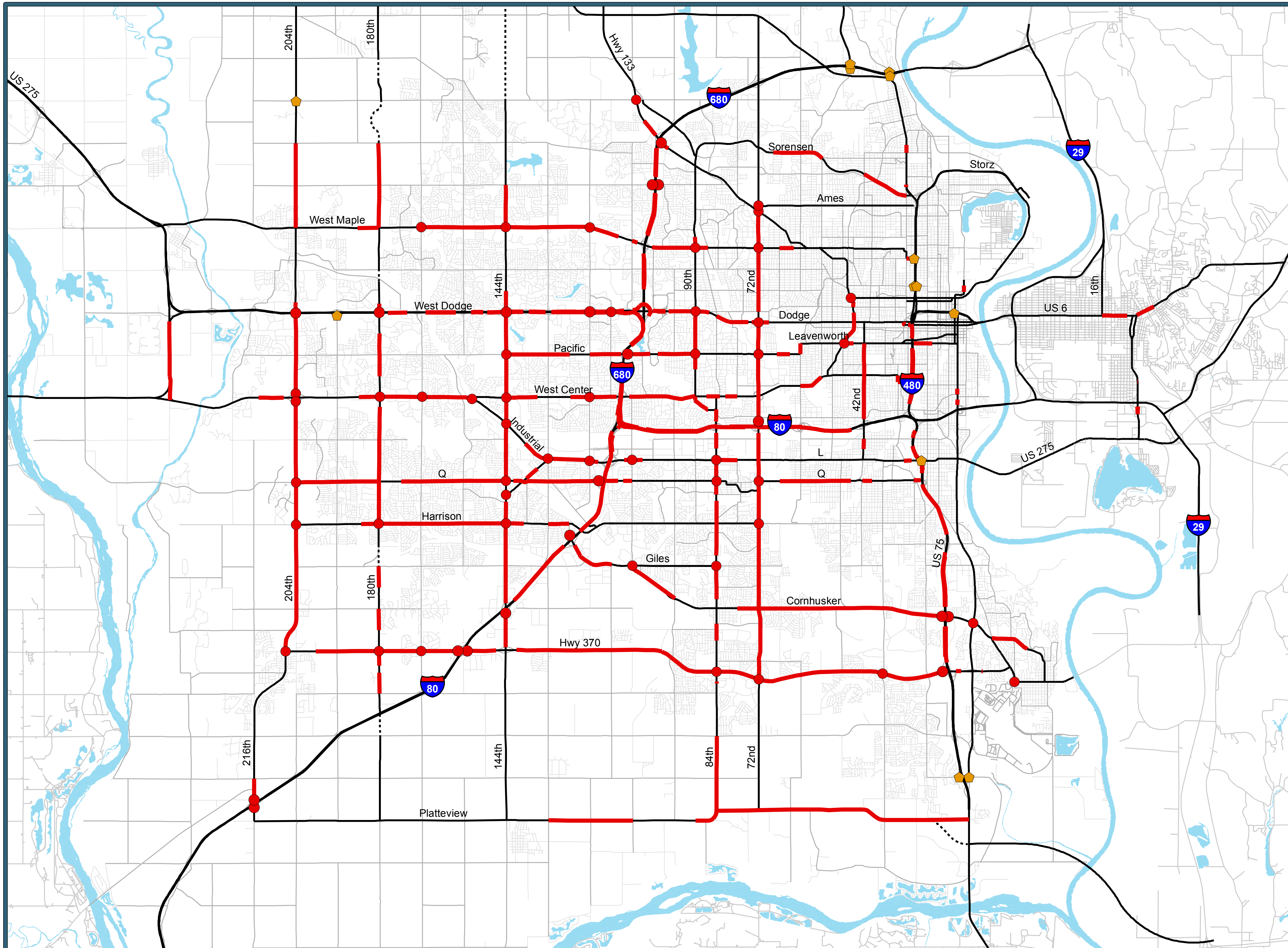

Figure 2.2: Traffic Operational Needs (Future No-Build 2040 E+C)

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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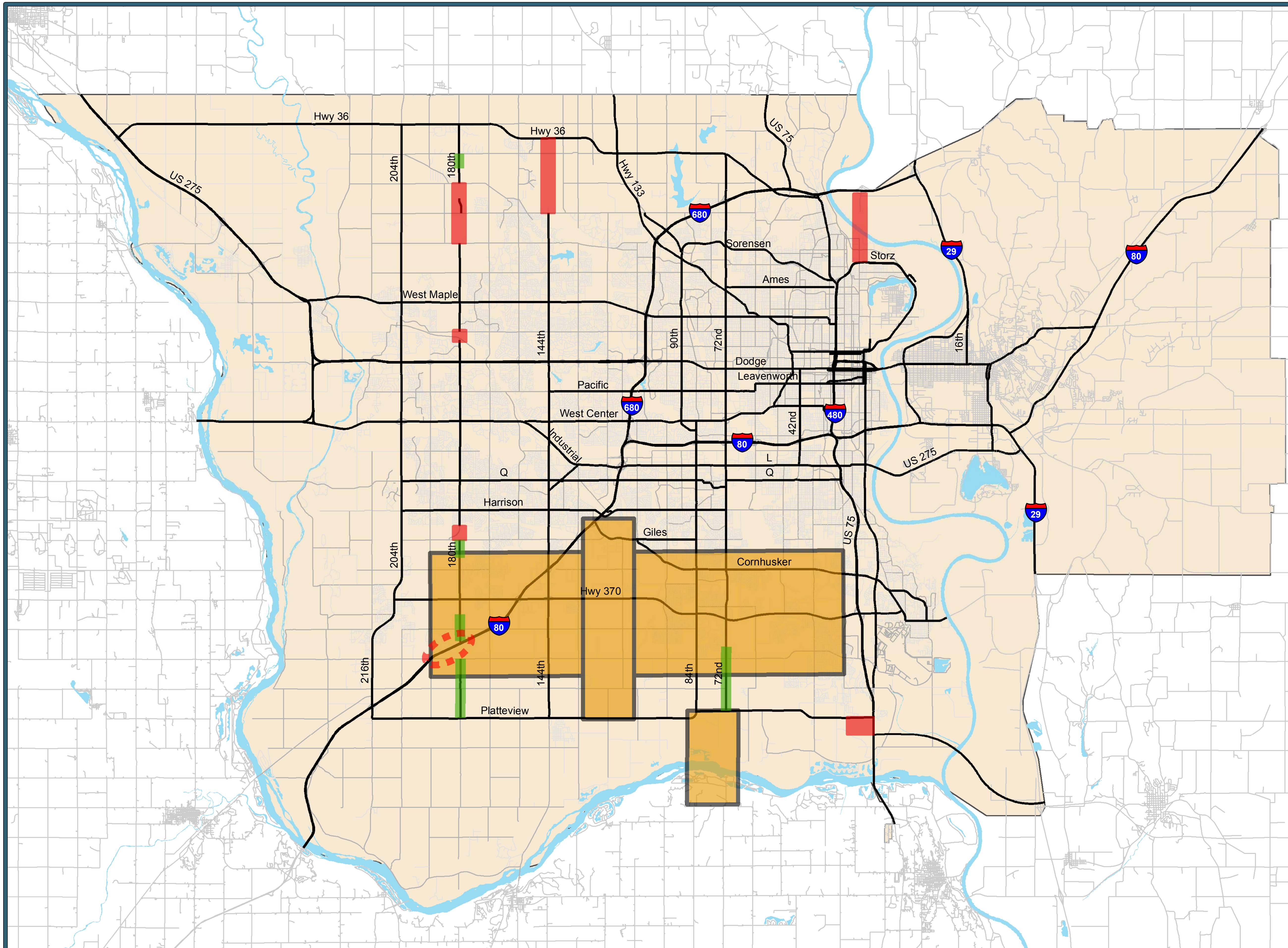
Figure 2.3: Discontinuities / Access Gaps (Existing)



Legend

- Gravel Roads
- Gap Needs
- Gap Needs (Interchange)
- Potential New Corridor
- Study Routes
- MTIS Study Area

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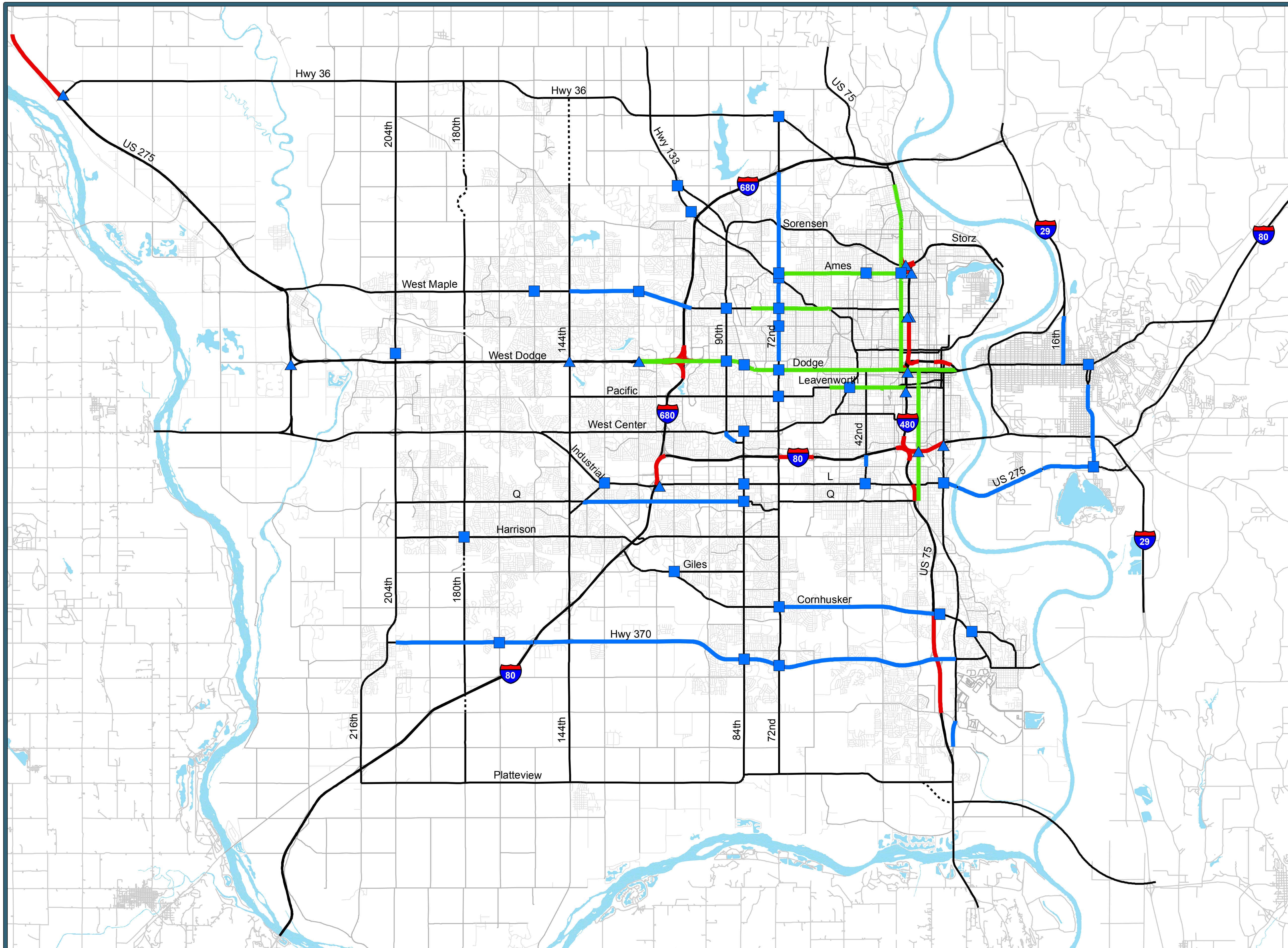

Figure 2.4: Locations with the Potential for Safety Improvement (Existing)

Legend

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

Metro Area Travel Improvement Study

Chapter 3 - MAPA Model Enhancements

Phase 2 included several enhancements made to the MAPA travel demand model to support the study analysis. Several tasks were suggested as part of a Travel Model Improvement Program (TMIP) Peer Review supported by the Federal Highway Administration. Two (2) of the suggested enhancements promised the clearest and most immediate benefit to the MTIS study:

- **Trip Distribution Enhancements**: Adding income segmentation into the trip distribution component.
- **Freight Model Enhancements**: Developing a truck forecasting module.

In addition to these two model enhancements that provided critical planning analysis capabilities to Phase 2, and were recommended by the TMIP Peer Review, an additional set of model enhancements included incorporating automated vehicle / connected vehicle (AV/CV) model elements.

Trip Distribution Enhancements

During Phase 1 of MTIS, AirSage data was used to evaluate travel patterns in the metro area. AirSage is a data provider that delivers anonymous, cellular-based mobile-device data points that can be used to identify travel patterns. The AirSage data were compared to output from the travel demand model, and it was noted that home-based work (HBW) trips between some portions of the MAPA area were under- or over-represented in the model. To improve capabilities of the travel demand model to accurately forecast flows between various sub-areas of the region, income segmentation for trip distribution was investigated.

Surveys show that income has a significant impact on travel behavior and increasingly travel demand models have introduced household income into demand segmentation. The state-of-the-practice is to include household income at several stages of the model, including trip distribution. Higher income households generate more trips relative to lower income households, and tend to make longer trips than those from low income households. Including household income in HBW trip distribution allows the model to better capture the travel patterns observed in the region. While the non-work trip distribution could also be separated by income, that is considered a lower priority, as the peak period travel tends to be dominated by work trips.

For the 2009 National Household Travel Survey (NHTS), MAPA purchased an additional “add-on sample” that brought the number of households in the 2009 NHTS up to a statistically-significant level. This NHTS add-on survey was used to stratify HBW travel characteristics and patterns by income category. AirSage data were used as a validity check on the NHTS data, so that when the model reasonably replicated the NHTS, it was considered to be a reasonable representation of the region’s travel demand patterns. Three (3) annual household income categories were used for this income-based trip distribution approach:

- Less than $35,000
- $35,000 to $65,000
- $65,000 or More

To evaluate trip patterns, the MTIS study area was subdivided into 14 districts. New trip distribution parameters were developed to get modeled HBW district-to-district flows to better match surveyed flows, by income category. The results of this HBW income-based trip distribution model improvement was a travel model that distributed HBW trips between districts in a manner much more consistent with NHTS and AirSage patterns than it previously did.

Freight Model Enhancements

A truck demand model was developed to help understand the impacts of freight on the transportation system, and use freight performance as one of the metrics for prioritizing MTIS investments. The truck module for the MAPA model estimates truck volume by origin-destination (O-D) for the entire MAPA region, broken down into the model’s four time periods (AM peak period, midday, PM peak period, and night) and for two truck types (light/medium and heavy). Note that some commercial vehicles will also fall into FHWA class 3 (four-tire) but these are not included in the model, because of the difficulty in differentiating these from passenger vehicles.

The development of the truck model was structured to fit into the existing MAPA model framework, using the same Traffic Analysis Zone (TAZ) system and road network. The overall truck model development process included:

- Review of existing truck count data and development of a relatively consistent dataset for development and validation of the MAPA truck model.
- Assessment of truck trip generation rates from other studies, and testing and fitting of those rates to the MAPA region. Truck trip generation was based on the locations and amount of general / industrial employment, retail / commercial employment, and households.
- Development of a base year set of truck volume flows by O-D pair using O-D Matrix Estimation (ODME).
- Implementation of a forecasting routine that pivots from the base year truck volume flows according to changes in forecasted socio-economic data, based on the MAPA-tailored truck trip generation rates.

Overall, the resulting truck model was well-calibrated to observed truck flows and employment data.

Automated Vehicle / Connected Vehicle Model Enhancements

As a future proofing exercise discussed in **Chapter 6**, model enhancements were made to the travel demand model to account for transportation technology. More details on the results of those scenarios are provided in that chapter. There were several individual model elements adjusted to provide the model the capabilities to test several responses to automated and connected vehicles.

These model adjustments included:

- Capacity Adjustment Factors, to account for improved automated vehicle throughput
- Trip Generation Adjustment Factors, to account for induced automated vehicle trips
- Travel Skim Time Reduction Factors, to reflect reduced value of time for automated vehicle trips
- Deadheading Trip Routine, which transposed the Non-Home Based Work trip matrix and applied a factor to reflect circulating autonomous vehicles.

Chapter 4 - Potential Strategies by Corridor/Area

The issues identified in Phase 1, and outlined in **Chapter 2**, required a comprehensive and performance-based set of solutions. It was determined that prior to developing combinations or sets of strategies to deal with the issues at a regional scale, it was first necessary to evaluate the issues and potential strategies at the corridor level. Thus, "menus" of potential strategies were investigated for each corridor or issue area. This chapter discusses the range of potential strategies considered by corridor and area.

Menu of Options

The menu of options that were developed included:

- Operational improvements, both at the corridor level and the regional level
- Safety improvements
- Other improvement types

Operational Improvement Strategies

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

Freeway Improvements

Freeway 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) or improved regional connections. Different types of freeway improvements include general purpose lanes, auxiliary lanes, collector-distributor roads, and interchange reconfigurations,

Arterial / Non-Freeway Improvements

Non-freeway improvements would consist of a set of roadway improvements to add capacity to an arterial corridor or system. These projects aim to provide additional capacity while alleviating congestion on other roadways or systems (i.e. freeways). The range of arterial improvements considered included:

- Widening or adding lanes
- Traditional improvements to intersections, such as added turn lanes or improved / reconfigured intersection control
- Innovative intersection improvements, such as displaced left-turn intersections, median U-turn intersections, or quadrant intersections. Examples of these innovative intersections are illustrated in **Appendix A**.
- Intelligent transportation systems (ITS) projects

Managed Lane Concepts

Managed Lane Concepts are strategies that maximize throughput of highway facilities or defined set of lanes by providing incentives for travelers to use the roadway more efficiently. Managed lanes are different from traditional traffic strategies because they proactively 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 include:

- **High Occupancy Vehicle (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.
- **High Occupancy Toll (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.
- **Reversible Lanes**: Lanes that can be reversed depending on the time of day to better serve peaking characteristics of inbound / outbound traffic.
- **Dedicated Truck Lanes**: Lanes dedicated for trucks or slower moving vehicles to improve the flow of traffic in general purpose lanes.

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 include:

- **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 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 include:

- **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 include rideshare programs, employer incentives, commuter tax benefits, and telecommute options / alternative work schedules.

Transit Strategies

Transit strategies can have a range of approaches. Metro's service changes in 2015, 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 include:

- **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) / Modern Streetcar**: While these two technologies were distinct from one another in the past, they have become more similar in their characteristics. They are fixed-guideway electric rail passenger service that operates in either mixed traffic or along a separated right-of-way at ground level.
- **Enhanced Bus Service**: Similar to existing services, but typically offers limited stops and service at a lower cost than BRT. Applications in the Omaha-Council Bluffs metro area were targeted at "reverse commute" connections to educational opportunities on the urban fringe.

Safety Improvement Strategies

The following safety improvement strategies were developed to mitigate issues in corridors that were identified in Phase 1 as having the greatest potential for safety improvement (shown previously in **Figure 2.4**). The safety performance of the proposed safety strategies were evaluated and quantified to estimate the reduction in fatal and injury crashes.

A comprehensive list of strategies was developed using the latest research on crash modification factors (CMFs). The CMFs were selected considering the strategy and countermeasures appropriate to the facility and corridor of interest to address, including the following:

- CMFs for various area types including "urban" and "suburban" for arterial and "urban" and "rural" for freeway corridors
- CMFs addressing fatal and severe injury crashes
- CMFs addressing specific collision types (for example, rear-end, angle, or sideswipe)
- CMFs addressing specific time of day
- CMFs involving various number of vehicles (for example, single-vehicle or multi-vehicle)

Each CMF has a rating that indicates the quality or confidence in the results of the study that produced the CMF. The star rating varies from 1 to 5, with 5 being the most effective. The CMFs included in the list of selected strategies have star rating of 3 or greater. A brief description of each strategy is provided in **Table 4.1** through **Table 4.4**.

Table 4.1. Freeway & Ramp Safety Strategies

Safety Strategy	Countermeasures	CMF Rating	Freeway Mainline	Ramps
Modify speed limits and increase enforcement to reduce truck and other vehicle speeds	Implement mobile speed cameras	3	●	
	Install automated section speed enforcement system	4		
Install shoulder rumble strips	Install continuous milled-in shoulder rumble strips	3	●	●
Apply shoulder treatments	Increase inside paved shoulder width from 4ft to 12ft	3	●	
Design safer slopes and ditches to prevent rollovers	Flatten side slopes	3	●	
Improve design and application of barrier and attenuation systems	Install any type of median barrier	4	●	
	Install cable median barrier	3		
	Installation of cable barriers in freeway medians	3		
Provide enhanced pavement markings and median delineation	• Install wider markings and edgeline rumble strips with resurfacing • Install wider markings with resurfacing • Install wider markings WITHOUT resurfacing	4	●	●
Provide improved pavement surfaces	• Improve pavement friction (Chip Seal) • Improve pavement friction (Diamond Grinding)	4	●	●
Provide wider medians	Convert median from 10 feet to 100 feet	5	●	
Improve median design for vehicle recovery	• Install raised median • Install steel median barrier	4	●	
Implement ITS strategies to improve safety	Install variable speed limit sign	4	●	
Provide improved highway geometry for horizontal curves	Increase the horizontal curve radius from X to Y feet	ISATe*		●
Widen the roadway	Increase the ramp lane width from X to Y feet	ISATe*		●
Apply shoulder treatments (Widen shoulders)	• Widen the left shoulders width from X to Y feet • Widen the right shoulders width from X to Y feet	ISATe*		●
Improve design and application of barrier and attenuation systems	• Install roadside barrier on the left side of ramp • Install roadside barrier on the right side of ramp	ISATe*		●
Increase the ramp segment capacity	Increase the number of lanes on-ramp segment	ISATe*		●

** Certain freeway safety strategies utilized the Enhanced Interchange Safety Analysis Tool (ISATe) instead of CMFs.*

Table 4.2. Ramp Terminal Intersection Safety Strategies

Safety Strategy	Countermeasures	CMF Rating
Construct special solutions	Install a traffic signal	4
Implement automated enforcement	Install red-light cameras	4
Improve visibility at intersection	Replace night-time flash with steady operation	3
	Install changeable crash ahead warning signs	4
	Install lighting	4
Provide enhanced pavement markings	Install wider markings with resurfacing	4
Implement automated enforcement	Install an automated speed camera (photo radar) at a signalized intersection	4
	Implement mobile automated speed enforcement system	4

Table 4.3. Arterial Segment Safety Strategies

Safety Strategy	Countermeasures	CMF Rating
Install median barriers for narrow-width medians	Provide a raised median (rear-end)	3
Restrict or eliminate turning maneuvers by providing channelization or closing median openings	Convert an open median to a directional median	4
Install edgeline “profile marking,” edgeline rumble strips or modified shoulder rumble strips on section with narrow or no paved shoulders	Install wider markings and edgeline rumble strips with resurfacing	4
Restrict or eliminate turning maneuvers by providing channelization or closing median openings	Convert an open median to a left-in only median	3
Eliminate parking that restricts sight distance	Prohibit on-street parking	5
Implement automated speed enforcement	Implement mobile automated speed enforcement system	4
Provide enhanced pavement markings	Install edgelines, centerlines, and post-mounted delineators	4
Provide enhanced pavement markings (curves)	Install edgelines (curves)	3
Provide lighting (of the curve)	Install lighting	4
Improve visibility at intersection	Install changeable "Queue Ahead" warning signs	3
Install shoulder rumble strips	Install shoulder rumble strips	3
Improve roadside	Widen shoulder width to 5 feet or greater	3
Install traffic calming strategies	Traffic calming	4
Provide transit improvements	Install transit signal and lane priority (at transit-serviced locations)	4
Provide accommodation for bicyclists	Install bicycle lanes	3

Table 4.4. Arterial Intersection Safety Strategies

Safety Strategy	Countermeasures	CMF Rating
Provide/improve left-turn channelization	Provide a left-turn lane on both major-road approaches	5
	Provide a left-turn lane on one major-road approach	4
Optimize clearance intervals	Increase all red clearance interval	3
Employ multiphase signal operation	Change left-turn phase from permissive to protected/permissive or permissive-protected phasing on one or more approaches	5
Employ signal coordination	Install adaptive traffic signal control	4
Improve operation of pedestrian and bicycle facilities at signalized intersections	Install of a High intensity Activated CrossWalk (HAWK) pedestrian-activated beacon	3
Implement automated enforcement of approach speeds (cameras)	Install an automated speed camera (photo radar) at a signalized intersection	4
Construct special solutions	Convert signalized intersection to modern roundabout	4
	Convert intersection with minor-road stop control to modern roundabout	4
	Convert at-grade intersection to grade-separated interchange	5
	Install a traffic signal	3
Improve visibility of signals and signs at intersections	Install transverse rumble strips as traffic calming device	4
Improve visibility of intersections on approach(es)	Install dynamic signal warning flashers	4
Improve operation of pedestrian and bicycle facilities at signalized intersections	Install high-visibility yellow, continental type crosswalks at schools	3

Other Strategies

The following strategies don’t fall into the operational improvement or safety improvement strategies listed earlier in this chapter, but are an integral part of the 2040 Regional Strategy Packages discussed in **Chapter 6**.

System Preservation / Asset Management Life-Cycle Strategies

System preservation is one of the study goals and objectives for 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. These strategies are discussed in detail in **Chapter 5**.

Pedestrian / Bicycle Strategies

Pedestrian / Bicycle strategies from the *Heartland Connections Bicycle and Pedestrian Plan* (Completed 2015) that were considered include:

- **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 / Bike 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.

Operational Improvement Corridors

Potential Corridors for Consideration

Arterials, expressways, freeways and potential new corridors that that would benefit operations in the MTIS study area are shown in **Figure 4.1**. Almost all of the operations needs that were developed in Phase 1 of MTIS have a corresponding operational improvement corridor to address the need unless the segment was short in length, or was on the cusp of the threshold for an operational need. An operation improvement corridor was considered if it met one of the following criteria:

- An operational need was present for the majority of the corridor:
  - HCM LOS ‘E’ or ‘F’
  - V/C Ratio greater than 0.9
- A “gap” existed between MTIS corridors that could provide better connectivity and access.
- As directed by the Management Team:
  - NDOR has planned to expand a number of expressways over the next 20 years as part of the Build Nebraska Act. These corridors are shown in Purple.
  - MAPA added various arterials that do not show an operational need but help link corridors together.
- The corridor has a poor travel time reliability.

Table 4.5 through **Table 4.7** provide a more detailed description of the corridor limits and the menu of options that were considered for each corridor. Note that the corridor numbers shown in **Figure 4.1** correspond with the first column in **Table 4.5** through **Table 4.7**. Also note that the corridor name and highway name (if applicable) are provided in the 2nd, 3rd, and 4th columns. For the remaining figures / tables, the most common name is used for each corridor.

Feasibility and Viability of Potential Strategies

The Study Team also screened the strategies developed for each corridor to determine if the options were feasible and viable. Considerations for this effort included a high level screening of right-of-way (ROW) impacts, order-of-magnitude costs, severity of the operational need, environmental constraints, consistency with previous studies, and perceived public acceptance. Strategies that were screened out are shown in red in **Table 4.5** through **Table 4.7** and are displayed in **Figure 4.2**.

Widening 72nd Street between Cass Street and I-80 to eight (8) lanes was removed from the strategy list due to ROW impacts and order-of-magnitude costs. A majority of the corridor widening projects that were screened out were due to ROW impacts and/or order-of-magnitude costs similar to the 72nd Street example.

Two (2) potential new corridors were removed due to environmental constraints identified by the Study Team:

- Cornhusker Road between 204th and 84th Street was removed due to existing reservoirs, planned flood control projects, and streams / floodways in its path.
- 42nd / 60th Street between I-80 and N-370 was removed due streams / floodways in its path.

Screening of Corridor / Area Strategies

The remaining options for each corridor were carried forward for developing the various 2040 Regional Strategy Packages discussed in **Chapter 6**.

Key Takeaways

The range of mobility, access, and safety issues identified for the MTIS study area required a comprehensive and performance-based set of solutions. Issues and potential strategies were evaluated at the corridor level. “Menus” of potential strategies were investigated for each corridor or issue area.

These multimodal strategies were developed and assessed to determine their potential impact on the existing / planned transportation system and regional performance measures:

- Pavement Preservation
- Bridge Preservation
- Freeway Improvements
- Arterial / Non-Freeway Improvements
- Managed Lane Concepts, such as High Occupancy Vehicle (HOV) lanes, High Occupancy Toll (HOT) lanes
- Transportation Systems Management (TSM) Strategies
- Intelligent Transportation Systems (ITS) Strategies
- Transportation Demand Management (TDM) Strategies
- Transit Improvement Strategies
- Safety Improvement Strategies
- System Preservation Strategies
- Pedestrian / Bicycle Strategies

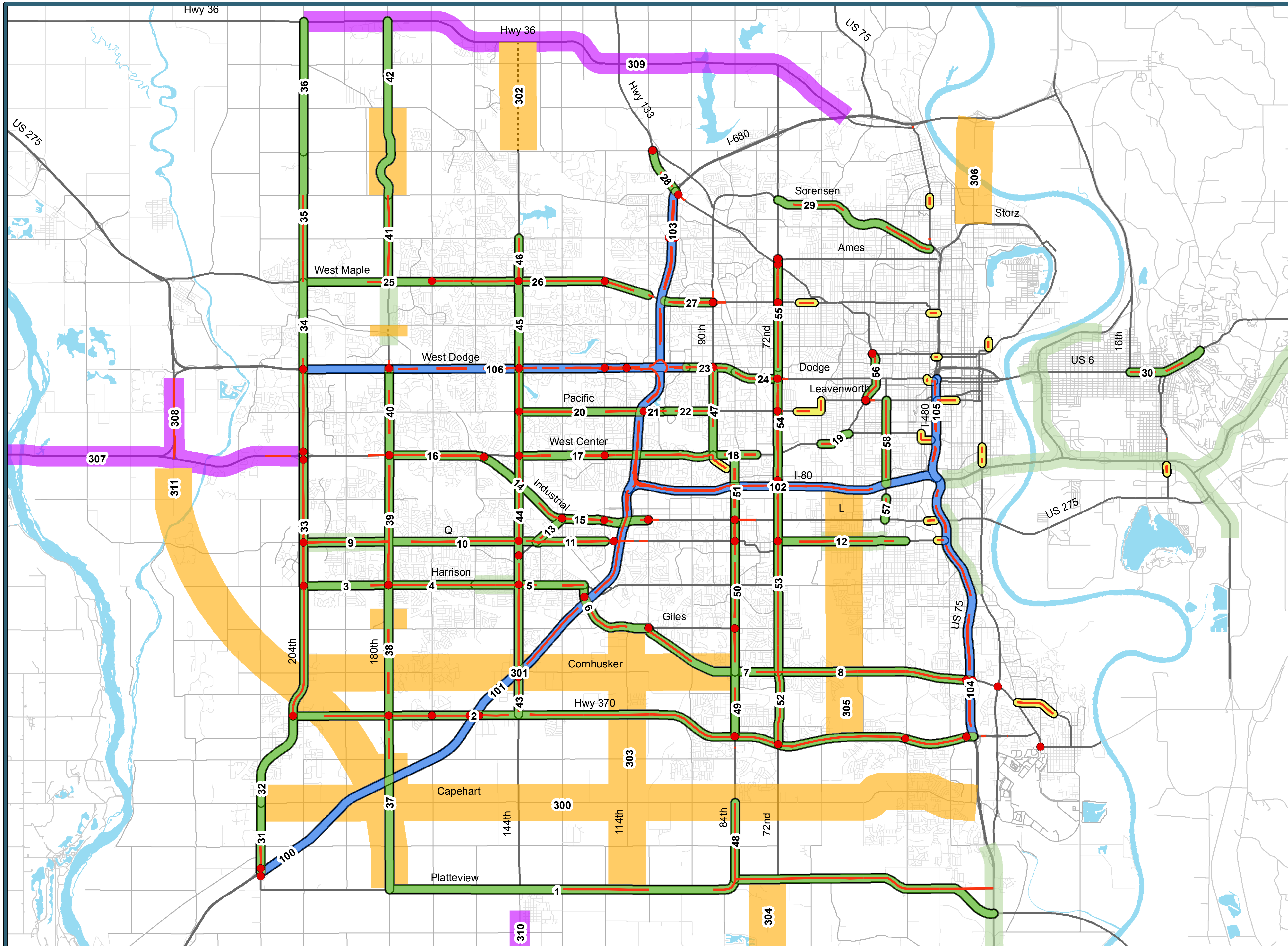

Figure 4.1 Operational Improvement Strategy Locations

Legend

Needs

- Intersection Needs
- Segment Needs

Strategies

- Arterial / Expressway
- Freeway
- Removed Needs
- Potential New Corridor
- Expressway Gap

Committed Widening Projects

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

Note that committed projects off of Study Area roadways are not displayed.

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Metro Area Travel Improvement Study

Table 4.5. Menu of Options & Feasibility / Viability of Options for Arterials

				Segment Capacity - Need Based		Segment Capacity - Vision Based		Segment Management			Node Capacity			ITS	Transit	TDM
Figure 4.1 ID	Road	From	To	Widen (# of Lanes)	Freeway (# of Lanes)	Widen (# of Lanes)	Freeway (# of Lanes)	Access Control	Major Access Control / Retrofit	Reversible Lane	Traditional Intersection Improvements	Innovative Intersection	Grade Separation	Signal Improvements / Cameras / DMS	Rapid (R), Local (L), or Express (E)	Corridors that Benefit
1	Platteview	180th	US-75	4		4 Expwy					●	●	●		E	●
2	N-370	204th (US-6)	US-75	6 Expwy	4					●	●	●	●	●	R/E	●
3	Harrison	204th (US-6)	180th	4												●
4	Harrison	180th	156th	4										●		●
5	Harrison	156th	Giles								●	●		●		●
6	Giles	Harrison	108th	6								●		●		●
7	Cornhusker	Giles	72nd	3										●		●
8	Cornhusker	72nd	US-75	6										●	L	●
9	Q	204th (US-6)	180th	In CIP								●				●
10	Q	180th	Millard (N-50)	6							●			●	E	●
11	Q	Millard (N-50)	120th	4				●			●			●	E/R	●
12	Q	72nd	36th	3							●			●	E/R	●
13	Millard (N-50)	L (US-275)	Q	6								●		●		
14	Industrial (US-275)	Center	132nd	6	6							●	●	●	L/E	●
15	L (US-275)	132nd	108th	8	6							●	●	●	L	●
16	Center (US-275)	180th	Industrial (US-275)	6								●		●	R	●
17	Center	144th	I-680	6								●	●	●	R	●
18	Center	I-680	78th	6								●		●	R	●
19	Center	60th	Saddle Creek	6				●			●			●	R	●
20	Pacific	144th	I-680								●			●		●
21	Pacific	I-680	Regency	6				●				●		●		●
22	Pacific	Regency	90th	4				●						●		●
23	Dodge (US-6)	Westroads	84th	10						●		●	●	●	R	●
24	Dodge (US-6)	84th	72nd	8						●		●	●	●	R	●
25	Maple (N-64)	204th	156th	6					●			●	●	●	E	●
26	Maple (N-64)	156th	108th	6					●			●	●	●	E	●
27	Maple (N-64)	I-680	90th	6					●			●		●	R	●
28	Blair High (N-133)	State	I-680	6					●				●	●	E	●
29	Sorensen	72nd	30th								●			●	L	●

Removed Option in Screening Process | Option added by Management Committee

Table 4.5 (Continued). Menu of Options & Feasibility / Viability of Options for Arterials

Figure 4.1 ID	Road	From	To	Segment Capacity - Need Based		Segment Capacity - Vision Based		Segment Management			Node Capacity			ITS	Transit	TDM
				Widen (# of Lanes)	Freeway (# of Lanes)	Widen (# of Lanes)	Freeway (# of Lanes)	Access Control	Major Access Control / Retrofit	Reversible Lane	Traditional Intersection Improvements	Innovative Intersection	Grade Separation	Signal Improvements / Cameras / DMS	Rapid (R), Local (L), or Express (E)	Corridors that Benefit
30	Broadway (US-6)	16th	N Broadway								●			●	R	●
31	216th (N-31/US-6)	I-80	Capehart	6				●			●			●		●
32	US-6	Capehart	N-370	6				●			●	●		●		●
33	204th (US-6)	N-370	Dodge (US-6)	6	4							●	●	●		●
34	204th (N-31)	Dodge (US-6)	Maple (N-64)			6						●	●			
35	204th (N-31)	Maple (N-64)	State	3		6	4				●	●	●			●
36	204th (N-31)	State	N-36			6						●				
37	180th	Platteview	N-370	2-3		6			●			●	●			●
38	180th	N-370	Harrison	3-4		6			●			●	●			●
39	180th	Harrison	Center	4		6			●			●		●	L	●
40	180th	Center	Dodge	4		6			●			●	●	●	L	●
41	180th	Maple (N-64)	Ida	3-4		6			●			●				●
42	180th	Ida	N-36	3		6			●			●				●
43	144th (N-50)	N-370	I-80	6	4				●			●	●		E	●
44	144th (N-50)	I-80	Dodge	6					●			●	●	●	E	●
45	144th	Dodge	Maple			6							●			
46	144th	Maple (N-64)	Fort	4		6						●	●			●
47	90th	Center	Dodge (US-6)	4				●				●				●
48	84th	Platteview	Capehart	3		4					●	●				●
49	84th (N-85)	N-370	Cornhusker	4								●	●	●	E	●
50	84th (N-85)	Cornhusker	L (US-275)	6										●	E	●
51	84th	L (US-275)	Center	6				●				●		●	E	●
52	72nd	N-370	Cornhusker			6						●	●	●	R	●
53	72nd	Cornhusker	I-80	6					●			●		●	R	●
54	72nd	I-80	Cass	8								●	●	●	R	●
55	72nd	Cass	Ames	6				●				●		●	R	●
56	Saddle Creek	Leavenworth	Cuming (N-64)	6				●				●	●	●	R	●
57	42nd	L (US-275)	F	4				●							L	●
58	42nd	I-80	Leavenworth	4				●							L	●

Removed Option in Screening Process | Option added by Management Committee

Table 4.6. Roadway (Expressway) Gaps & Potential New Corridors

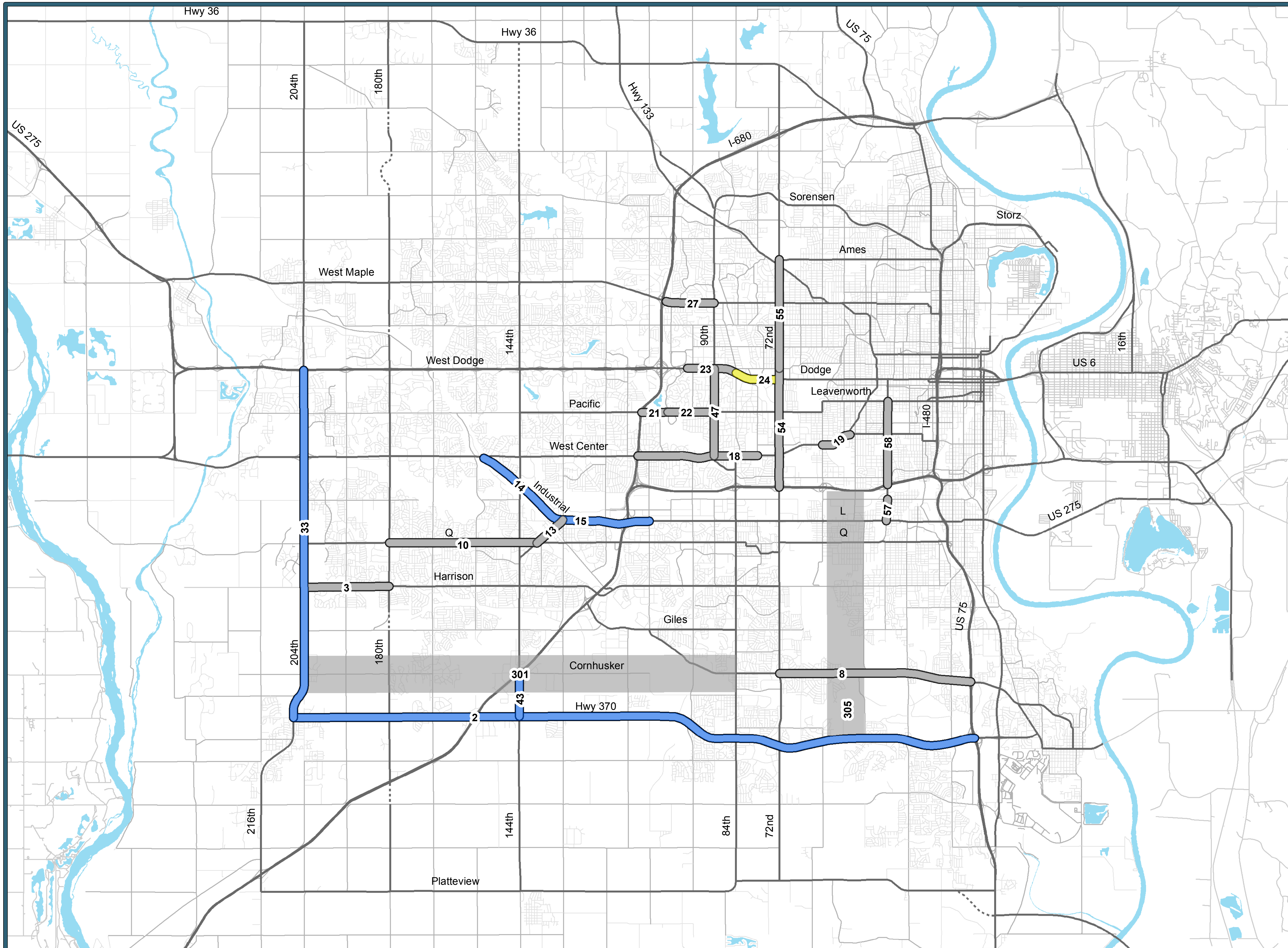
Figure 4.1 ID	Road	From	To	Segment Capacity - Need Based		Segment Capacity - Vision Based		Segment Management			Node Capacity			ITS	Transit	TDM	Gaps
				Widen (# of Lanes)	Freeway (# of Lanes)	Widen (# of Lanes)	Freeway (# of Lanes)	Access Control	Major Access Control / Retrofit	Reversible Lane	Traditional Intersection Improvements	Innovative Intersection	Grade Separation	Signal Improvements / Cameras / DMS	Rapid (R) or Local (L)	Corridors that Benefit	Potential New Corridor
300	Capehart	216th (N-31/US-6)	US-75	3 - 4													●
301	Cornhusker	204th (US-6)	84th (N-85)	3 - 4													●
302	138th - 144th	N-36	State	3													●
303	114th	Giles	Platteview	4 Expwy								●	●				●
304	Platte River Crossing	Near 72nd		2													●
305	42nd / 48th / 60th	I-80	N-370	3 - 4													●
306	16th	I-680	Storz Expwy	4													●
307	Center (N-92/US-275)	Platte River	204th			4 Expwy											
308	240th (US-275)	Dodge	Center			4 Expwy											
309	N-36	204th (N-31)	I-680			4 Expwy											
310	144th (N-50)	Springfield	Platte River			4 Expwy											
311	SW Beltway	Center (US-275)	Platteview			4 Expwy											●

Table 4.7. Menu of Options & Feasibility / Viability of Options for Freeways

Figure 4.1 ID	Road	From	To	Capacity Improvements					Managed Lanes								ITS				Transit		TDM		
				General Purpose Lanes (# of Lanes)	Auxiliary Lanes	CD Roads	Interchange Improvements / Reconfiguration	New Interchange	HSR (All Vehicles)	HSR (Buses)	Reversible Lanes (Free)	Reversible Lanes (HOT)	HOV Lanes	HOT Lanes	Dedicated Truck Lanes	Managed Lanes with Bus / Inline Stations	Ramp Metering	Variable Speed Limits	Dynamic Lane Use Control	TIM	BRT	LRT	Park & Ride	Vanpool / Carpool Rideshare	Other TDM
100	I-80	216th (N-31)	N-370				●	●							●					●			●	●	●
101	I-80	N-370	I-680	8	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
102	I-80	I-680	I-480	10		●	●		●	●			●	●	●	●	●	●	●	●	●	●	●	●	●
103	I-680	Blair High (N-133)	I-80	6 & 8	●	●	●		●	●	●	●	●	●			●	●	●	●	●	●	●	●	●
104	US-75	I-80	N-370	6 & 8	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●
105	I-480 / US-75	Cuming (N-64)	I-80	8 & 10	●				●	●	●	●	●	●			●	●	●	●	●	●	●	●	●
106	Dodge (US-6)	204th (N-31)	Westroads	8	●	●			●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●

Removed Option in Screening Process	Option added by Management Committee

Figure 4.2 Removed Corridor Strategies



Legend

Removed Strategies

- Arterial Widening
- Freeway Expansion
- Grade Separated Intersections
- Potential New Corridor

Metro Area Travel Improvement Study

Chapter 5 - System Preservation / Life-Cycle Maintenance Strategies

This chapter summarizes the forecasted conditions for bridges and pavements, as well as specific investments of pavement and bridge assets in the MTIS study area. For both pavement and bridge, the general approach to assessing the system preservation and asset management assessment followed this process:

- Establishing current asset conditions (as outlined in Phase 1)
- Developing an asset deterioration model
- Identifying a life-cycle maintenance strategy
- Associating a cost with that strategy

Bridge Preservation Assessment

Bridge Asset Inventory

The National Bridge Inventory (NBI) was obtained from NDOR and Iowa DOT. There are a total of 386 bridges included on MTIS study roadways: 312 bridges in Nebraska and 74 bridges in Iowa. Based on original construction or reconstruction year, the average age of bridges in the study area is 36 years. Since it is possible that a reconstruction project focused only on a bridge's deck, substructure, or superstructure, the true average age of bridges in the study area is likely higher than 36 years. The existing conditions (rate by NBI rating) of the bridges are summarized in **Table 5.1** below. Note that the information shown in **Table 5.1** is based on the existing bridge condition assessment that was conducted in Phase 1 using the FHWA Bridge Rating Scale that was applicable at that time. FHWA has subsequently established regulations (Final Rule published on January 18, 2017 and effective May 20, 2017) for the new performance aspects of the National Highway Performance Program (NHPP). These new performance aspects address measures, targets, and reporting relative to pavement and bridge condition on the NHS. Future updates to MTIS will need to consider these new regulations.

Table 5.1. MTIS Study Area Bridge Inventory, Expected Service Life of Bridge Elements

State	Number Bridges		
	Satisfactory / Good (Condition Rating ≥ 6)	Fair (Condition Rating = 5)	Poor (Condition Rating ≤ 4)
Nebraska	194	109	9
Iowa	5	69	0

Bridge Deterioration Modeling

To forecast bridge conditions, it was necessary to understand current bridge conditions and develop models that estimated how bridges deteriorate. All bridges deteriorate with age due to increasing levels of traffic and climatic loadings, collisions, etc. The rate of deterioration of the structure depends a number of factors such as age, material (e.g., concrete, steel), geographic location (e.g., urban/rural, soil type), repair history (frequency and intensity), and existence of a preservation system. The deterioration models are based on historical bridge inspection results. The predictive method used in this study is empirical-based, discrete-time Markov chains. This predictive method is one of the most commonly applied techniques for bridges.

To build the deterioration models, 16 years (2000 to 2015) of NBI data were analyzed for metro area bridges. The frequency of bridges moving from one condition state to the next was recorded for various age groups (organized into 16 five-year intervals). These observations were then used as the transition probabilities in the Markov chains. Twelve (12) deterioration models were developed to predict bridge elements (deck, superstructure and substructure) decay over time and their remaining useful life. The 12 deterioration models are listed in **Table 5.2**.

Table 5.2. Combination of Bridge Deterioration Models

Model #	Bridge Elements	Material	Location
1	Deck	Steel	Urban
2	Deck	Concrete	Urban
3	Deck	Steel	Rural
4	Deck	Concrete	Rural
5	Superstructure	Steel	Urban
6	Superstructure	Concrete	Urban
7	Superstructure	Steel	Rural
8	Superstructure	Concrete	Rural
9	Substructure	Steel	Urban
10	Substructure	Concrete	Urban
11	Substructure	Steel	Rural
12	Substructure	Concrete	Rural

Note: Since 2011, NDOR has shifted to a preservation first methodology for bridges.

Assuming that only routine maintenance is provided, the deterioration models predict that the bridge elements in the study area will have the service life estimates (i.e. number of years for a bridge element to reach a rating of 4 from a rating of 9) as shown in **Table 5.3**.

Table 5.3. Expected Service Life of Bridge Elements

Bridge Element	Material	Expected Service Life (Year)	
		Urban	Rural
Deck	Steel	65	60
Deck	Concrete	64	71
Superstructure	Steel	71	79
Superstructure	Concrete	77	78
Substructure	Steel	72	72
Substructure	Concrete	77	84

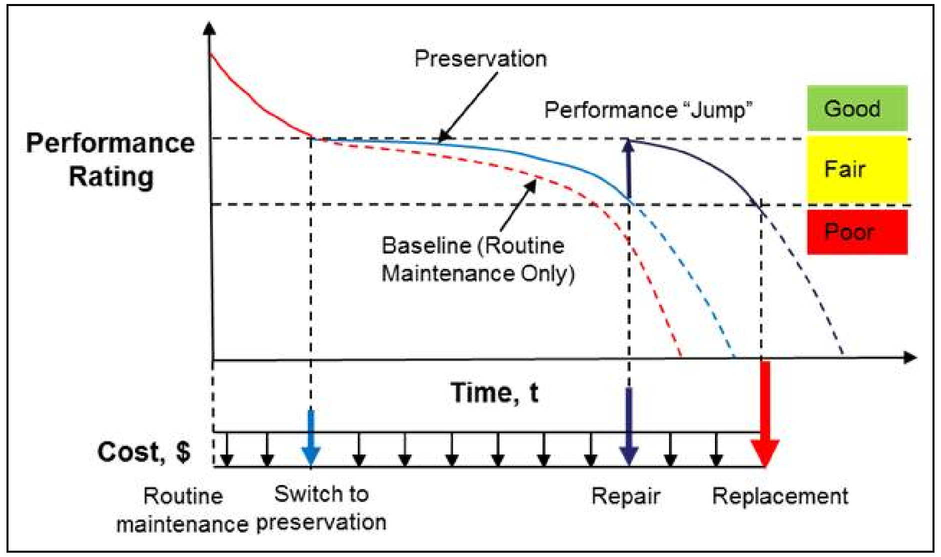
Bridge Life-cycle Maintenance Strategies Assessment

Three (3) types of maintenance strategies are considered for each bridge based on its existing asset condition: preservation, rehabilitation and replacement.

Figure 5.1 illustrates a typical bridge life-cycle and maintenance events. If only routine maintenance is provided, the bridge condition will deteriorate according to the red curve. Under a preservation scenario (blue arrow and line), it is assumed that the main effect is a slowdown of the deterioration rate. An increase in condition and extension of service life are expected for rehabilitation activities (green arrow and line). If the bridge has come to the end of its service life and any rehabilitation activity is not considered to be financially viable, a bridge replacement (red arrows) will reset the condition rating back to the highest condition rating of 9.

The life-cycle strategy selection process starts with an evaluation of the bridge's condition. If the condition state is 6 or above, the structure is considered in satisfactory/good condition and hence no immediate rehabilitation activity is required.

Figure 5.1. Asset Management Strategy



The structure is in fair condition at state of 5, all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour. Different rehabilitation activities will be considered to improve the bridge condition. When the condition state of the structure is poor (4 or below), bridge replacement project will be recommended.

The optimal timing for a rehabilitation activity is to perform the activity just prior to the transition to a lower state. Rehabilitation will be considered by the deterioration model at the time of the proposed repair activity to understand the expected improvement in condition state.

The optimal life-cycle strategy is to minimize the total life-cycle cost of each bridge while meeting the performance requirement (i.e. 100% of the bridge should have NBI condition rating higher than 4). The life-cycle analysis results in a number of recommended rehabilitation/replacement activities under an unlimited budget assumption, but associates an estimated cost with that scenario. The analysis allocates budget to the entire bridge network every 5 years for various preservation activities.

Bridge Costs

This analysis provides conceptual level cost estimates for the preservation, rehabilitation and replacement activities. Unit cost for of the maintenance work items were estimated by cost history for similar projects from Iowa Department of Transportation (IDOT) and NDOR. The unit costs for different maintenance projects are summarized in **Table 5.4.** All costs are provided as 2015 dollars. An annual inflation rate of 3% was applied to escalate the project cost to the year of expenditure dollar (YOE).

Table 5.4. Project Unit Costs

Project Type	Unit Cost (per SF)
Preservation	$4.5
Minor Rehabilitation (e.g. Deck Repair)	$25
Major Rehabilitation	$50
Deck Replacement	$115
Bridge Replacement	$300

Bridge Performance Target

A bridge condition performance target was developed during Phase 1 of MTIS. The target is to have 95% of the bridge NBI condition rating above 4 by year 2040. Through later discussions with the Study Team, it was agreed that the bridge condition assessment should focus on Nebraska bridge inventory only. And the initial performance target is to achieve 100% bridge with NBI condition rating above 4. Note that there are only nine study area bridges currently not meeting this target per **Table 5.1** at the time of this report.

Bridge Analysis Results

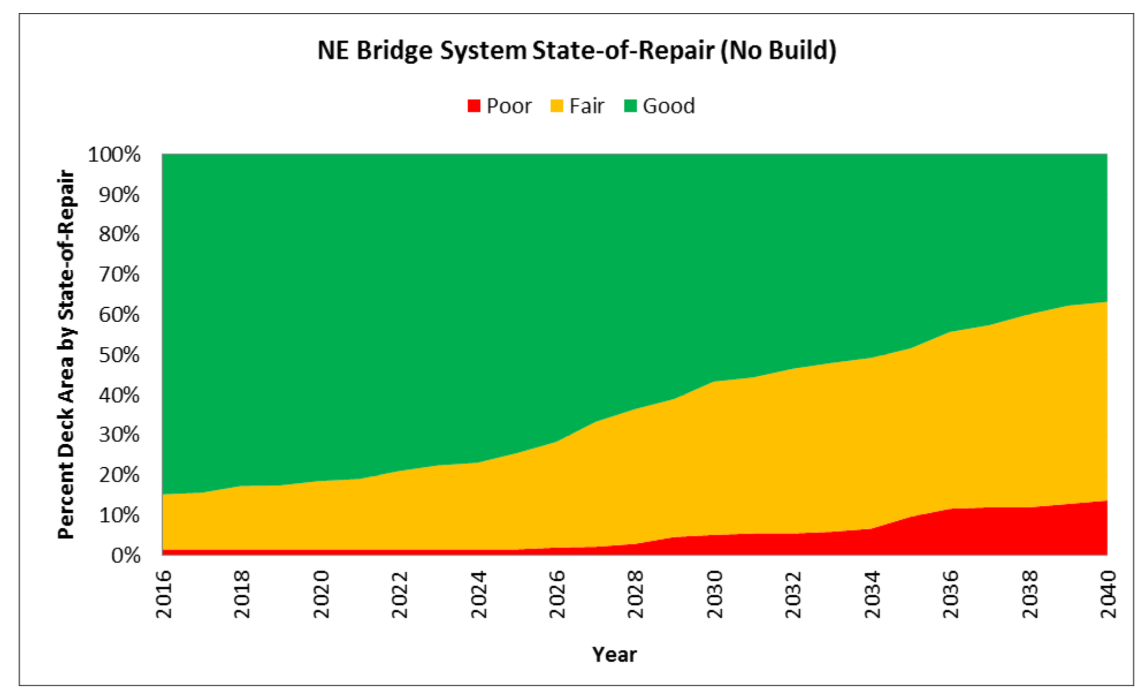
The funding analysis for the Nebraska bridge inventory was analyzed for the following scenarios:

- **No Build Scenario**: This scenario assumed no further preservation or rehabilitation treatments would be applied.
- **Funding Needs Scenario**: This scenario determined the minimum annual funding requirement for the MTIS bridge system to meet the performance target (100% bridge with NBI condition higher than 4).
- **Optimized Budget Scenario**: This scenario assigned different funding levels to the bridge inventory to determine the optimal budget level that provides the best value of money.

No Build Scenario

The no build scenario Nebraska bridge condition through 2040 is shown in **Figure 5.2**. If no bridge treatment is implemented throughout the entire study period 14% of the bridge inventory will be in poor condition by year 2040.

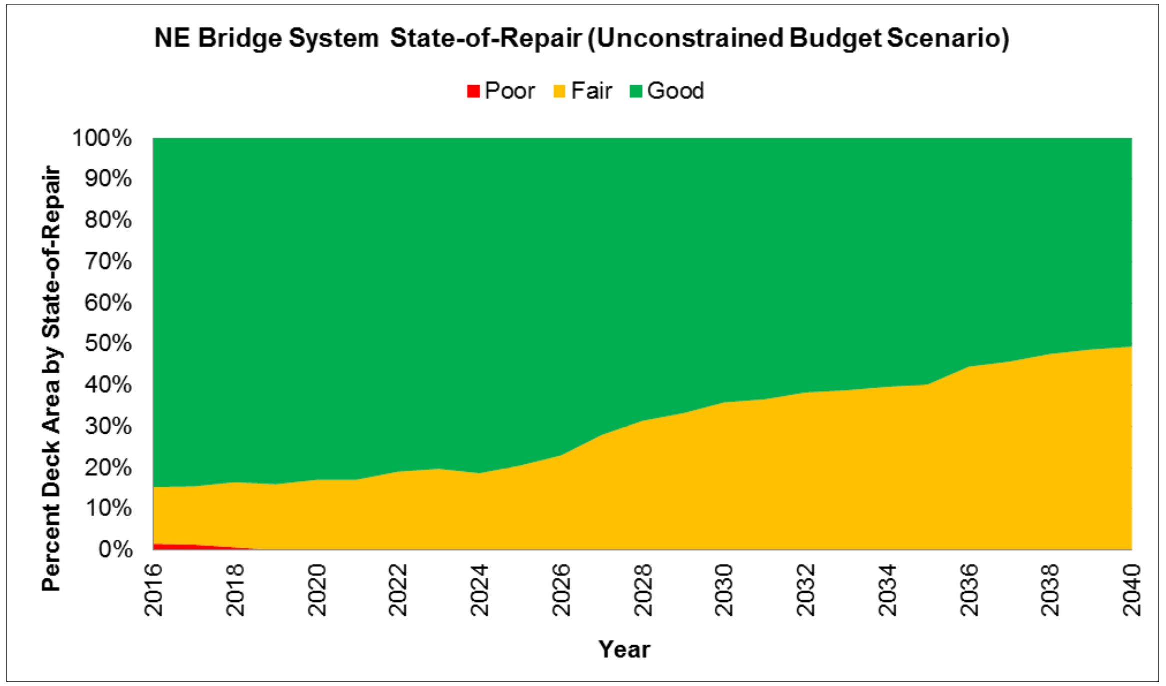
Figure 5.2. Nebraska Bridge State-of-Repair from 2016 to 2040 (No Build)



Funding Needs / Unconstrained Budget Scenario

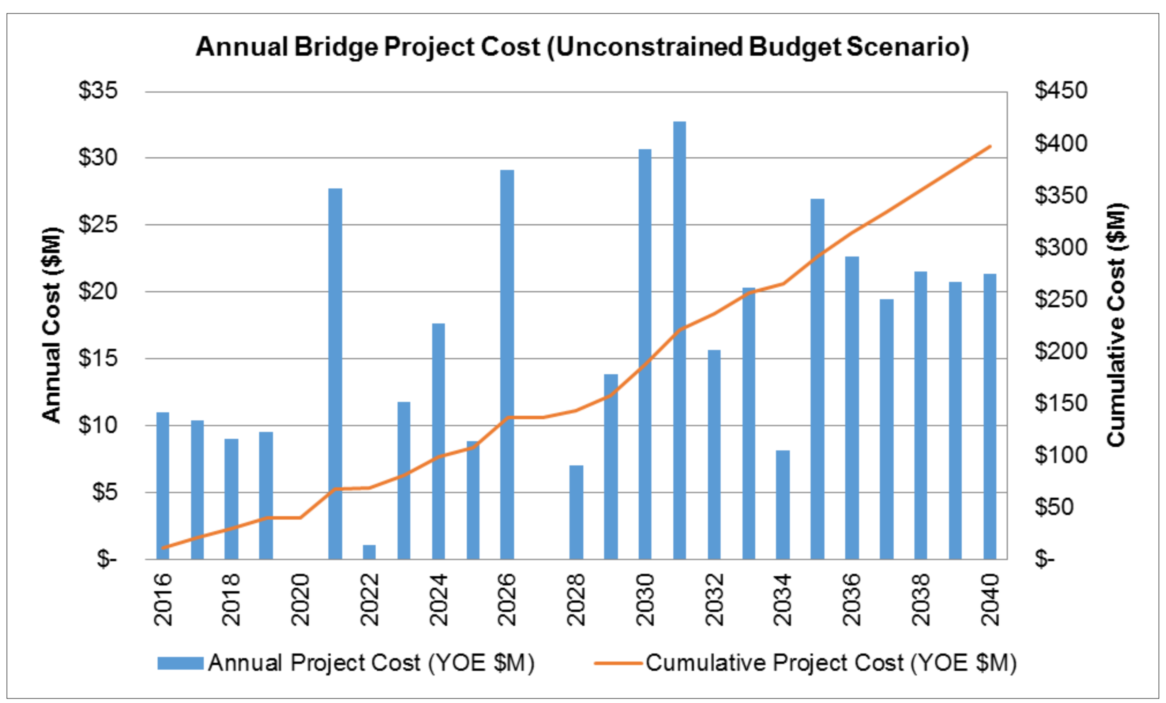
The Nebraska bridge inventory was analyzed for the performance target of 100% of bridge system with NBI rating above 4 by 2040. Through an iterative analysis process, it was found that a minimum budget of $400 Million (YOE) would be required in order to achieve the performance target. Bridge conditions over the analysis period for the "funding needs" scenario are shown in **Figure 5.3**. Under this scenario by 2040, 50% of the bridge inventory will have a fair rating and another 50% will have a satisfactory/good rating.

Figure 5.3. Nebraska Bridge State-of-Repair from 2016 to 2040 (Unconstrained Budget Scenario)



The annual and cumulative funding ($ Million YOE) required to meet the performance target of 100% of bridges in fair or better condition by 2040 is shown in **Figure 5.4**.

Figure 5.4. Annual Bridge Project Cost (Unconstrained Budget Scenario)



Optimized Budget Scenario

With current funding constraints, the next step was to investigate the optimal spending level that would provide the best value for bridge maintenance investment. Three (3) additional funding levels ($200M, $300M & $500M) were analyzed and the resulting percentages of bridges in fair or better condition were compared. The sensitivity analysis shows that the percentage of bridges in better condition does not significantly improve when the average annual spending is more than $15M (or $375M for the analysis period). Therefore the optimized budget scenario is to spend $375M from 2016 to 2040. This budget level results in 50% of bridges in satisfactory/good condition, 49% in fair condition and 1% in poor condition in 2040. The change in bridge condition is shown in **Figure 5.5** and the annual bridge treatment cost is provided in **Figure 5.6**. Thus, the cost of maintaining the MTIS bridge system in Nebraska is estimated at $375 Million. This cost will be included in the total cost for each strategy package.

Figure 5.5. Nebraska Bridge State-of-Repair from 2016 to 2040 (Optimized Budget Scenario)

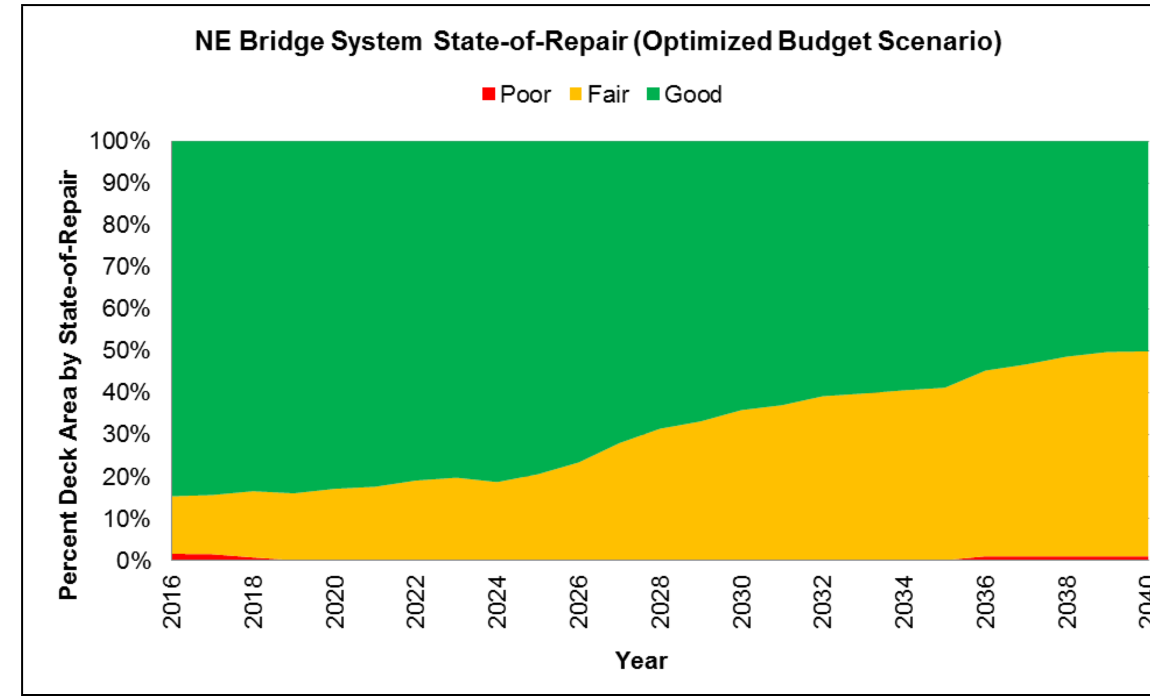
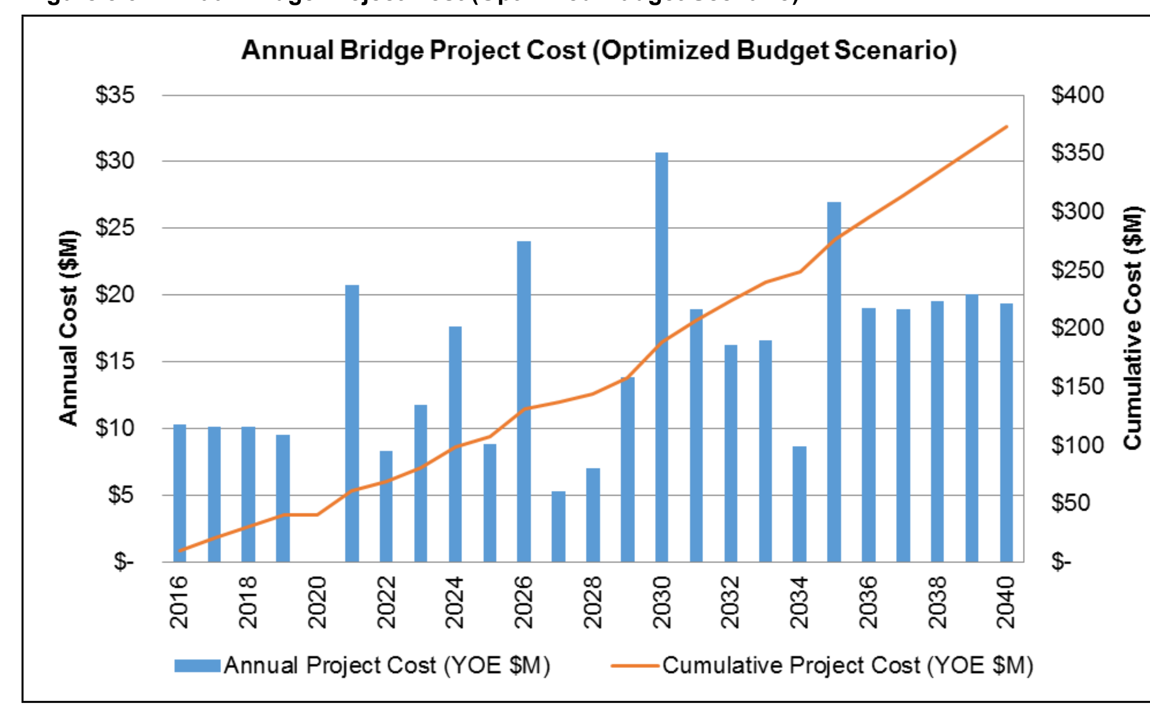


Figure 5.6. Annual Bridge Project Cost (Optimized Budget Scenario)



Pavement Assessment

Pavement Asset Inventory

The pavement analysis included all interstate, freeway, state highway, and local arterials included in the MTIS study area. **Table 5.5** provides an inventory of pavement segments considered in the analysis by total segment miles and lane-miles.

Table 5.5. MTIS Study Area Pavement Inventory

Roadway Type	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	79.3	174.8
State Highway	268.4	543.6	29.45	69	293.4	612.6
Local Roads	326	515	1.8	3.6	327.8	518.6
Total	**765**	**1509**	**111.3**	**240**	**876**	**1749**

Pavement Data, Performance Measures and Targets

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
- 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 a measure of pavement surface quality. Higher IRI values indicate higher pavement roughness and thus reduced ride quality. NDOR and Iowa DOT pavement inspection data were used to support these measures. NSI/PCI and IRI were collected for all interstate, national, and state roadways included in the analysis. For non-state MTIS roadways, NDOR conducted a visual inspection of pavement surface conditions[1]. Pavement performance targets (developed during Phase 1) are presented in **Table 5.6**.

Table 5.6. Pavement 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)

[1] NDOR staff used the Pavement Surface and Evaluation Rating (PASER) scale with the corresponding State of Repair category to convert the PASER ratings to NSI

Pavement Deterioration and Performance Model

As with the bridge models, pavement deterioration models simulate the pavement deterioration process and can be used to predict future pavement conditions. Pavement deterioration models were derived using a combination of historical condition data and the NDOR pavement model (developed from 2011 Pavement Optimization Program). The deterioration rates were applied to the MTIS pavement network to forecast future pavement condition and determine the time at which pavement assets would become deficient. With predicted conditions, appropriate pavement treatment activities can be recommended.

Based on the Nebraska Pavement Optimization Program, the MTIS pavement performance model was developed. Pavement indices will improve after different treatment strategies (preservation, rehabilitation, and reconstruction). These pavement strategies were aggregated into five different groups and assigned a typical treatment effectiveness, which are defined in **Table 5.7** below.

Table 5.7. Pavement Treatment Groups and Effectiveness

Treatment Group	Treatment Effectiveness		
	ΔNSI	ΔPCI	ΔIRI
Preservation A*	3	3	-15
Preservation B**	9	9	-30
Minor Rehabilitation	9	9	-50
Rehabilitation	25	25	-100
Replacement	100	100	-500

** Preservation A strategies such as sealing and patching, typically done every 8 years*

***Preservation B strategies such as slab stabilization with diamond grinding, typically done every 16 years*

Pavement Project Unit Cost

Pavement treatment unit costs were provided by NDOR and shown in **Table 5.8** below. The unit costs were derived from historic cost data and include a 1.32 factor for engineering and construction mark-up.

Table 5.8. Pavement Treatment Cost

Treatment Group	Cost ($/Square Yard)
Preservation A*	$4.08
Preservation B**	$14.20
Minor Rehabilitation	$14.20
Rehabilitation	$28.90
Replacement	$78.60

Pavement Analysis Results

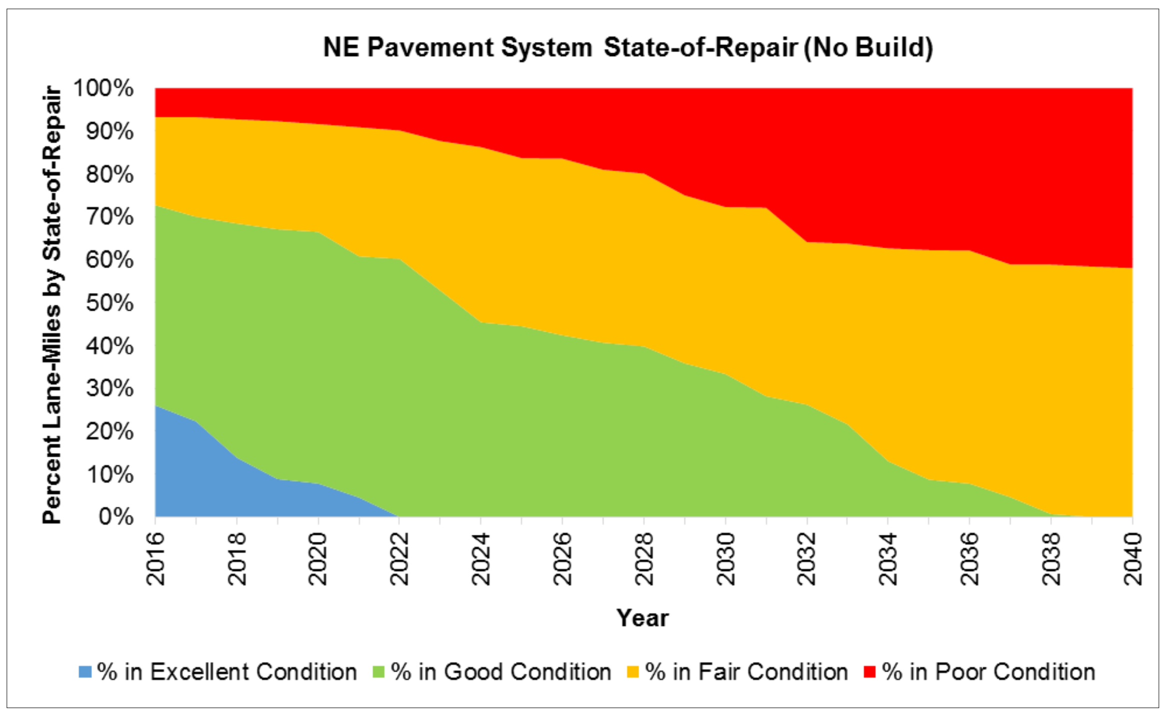
The pavement inventory for the MTIS study area was analyzed for the following scenarios:

- **No Build Scenario**: This scenario assumed no further preservation or rehabilitation treatments would be applied.
- **Funding Needs Scenario**: This scenario determined the minimum annual funding requirement for the MTIS pavement system to meet the performance targets.
- **Optimized Budget Scenario**: This scenario assigned different funding levels to the pavement inventory to determine the optimal budget level that provides the best value of money.

No Build Scenario

Pavement condition from 2016 to 2040 under the no build scenario is shown in **Figure 5.7**. The pavement forecasts indicate that 50% of the pavement will be in fair or poor condition by year 2023. If no pavement treatment is implemented, the entire pavement system will fall into poor or fair condition in 2038.

Figure 5.7. Nebraska Pavement System State-of-Repair from 2016 to 2040 (No Build)



Funding Needs / Unconstrained Budget Scenario

The pavement inventory was analyzed for the performance target of 84% of highway system miles in good or better condition by 2040. Through an iterative analysis, it was found that a minimum budget of $1.08 billion (YOE) would be required in order to achieve the performance target. Pavement conditions over the analysis period are shown in **Figure 5.8**.

Annual and cumulative funding ($ Million YOE) required to meet the performance target of 84% of highway miles in good or better condition by 2040 is shown in **Figure 5.9**. Funding requirements peak between 2036 and 2039 in order to meet the stipulated performance target by 2040.

Figure 5.8. Nebraska Pavement System State-of-Repair from 2016 to 2040 (Unconstrained Budget Scenario)

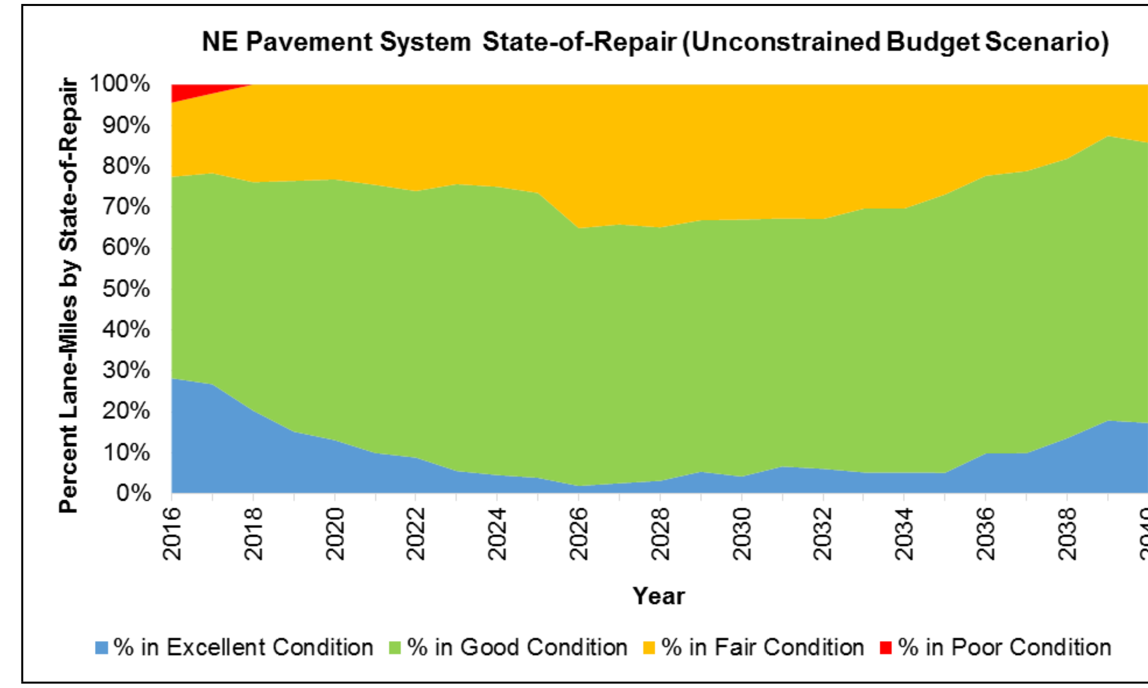
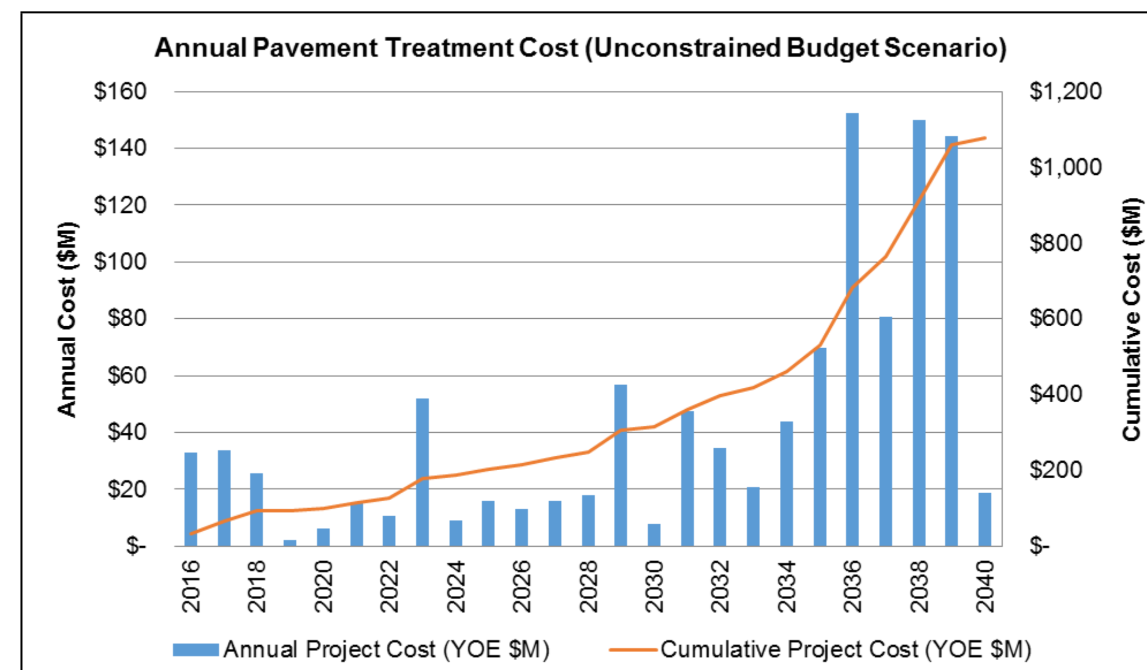


Figure 5.9. Annual Pavement Treatment Cost (Unconstrained Budget Scenario)



Optimized Budget Scenario

The funding needs analysis above indicates that in order to achieve the 84% of highway system miles in good or better condition by 2040, a budget close to $1.1 billion is needed from 2016 to 2040. A significant portion of those investments would be required between 2036 and 2040 (averaging over $100M per year for those 5 years.) With current funding constraints, the Study Team investigated the optimal spending level that would provide the best investment value.

Four additional funding levels ($400M, $600M, $800M & $1000M) were analyzed and compared for the percentage of MTIS system miles in good or better condition. In all models, there are relatively stable pavement conditions for the first 20 years until 2035, after 2035 extensive investment is required in order to maintain/improve the pavement system. The sensitivity analysis also showed that the percentage of "good" pavement does not significantly increase beyond an average annual spending level of more than $27M (or $675M for the analysis period). Therefore the optimized budget scenario is to spend $675M from 2016 to 2040 in Nebraska. This budget level results in 67% of pavement in good or better conditions in 2040. Change in pavement condition is shown in **Figure 5.10** and the annual pavement treatment cost is provided in **Figure 5.11**.

Figure 5.10. Nebraska Pavement System State-of-Repair from 2016 to 2040 (Optimized Budget Scenario)

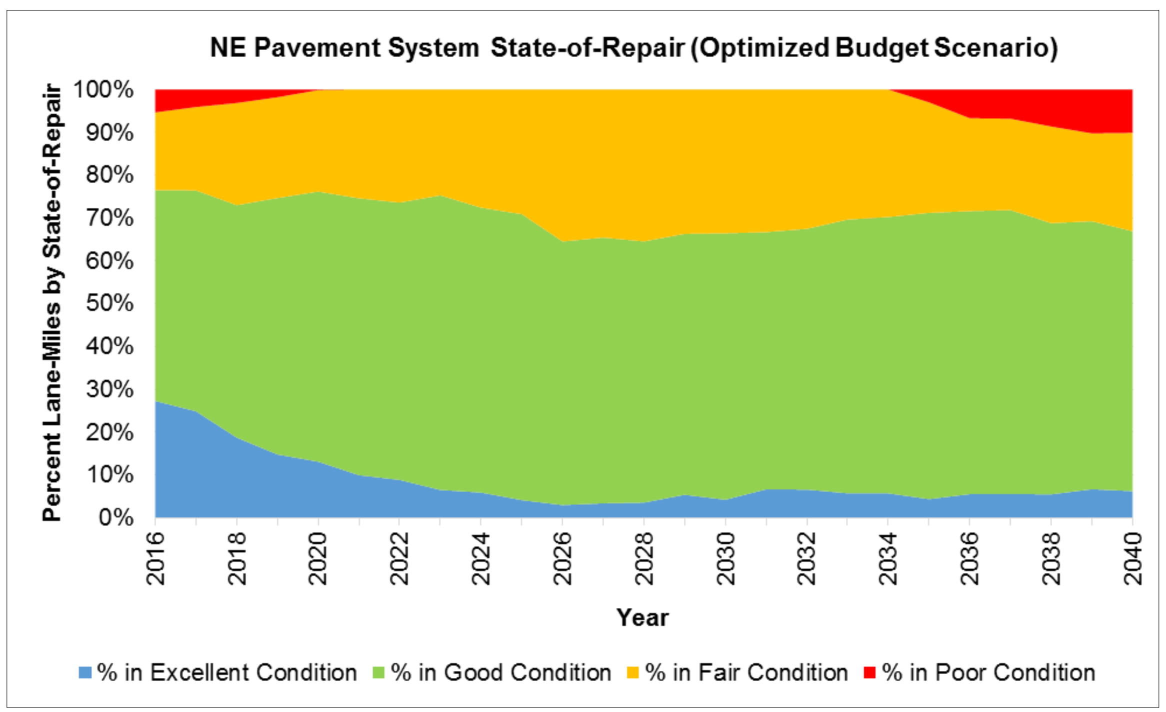
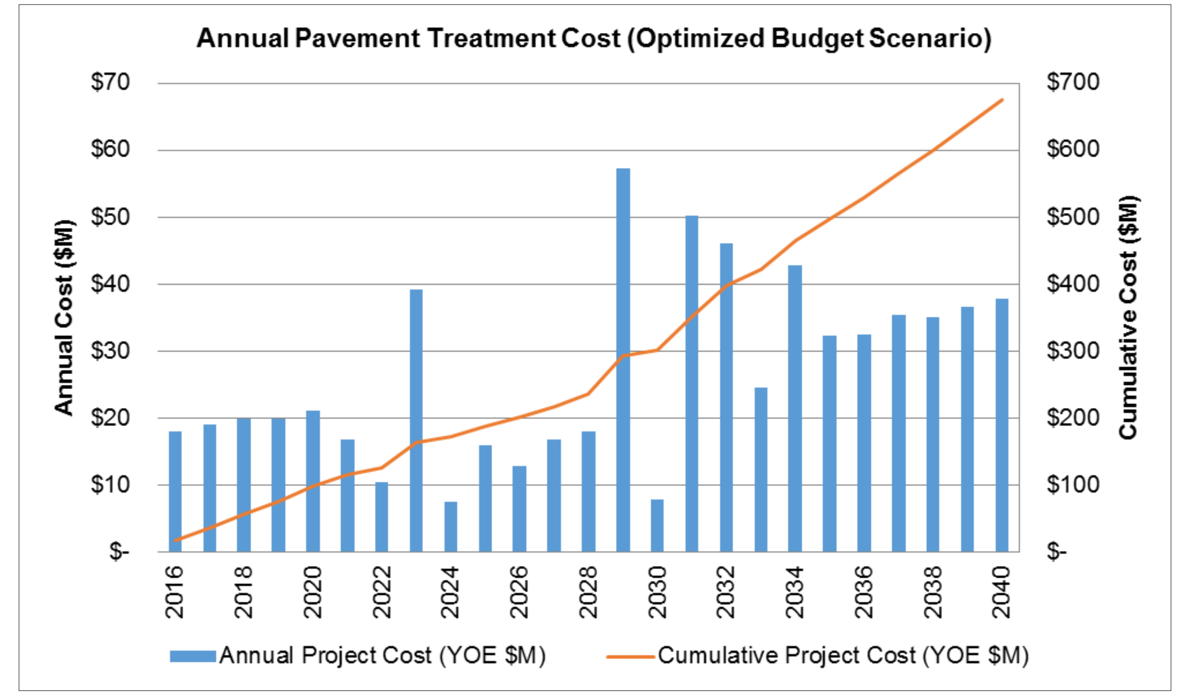


Figure 5.11. Annual Pavement Treatment Cost (Optimized Budget Scenario)



Thus, the cost of maintaining the MTIS pavement system in Nebraska is estimated at $675 Million. This cost will be included in the total cost for each strategy package.

Iowa Bridge and Pavement Costs

Similar methodologies were applied for Iowa pavement and bridges. To achieve the pavement and bridge targets for the non-Freeway system in Iowa, the results of the analysis were:

- $141 Million in pavement life-cycle investment costs between 2017 and 2040.
- $75 Million in bridge life-cycle investment costs between 2017 and 2040.

Transit O&M / Fleet Replacement Costs

Transit O&M Cost Methodology

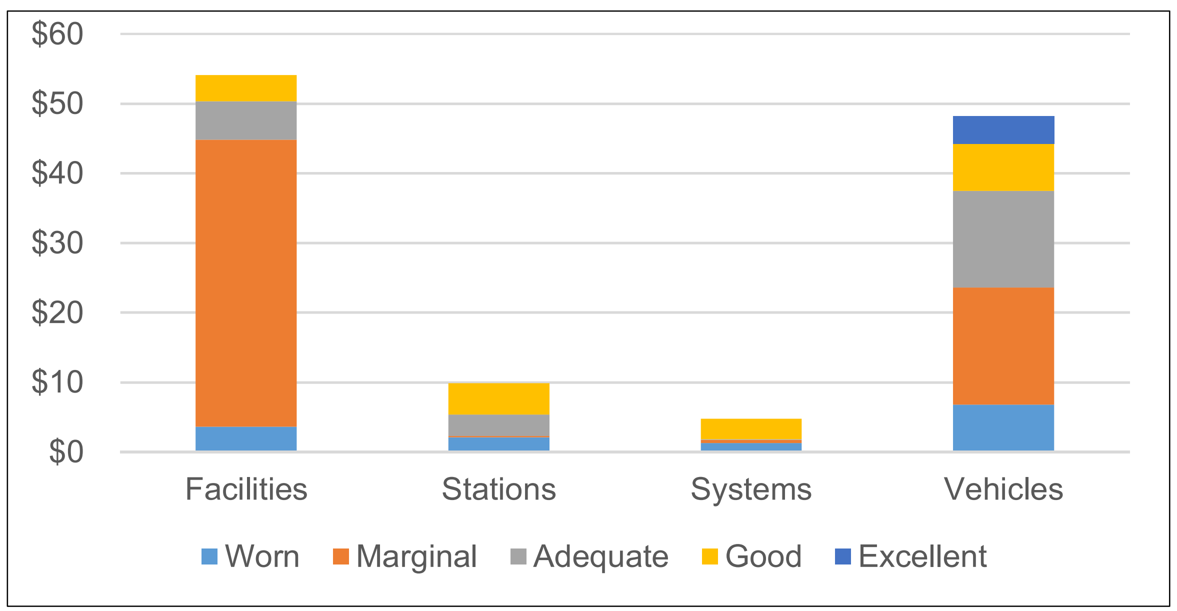
Baseline operating and maintenance (O&M) costs for Metro were determined by the historical trends in O&M costs reported to the National Transit Database (NTD) over the past decade. Metro's O&M costs have historically grown at 2.6% annually, which was applied to project future O&M costs in YOE dollars for a "no growth" scenario. The baseline O&M cost for 2016 was validated by Metro as approximately $27 Million based on their current budget.

The Regional Transit Vision Feasibility Analysis (RTV) from 2013 provided assumptions for developing O&M costs for each proposed expansion scenario. The RTV included a 10% ratio of capital to operating costs for all of the proposed infrastructure-related expansions, and an annual O&M cost of $60,223 (in 2012 dollars) per new bus.

Transit State-of-Good-Repair Targets

The transit state-of-good-repair performance measure targets are that all assets be in state-of-good-repair (no assets in Worn or Marginal condition). Current Metro transit asset conditions are shown in **Figure 5.12**. It should be noted that this level of investment in new vehicles and facilities is significantly higher than current investment levels, since 62% of current assets are in Worn or Marginal condition.

Figure 5.12. Metro Transit Current Asset Condition Estimate by Asset Type ($2014 Million)



The capital costs of infrastructure for the expansion projects were based on RTV study options and discussions with MAPA and Metro. To determine the fleet size related to expansion projects, the expected ridership increase for an average weekday or the expected decrease in headway was converted to a number of buses. In the case of decreased headways, Metro provided the new number of buses required based on the rule of thumb that halving headway doubles fleet numbers.

Transit State-of-Good-Repair Costs

To operate the current transit system and achieve the target of maintaining all transit assets in a state-of-good-repair, the following costs were estimated:

- $1,071 Million in operations and maintenance costs between 2017 and 2040 (YOE).
- $522 Million in capital replacement costs between 2017 and 2040 (YOE).

Thus, the combined cost of meeting the state-of-good-repair targets and maintaining the transit system is estimated at $1.593 billion.

Key Takeaways

For cost estimating purposes for the Strategy Packages that will be discussed in **Chapter 7**, the following costs will be included in the total cost of each Strategy Package.

- Bridge and Pavement System Preservation Costs: $1,266 Million
- Transit State-of-Good-Repair Costs: $1,593 Million

Note that the bridge and pavement costs are only for MTIS Study Roadways. This accounts for 46% of the total freeway, arterial, and collector lane mileage in the MTIS Study Area.

Also note that the total cost for transit relates to a more proactive replacement strategy for vehicles to meet the performance measure for state-of-good-repair of no assets in worn or marginal condition.

Chapter 6 - Regional Strategy Packages

A range of potential Regional Strategy Packages were identified based on the needs identified in Phase 1 and the potential strategies reviewed in **Chapter 4**. The development and testing of Regional Strategy Packages involved the following steps:

- Identification of the range of investment levels by strategy type and mode. These tended to be organized by low, medium, and high levels, and corresponded with specific sets of corridor-level improvements.
- Combining the strategies into a series of "theme-based" Strategy Packages that tested the extremes of each type of strategy. Performance measures were applied to these theme-based Strategy Packages, which were named Strategy Package 1 through 6.
- Reviewing the performance results of Strategy Packages 1 through 6, and identifying a combination of elements from those packages that could form a locally-tailored vision plan that meets the region's performance objectives, while being reasonably implementable. This resulted in developing Strategy Package 7, the regional transportation vision.
- Testing the performance of Strategy Package 7 against regional performance goals and targets.

Performance Measures

A performance-based planning approach formed the framework for developing and assessing the Regional Strategy Packages. One (1) or more performance measures were developed for each of the performance goal areas. This approach is consistent with the regional goal to link performance goals with planning and programming decisions, and the performance goal areas and measures were used at every step of strategy package development. The Study Team established performance targets for this study that are:

- Useful for monitoring system performance and prioritizing transportation investments.
- Feasible to implement and maintain given regional analysis tools and data sources.
- Aspirational and challenging for the region, with targets that could be reasonably attained.

These targets were modified during Phase 2 as testing revealed some targets identified in Phase 1 were too high, and some too low. The five (5) performance goal areas and associated performance measures are shown in **Table 6.1**.

In order to apply the performance measures for system evaluation, it was critical to "weight" the measures. These weights provided a quantitative method for combining performance measure results into a cohesive score that reflected overall strategy package performance. The weights were jointly developed by NDOR and MAPA, and are shown in **Table 6.2**.

Table 6.1. MTIS Goal Areas and Associated Performance Measures

System Preservation Performance Measures	Congestion Reduction Performance Measures	Mobility & Accessibility Performance Measures	Stewardship & Environment Performance Measures	Safety Performance Measures
Pavement: Nebraska Serviceability Index (NSI)	System Reliability: • Autos • Freight	Regional Mode Share	Criteria Pollutant Emissions	Total Number of Fatalities
Bridge: National Bridge Index (NBI)	Vehicle Miles Traveled (VMT)	Access to Jobs	Sustainability Score	Total Number of Serious Injuries
Transit: State-of-Good-Repair	Vehicle Hours Traveled (VHT)	Access (Proximity) to Transit		Fatality Rate
	Delay	Environmental Justice (EJ) Access to Jobs		Serious Injury Rate
	LOS / Congested Miles of Freeway (Mainline)	EJ Access (Proximity) to Transit		Non-Motorized
	Miles of Congested Non-Freeway Segments	Bike and Pedestrian Accessibility / Proximity		
		Transit Passenger Trips		

Table 6.2. Goal and Performance Measure Weights for Strategy Package Assessments

Goal	Goal Weight	Performance Measure	Measure Weight
Congestion Reduction	45%	VMT	2%
		VHT	9%
		Delay	10%
		Miles of Congested Freeway (Mainline) Segments	15%
		Miles of Congested Non-Freeway Segments	9%
Mobility & Accessibility	25%	Regional Mode Share	5%
		Access to Jobs	3%
		Proximity to Transit	3%
		EJ Access to Jobs	6%
		EJ Proximity to Transit	7%
		Proximity to Bicycle / Pedestrian Facilities	1%
Stewardship & Environment	10%	Criteria Pollutant Emissions	8%
		Sustainability Score	2%
Safety	20%	# of Fatalities per 100 MVMT	8%
		# of Serious Injuries per 100 MVMT	6%
		# of Non-motorized Fatalities and Serious Injuries	6%

Range of Investment Types

Prior to developing Strategy Packages, varying levels of investment were identified by strategy type. Based on the work completed in Phase 1, and the menu of options developed for each corridor (as described in **Chapter 4**), it was recognized that the range of strategies that should be analyzed included:

- Arterial Operations Improvements
- Freeway Operations Improvements
- Transit System Improvements
- Travel Demand Management
- Addressing System Gaps
- Traffic Safety Improvements
- Bicycle and Pedestrian System Improvements

Different investment levels were identified for potential inclusion in each of the Strategy Packages. Each investment level was associated with high, medium, and low intensities of project improvements. Specific projects were associated with each investment level. The “Low” or “Targeted” levels of investment typically included those projects that addressed the highest need corridors only. The “High” or “Full” levels of investment typically included a greater number of projects. **Table 6.3** shows the investment levels identified for inclusion in the Strategy Packages.

Table 6.3. Investment Levels Identified by System and Mode for Inclusion in Strategy Packages

Arterials	Freeways	Transit	Travel Demand Management	System Gaps	Safety	Bicycle and Pedestrian
Full Operational Needs	Full Operational Needs	High Transit Vision	Full TDM	All System Gaps	Needs Plus	Build Bike and Pedestrian Plan
Targeted Operational Needs	Targeted Operational Needs	Moderate Transit Vision	Partial TDM	Arterial System Gaps	Needs	Highest Priority Projects Only
Intersection Improvements Only	System Management	Low Transit Vision		Freeway System Gaps		
ITS		Increase Frequency of Existing Routes		Targeted Gap Improvements		

Initial Strategy Package Set (Strategy Packages 1 through 6)

An initial set of working Strategy Packages was developed based on input from the Stakeholder Committee. These initial Strategy Packages were not established to reflect a reasonably implementable plan for the region; they were intended to test how a range of approaches to each system / mode would impact system performance. In general, the Strategy Packages were intended to test the extremes of potential investment levels by putting high levels of investment in one or two areas, and neglecting other areas to see how these combinations affected the various performance measures.

The Strategy Packages were organized based on themes, with one strategy package representing the high-end of investment in most categories (Strategy Package 1) and one strategy package representing the low-end of investment in most categories (Strategy Package 5):

- **Strategy Package 1 - High Levels of Balanced Investment**: High level of investments on freeway and arterial system addressing all operational needs, significant transit investment and TDM implementation. Highest-benefit gaps and parallel routes improved.
- **Strategy Package 2 - Freeway-Focused Improvements:** Focuses improvements on freeway system, highest priority arterial system improvements only, limited transit system expansion. No arterial gap investments.
- **Strategy Package 3 - Arterial-Focused Improvements:** Focuses improvements on arterial system, enhance existing transit routes, bottleneck only on freeway system. Highest-benefit parallel routes improved.
- **Strategy Package 4 - System Management and Transit Focus**: Targeted arterial and freeway investments only, highest-level of transit investment, system management, and TDM implementation.
- **Strategy Package 5 - Limited Levels of Investment**: Relatively low investment levels in arterial and freeway systems; no additional non-roadway investments.
- **Strategy Package 6 - Geographic Distribution Scenario**: Provide different strategies in "Central City" and "Suburban" environs. Central City for Omaha is approximately within the I-680 / I-80 loop, and older parts of Bellevue and Council Bluffs. Suburban are urbanized portions not considered "Central City". Recognizes the different streetscape and development patterns typically present in the older and newer portions of the urban area.

The associated levels of investment for each system are shown in **Table 6.4**. The following figures illustrate the projects associated with each strategy package:

- **Figure 6.1**: Strategy Package 1 - Roadway and System Gaps Projects
- **Figure 6.2**: Strategy Package 1 - Transit Projects
- **Figure 6.3**: Strategy Package 2 - Roadway and System Gaps Projects
- **Figure 6.4**: Strategy Package 2 - Transit Projects
- **Figure 6.5**: Strategy Package 3 - Roadway and System Gaps Projects
    - Strategy Package 3 assumes no significant new transit lines. Package includes increased frequencies for existing routes with low growth in the Demand Response system.
- **Figure 6.6**: Strategy Package 4 - Roadway and System Gaps Projects
- **Figure 6.7**: Strategy Package 4 - Transit Projects
- **Figure 6.8**: Strategy Package 5 - Roadway and System Gaps Projects
    - Strategy Package 5 assumes no transit improvements.
- **Figure 6.9**: Strategy Package 6 - Roadway and System Gaps Projects
- **Figure 6.10**: Strategy Package 6 - Transit Projects

Table 6.4. Inital Strategy Packages

Strategy Package	Strategy Theme	System Investment Levels by Strategy						
		Arterial Operations	**Freeway Operations**	**Transit**	**Demand Management**	**System Gaps**	**Safety**	**Bicycle and Pedestrian**
1	High Levels of Balanced Investment	Full Operations Needs + ITS Improvements	Full Operations Needs + System Management	Moderate Transit Vision Scenario / High Demand Response Growth	Partial TDM	Targeted (Partial) Gap Improvements	Central City: Needs Plus Non-Motorized Suburban: Needs	Build Bike and Pedestrian Plan
2	High Demand Response Growth	Targeted Operational Needs + ITS Improvements	Full Operations Needs + System Management	Low Transit Vision Scenario / Medium Demand Response Growth	No TDM	Improve Freeway System Gaps	Needs	Build Bike and Pedestrian Plan
3	Freeway-Focused Improvements	High Priority Corridor Vision + Full Operations Needs + ITS Improvements	Targeted Operations Needs	Increase Frequency on Existing Routes / Low Demand Response Growth	No TDM	Improve Arterial System Gaps	Needs	Build Bike and Pedestrian Plan
4	System Management and Transit Focus	Targeted Operational Needs + ITS Improvements	Targeted Operations Needs + System Management	High Transit Vision Scenario / High Demand Response Growth	Full TDM	Targeted (Partial) Gap Improvements	Needs Plus	Build Bike and Pedestrian Plan
5	Limited Levels of Investment	Targeted Operational Needs	Targeted Operations Needs	No Transit Improvements / No Change to Demand Response	No TDM	No Gap Projects	Needs	Highest Priority Bike and Pedestrian Plan projects only
6	Geographic Distribution Scenario	Central City: Intersection Improvements + ITS. Suburban: Full Operations Needs	Central City: Targeted Operations Needs + System Management. Suburban: Full Operations Needs + System Management.	Central City: High Transit Vision Scenario Suburban: Targeted Transit Improvements Medium Demand Response Growth	Regionwide: Partial TDM	Suburban: Improve All System Gaps	Central City: Needs Plus Non-Motorized Suburban: Needs	Central City: Build Bike and Pedestrian Plan Suburban: Highest Priority Bike and Pedestrian Plan projects only

Figure 6.1. Strategy Package #1 - Roadway and System Gap Projects

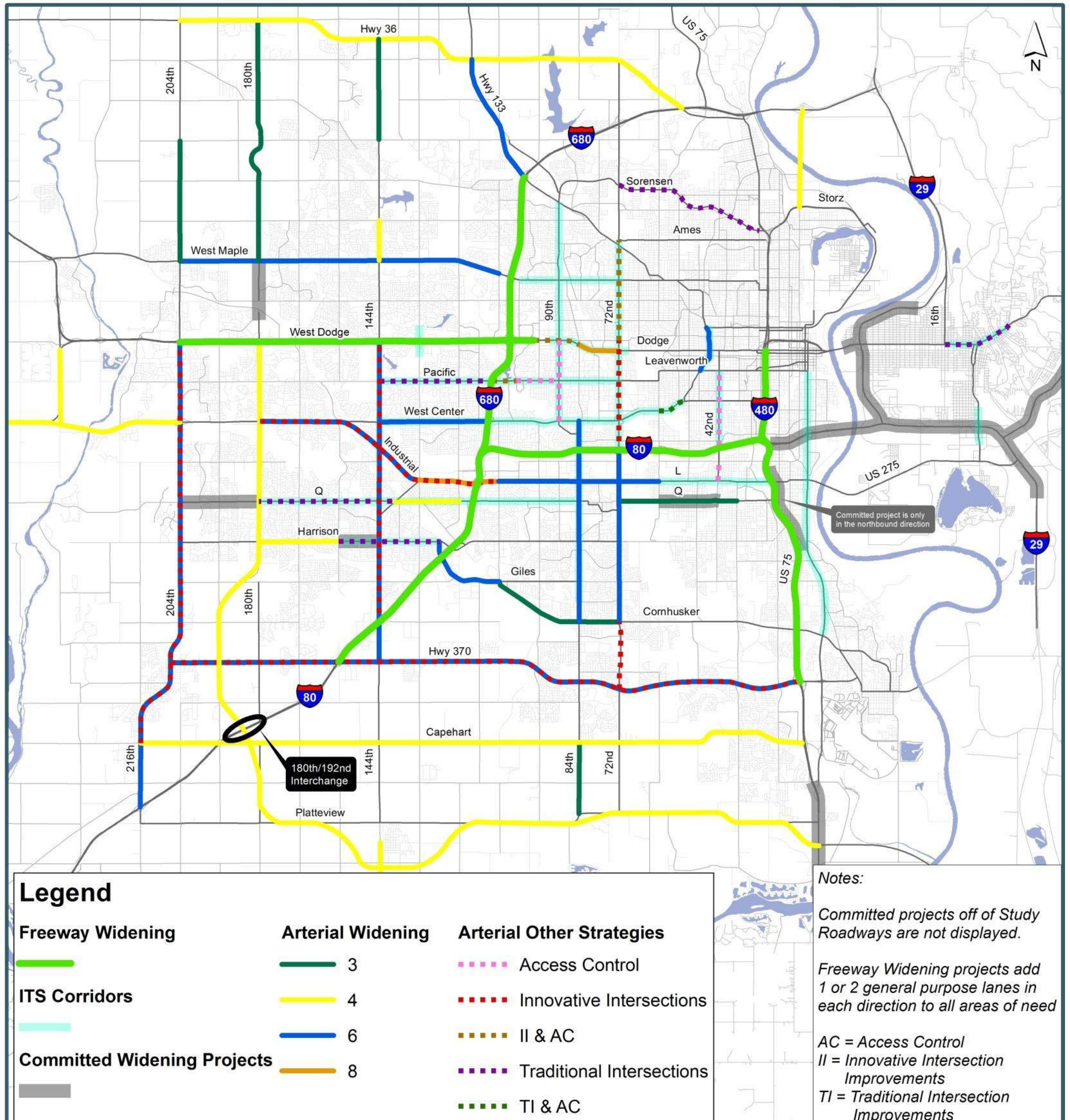


Figure 6.2. Strategy Package #1 - Transit Projects

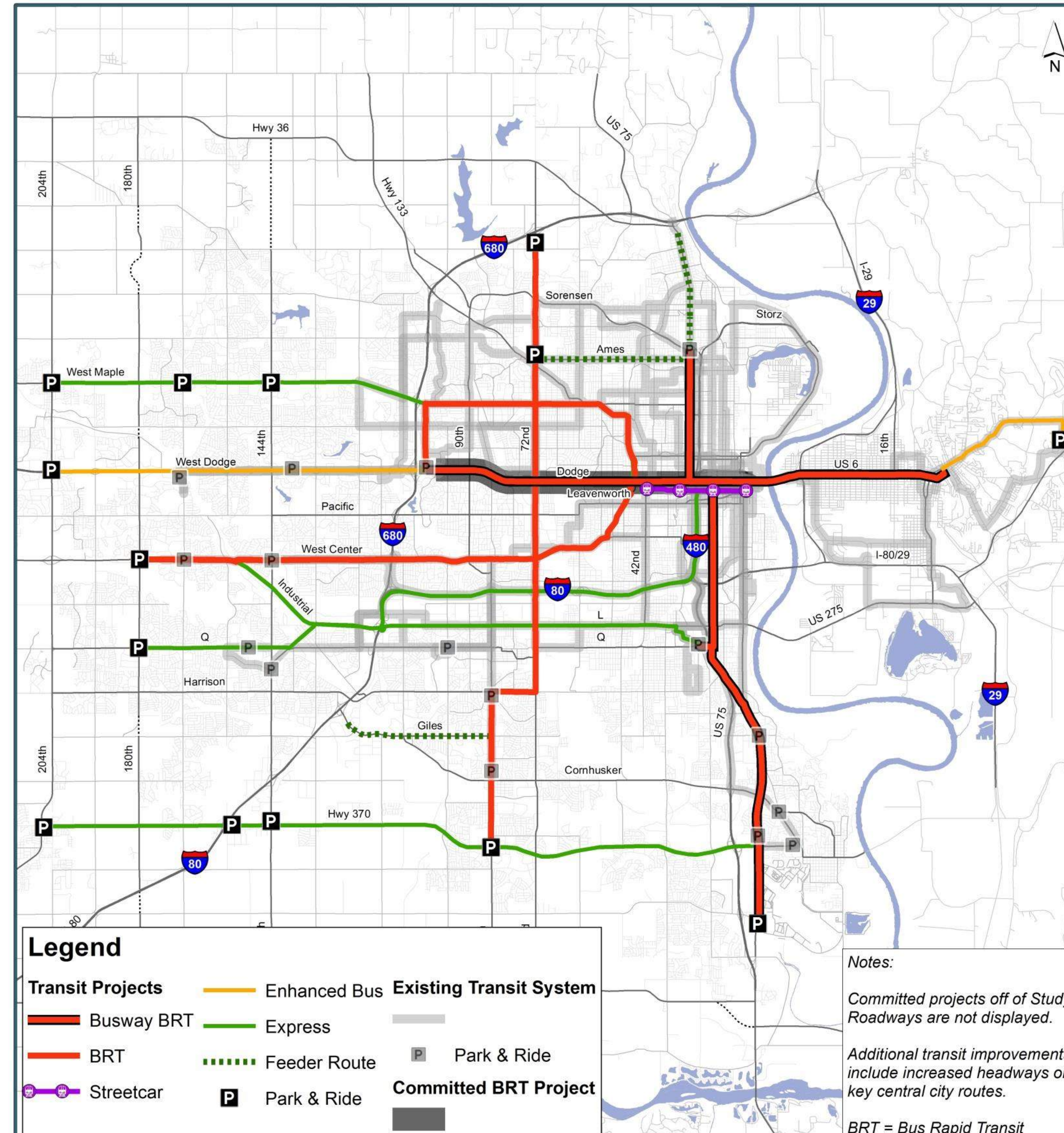


Figure 6.3. Strategy Package #2 - Roadway and System Gap Projects

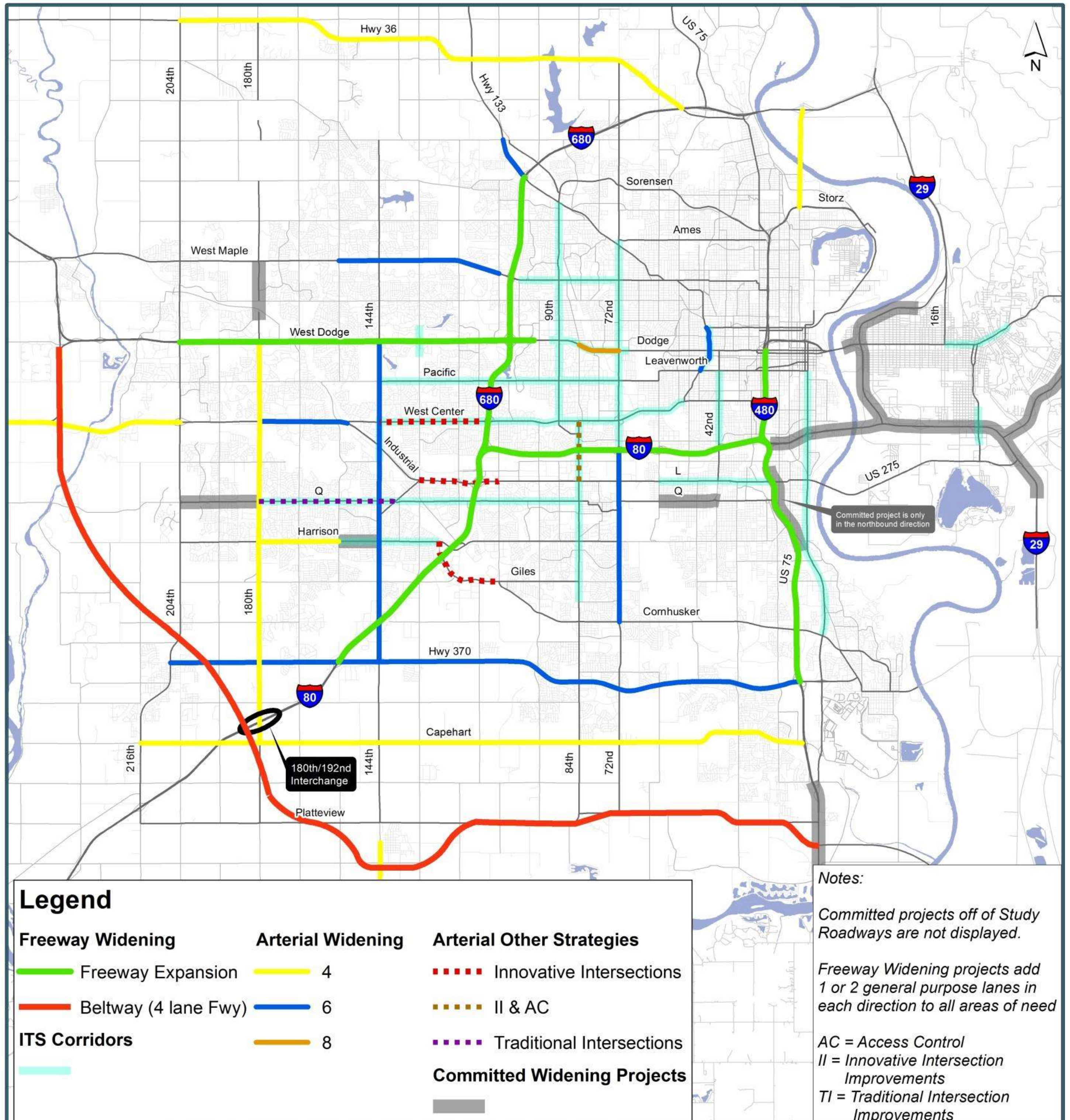


Figure 6.4. Strategy Package #2 - Transit Projects

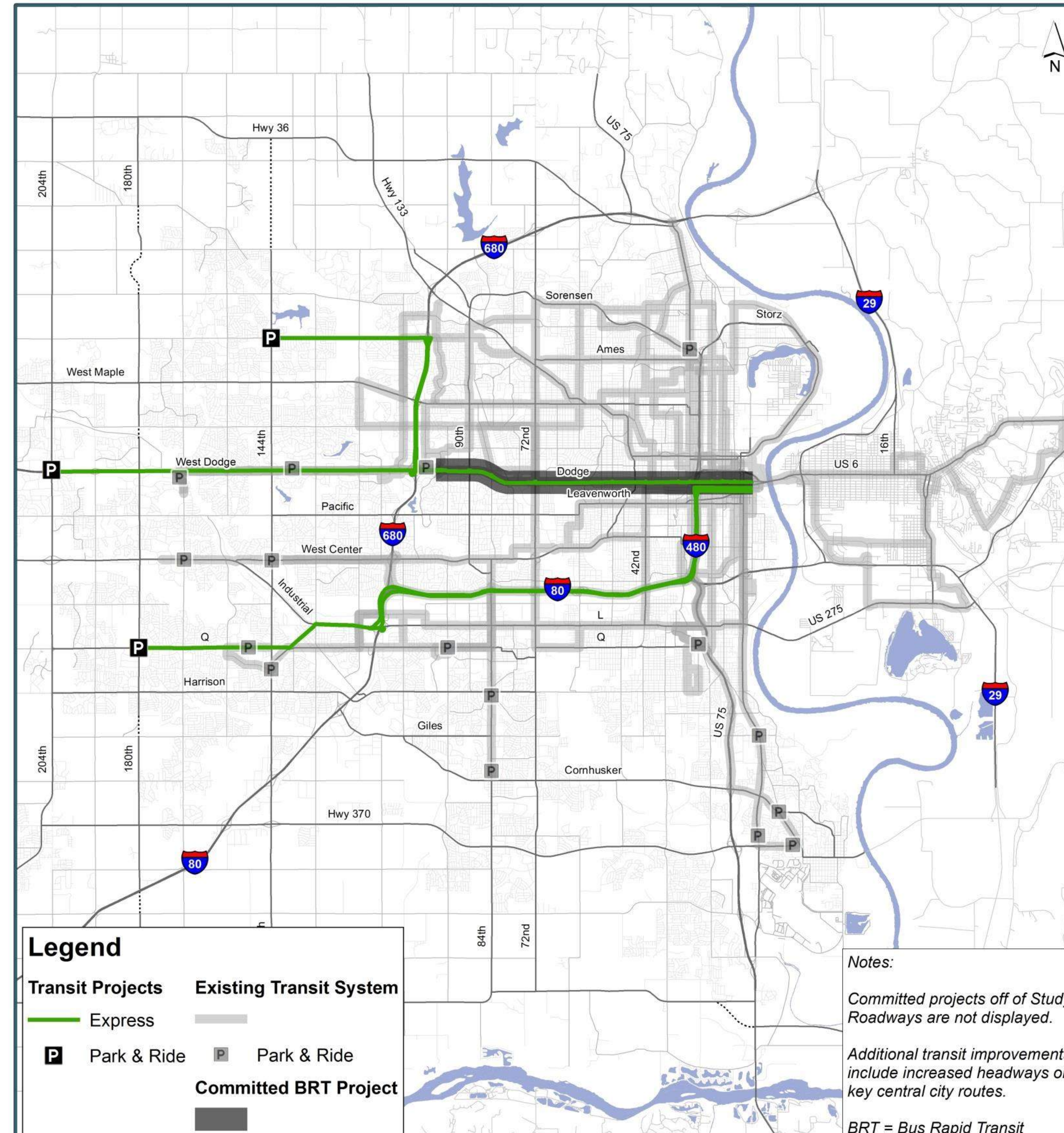
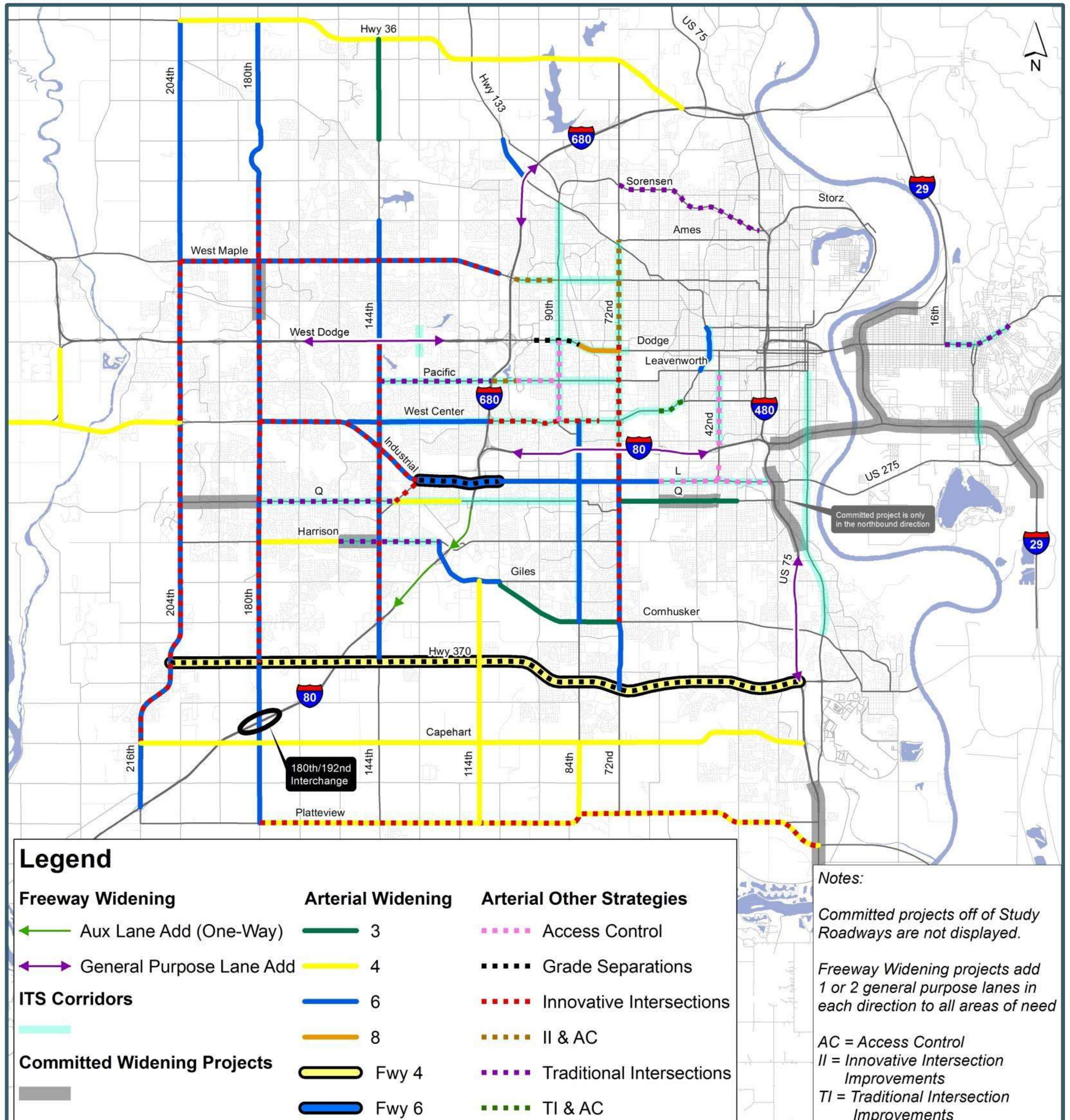


Figure 6.5. Strategy Package #3 - Roadway and System Gap Projects



Strategy Package #3 - Transit Projects

- Increase Frequency on Existing Routes
- Low Demand Response Growth

Figure 6.6. Strategy Package #4 - Roadway and System Gap Projects

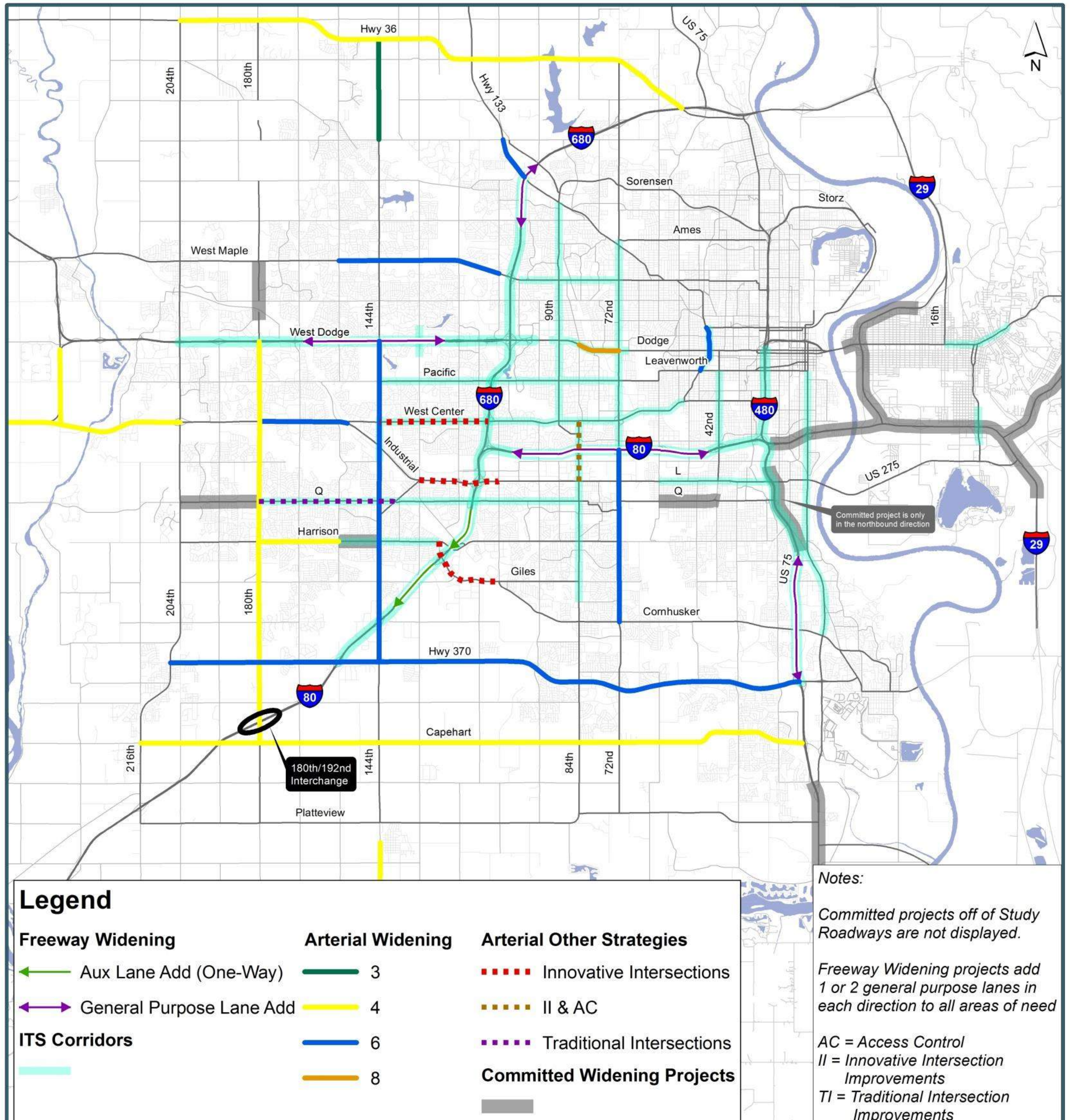


Figure 6.7. Strategy Package #4 - Transit Projects

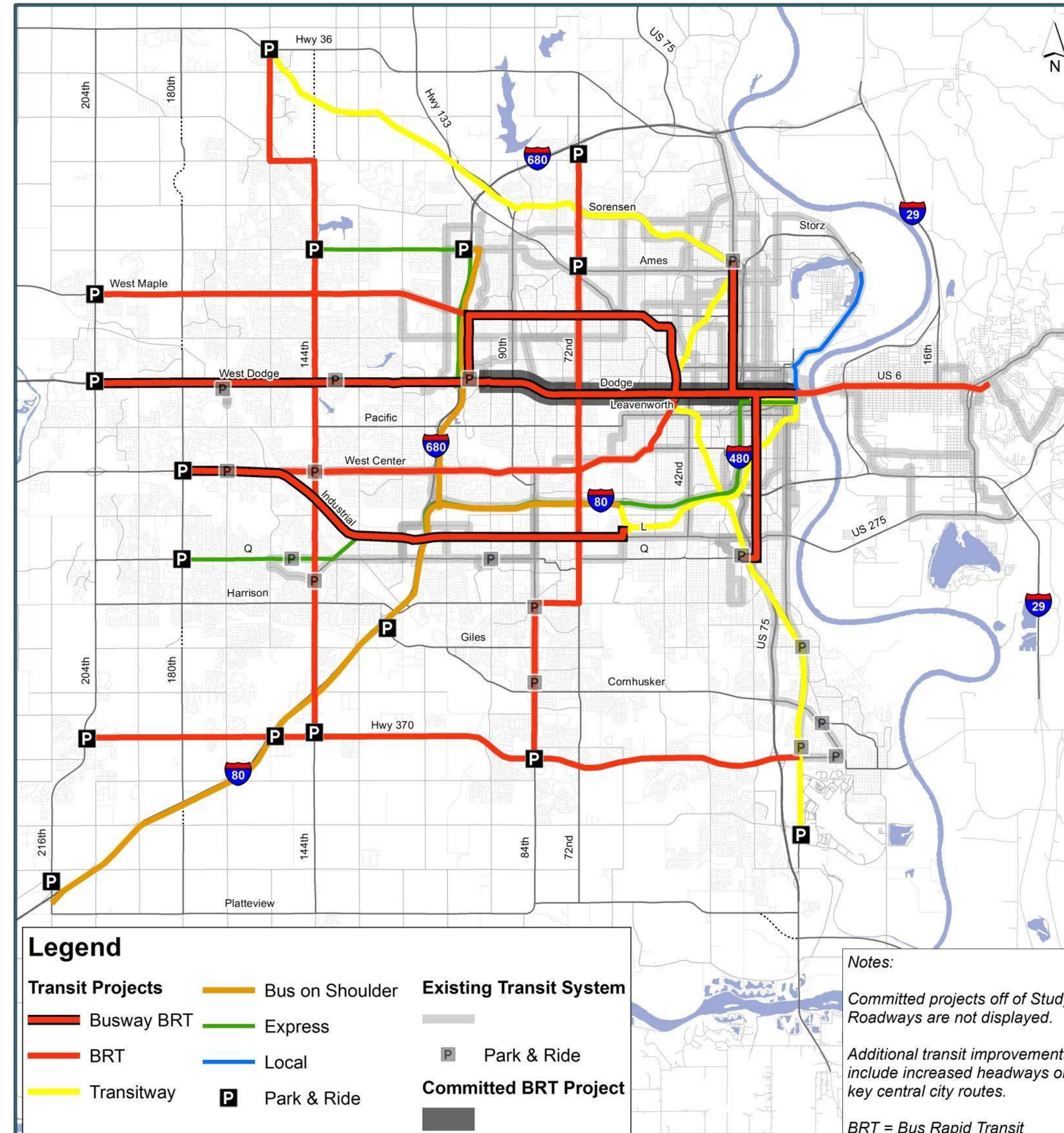
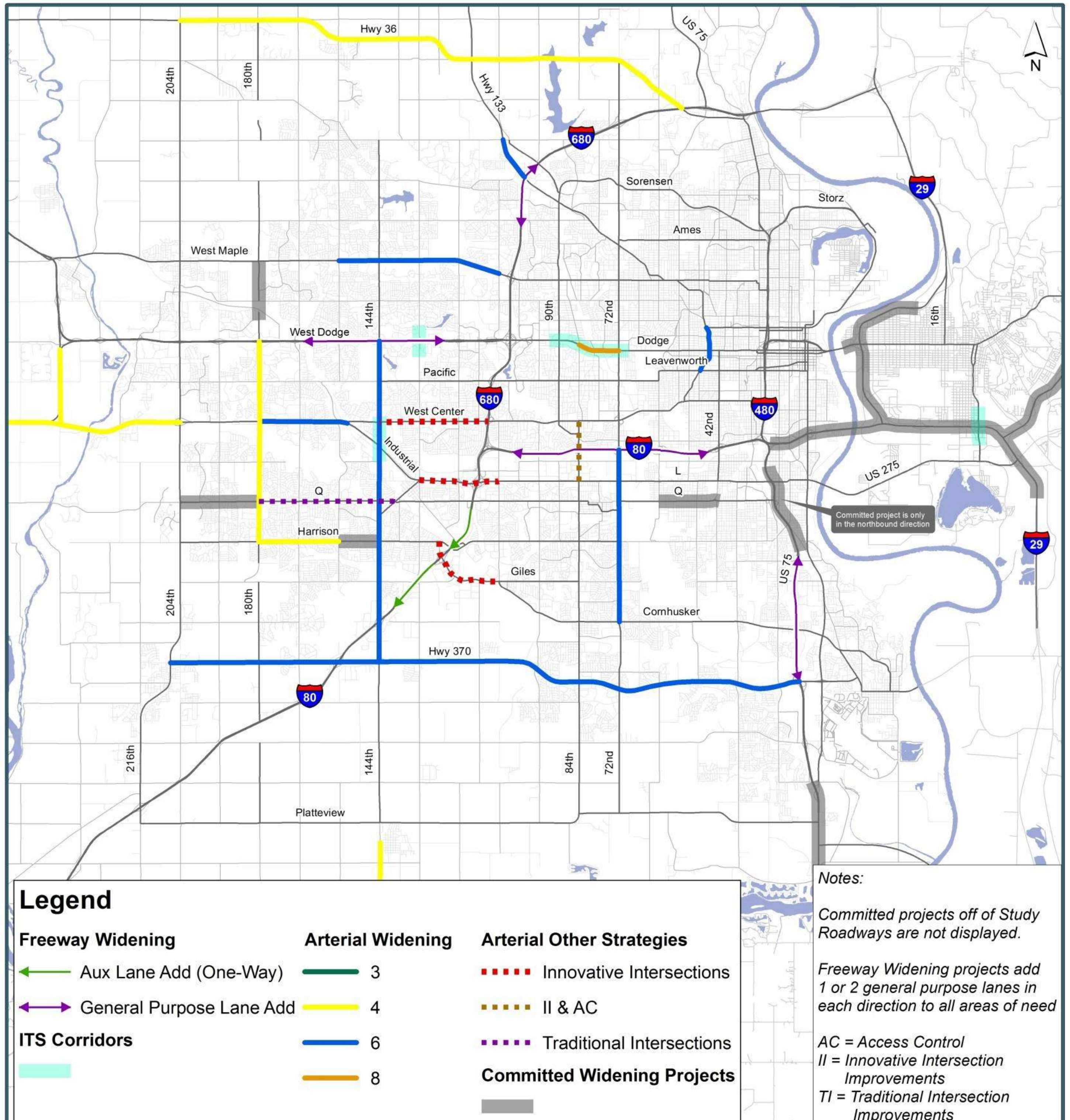


Figure 6.8. Strategy Package #5 - Roadway and System Gap Projects



Strategy Package #5 - Transit Projects

- No Transit Improvements
- No Change to Demand Response

Figure 6.9. Strategy Package #6 - Roadway and System Gap Projects

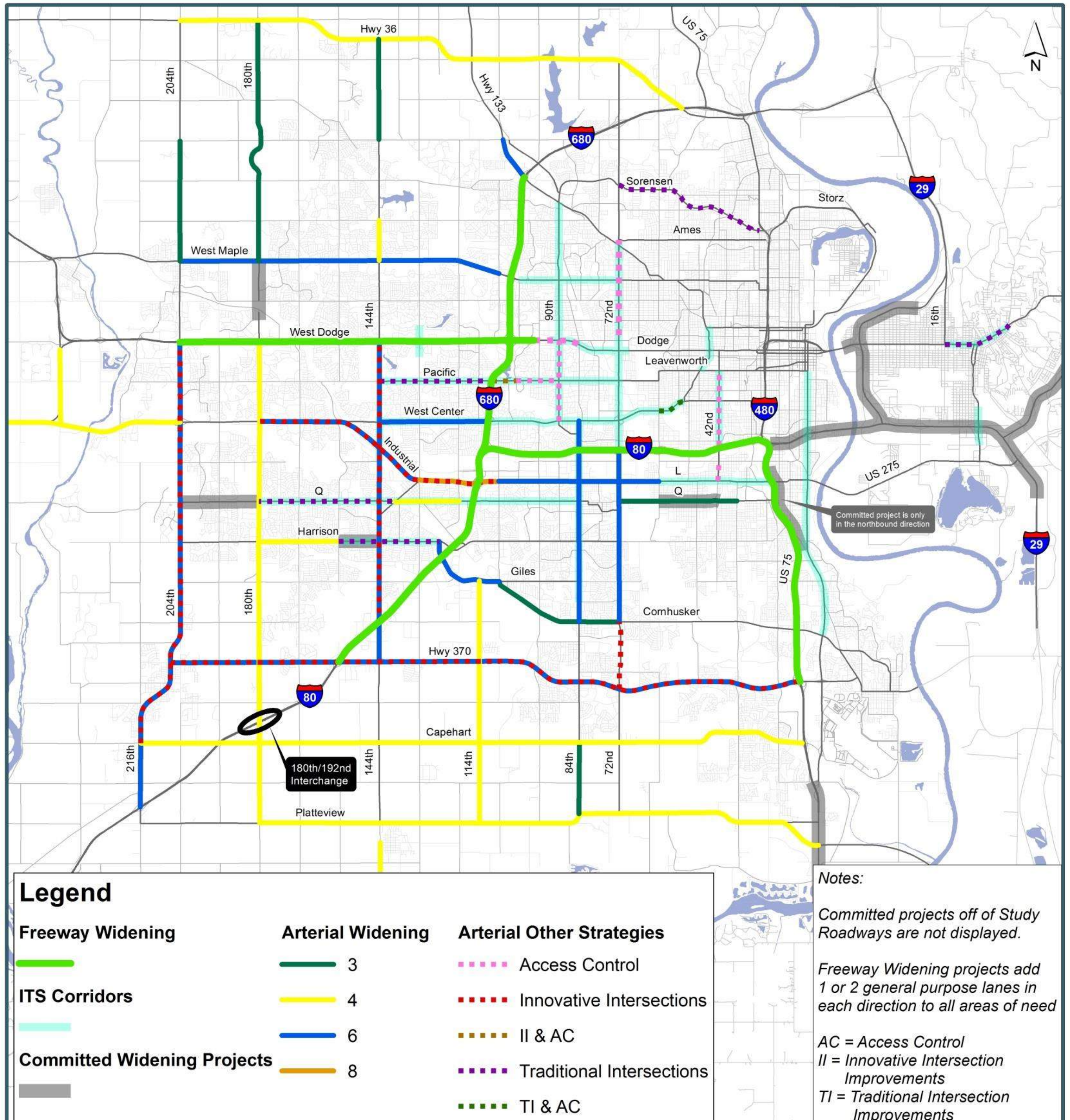
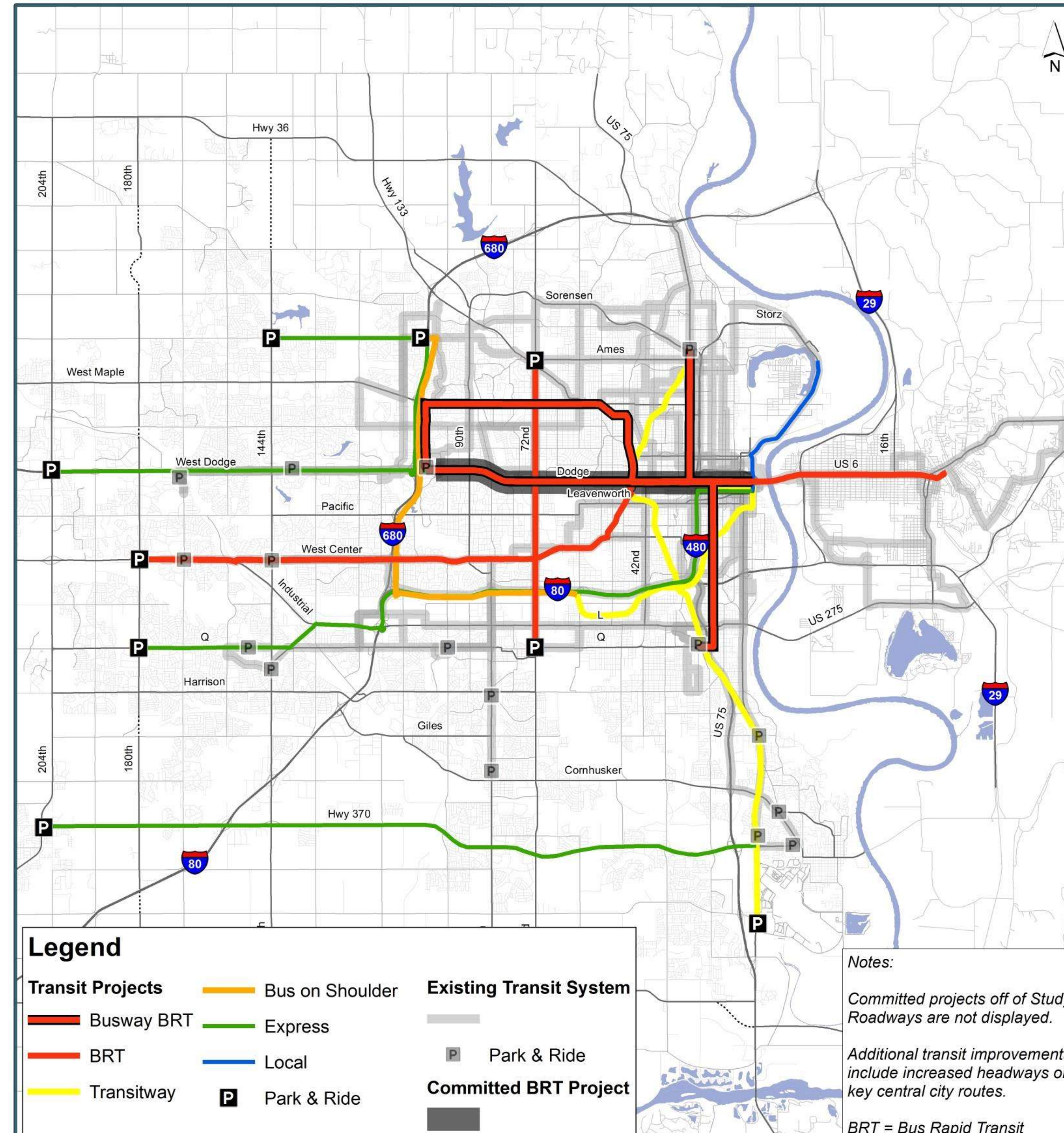


Figure 6.10. Strategy Package #6 - Transit Projects



Travel Demand Management

TDM strategies attempt to alter how and when regional travel occurs, in order to use the transportation system more efficiently without adding capacity to the system. Two (2) different levels of TDM strategies were assumed:

- **Full TDM investment**: Assumes a full and comprehensive regional travel demand management program is in place, including vanpooling, employer-based TDM associations, parking management policies, and a wide range of multimodal incentive programs.
- **Partial TDM Investment**: Assumes some basic regional travel demand management elements are in place, including vanpooling, ridesharing, and some multimodal incentive programs.

Safety Projects

Safety projects in the MTIS study area were split into three main groups: Safety Needs, Operational Needs, and Safety Needs Plus.

- **Safety Needs**: Includes locations identified in Phase 1 based on a critical threshold of observed to predicted crashes. These locations can be found in **Chapter 2** (**Figure 2.4**).
- **Operational Needs**: Includes locations where geometric improvements are primarily intended to mitigate operational deficiencies, but these improvements would be expected to improve safety. (i.e. the safety benefits/implications if a four-lane divided roadway is converted to a six-lane divided roadway or installing a raised median).
- **Safety Needs Plus**: Includes safety strategies applied to locations with operational needs. Note that these safety projects are applied "on top of" a standard widening project.

Two (2) groups (safety needs and safety needs plus) are discussed in the following sections. Note that the strategies listed were applied to all applicable segments.

Roadway Segment Strategies

Safety Needs

- Install bicycle lanes
- Install edge line, centerline, and post-mounted delineators
- Increase pavement friction

Note that locations for bike lanes correspond with recommendations identified in the *Heartland Connections Bicycle and Pedestrian Plan*.

Safety Needs Plus

- Skid resistance improvement
- Pavement markings

Other Site Specific Strategies

Some site specific strategies were identified but not considered as part of the analysis:

- Change driveway density from X to Y (driveways/mile for segment)
- Bus stop consolidation
- Provide a right-turn and left-turn lane on both major-road approaches at driveways

Intersection Strategies

Safety Needs

- Change the left-turn phase from permissive to flashing yellow arrow (FYA)
- Install high-visibility crosswalk
- Increase pedestrian crossing time
- Add 3-inch yellow retro-reflective sheeting to signal back plates

Safety Needs Plus

Note that no additional Safety Needs Plus strategies were developed for intersections.

Other Site Specific Strategies

Some site specific strategies were identified but not considered as part of the analysis:

- Install adaptive traffic signal control
- Install restricted crossing U-turn intersection (Replace left-turn with right turn/U-turn) and other innovative intersection treatments
- Introducing zero or positive offset left-turn lane on crossing roadway

Freeway Segment Strategies

Safety Needs

- Install roadside barrier
- Install wider markings and shoulder rumble strips with resurfacing
- Install a combination of chevron signs, curve warning signs, and/or sequential flashing beacons
- Install transverse rumble strips as traffic calming device

Safety Needs Plus

Note that no additional Safety Needs Plus strategies were developed for freeways.

Other Site Specific Strategies

Some site specific strategies were identified but not considered as part of the analysis:

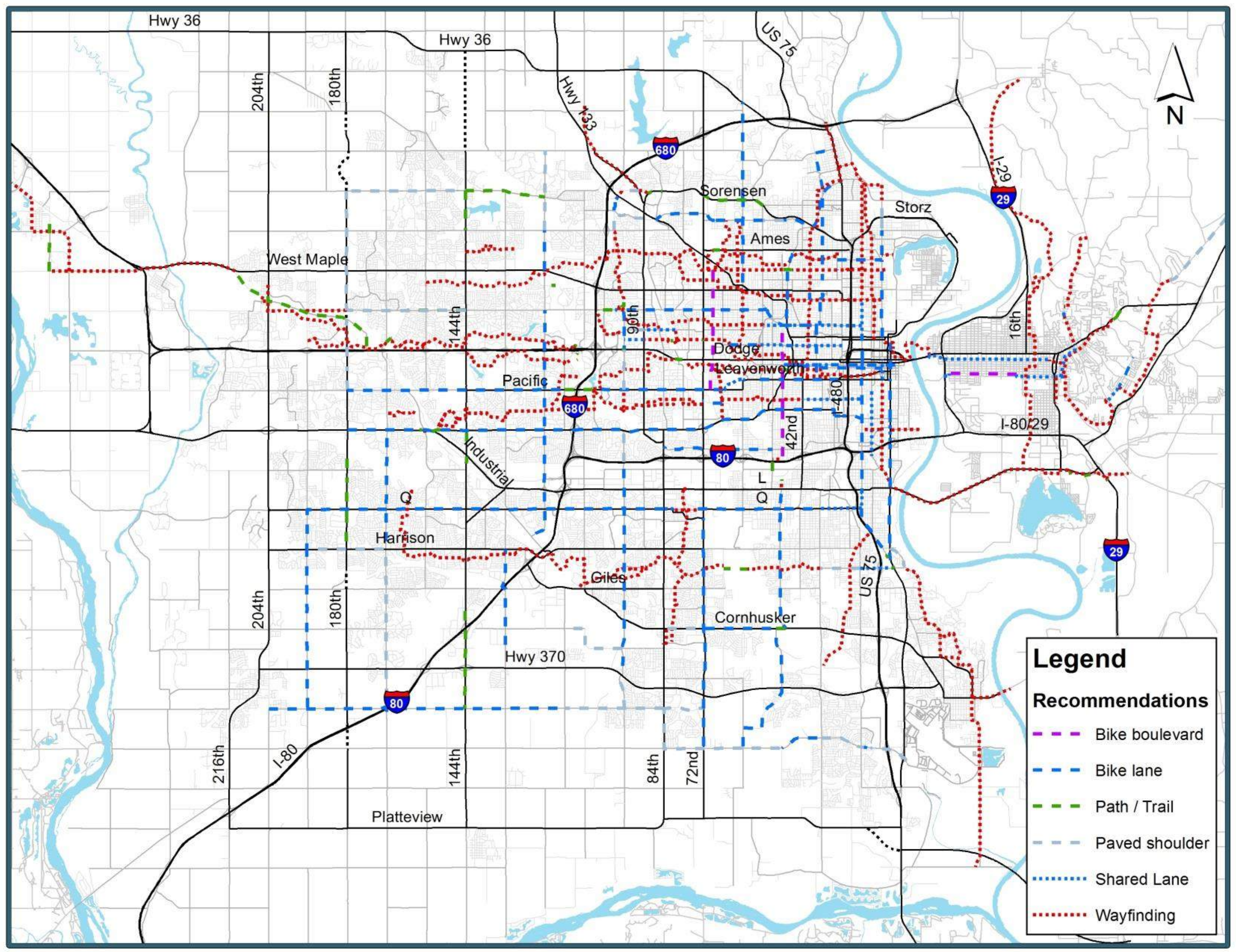
- Install advance warning signs (positive guidance)
- Extend acceleration lanes
- Increase weaving length distance

Bicycle and Pedestrian Projects

The *Heartland Connections Bicycle and Pedestrian Plan* provided facility recommendations to improve bicycling and walkability in the study area. The recommendations shown in **Figure 6.11** represent all (short-, medium-, and long-term) projects recommended for the study area.

Note that Strategy Package 5 and part of Strategy Package 6 include highest priority bicycle and pedestrian recommendations only. A complete discussion of these projects can be found on MAPA's website: (*mapacog.org/reports/regional-bicycle-and-pedestrian-plan/*).

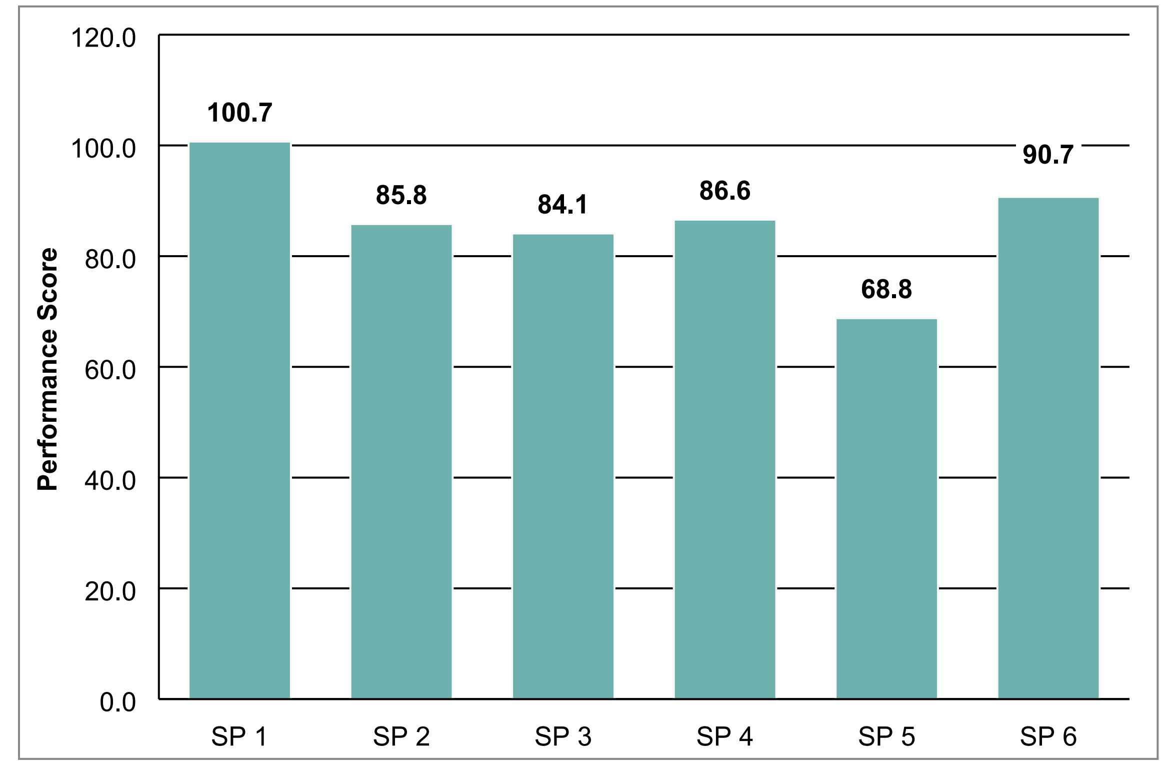
Figure 6.11. Bicycle and Pedestrian Facility Recommendations



Performance Assessment of Initial Strategy Packages

The performance measures and weights were applied to the Strategy Packages, and the results were evaluated in a relative manner. The absolute scores themselves were not as important as how the strategy package scores ranked in comparison to other packages. The results of the initial strategy package performance assessment are shown in **Figure 6.12**.

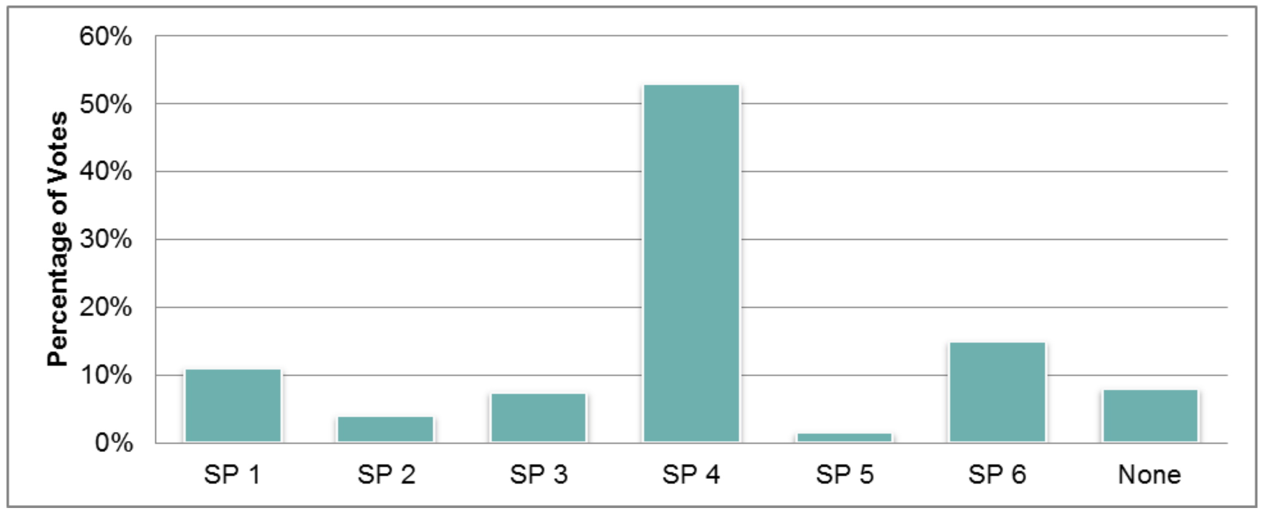
Figure 6.12. Initial Strategy Package Performance Scoring Results



Public and Stakeholder Input on Strategy Packages

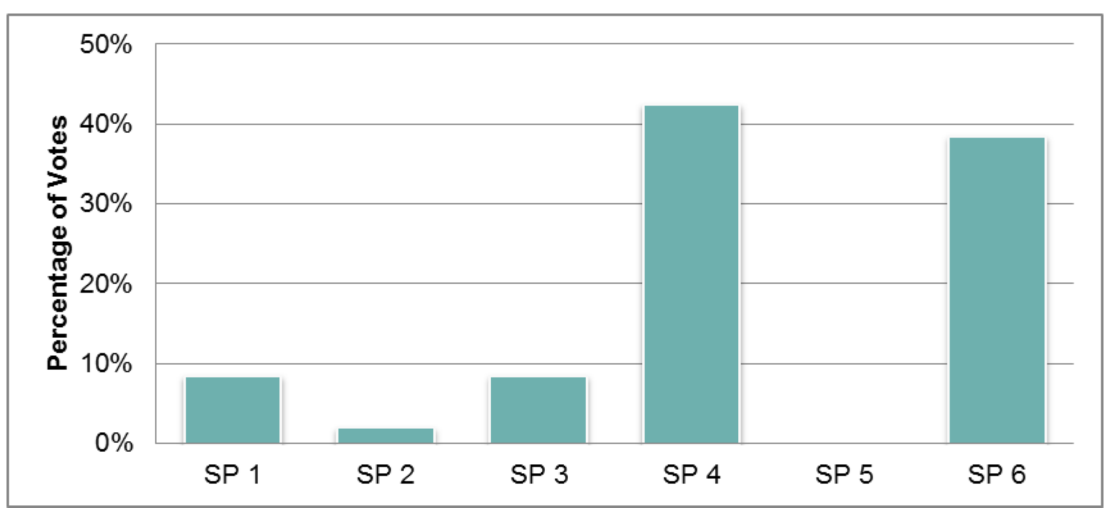
At LRTP public meetings held across the Omaha-Council Bluffs metro area in 2016, MAPA presented the initial Strategy Packages and had interactive polling to ask the public to identify their preferred package. More than 300 meeting attendees voted. The results of the public meeting voting are shown in **Figure 6.13**.

Figure 6.13. Preference Voting of Public at MAPA LRTP Meetings



At a July 2016 meeting, the Stakeholder Committee was also asked for their input on the Strategy Packages, including identification of their preferred strategy package. The results of the Stakeholder Committee voting are shown in **Figure 6.14**.

Figure 6.14. Preference Voting of Stakeholders at July 2016 Meeting



As shown in the voting results of the public meetings and stakeholders in attendance, the following three packages received the most preference (in order of preference):

1 - **Strategy Package 4**: System Management and Transit Focus
2 - **Strategy Package 6**: Geographic Distribution Scenario
3 - **Strategy Package 1**: High Levels of Balanced Investment

Selection of Preferred Regional Strategy Package

For developing the preferred regional strategy package, a set of guiding principles were developed based on the preferences and input received on Strategy Packages 1 through 6. The guiding principles for the ultimate vision plan were:

- Balanced investments across modes and systems.
- Targeted investments on the arterial system to address the highest arterial congestion issues.
- Full expansion of the freeway system to meet wider regional mobility and freight service needs.
- Application of technology and system management approaches to get more out of the current system.
- Significant expansion of the transit system.
- High levels of investment in system safety needs.
- Moderate levels of travel demand management expansion.

The preferred plan, Strategy Package 7, was developed based on the guiding principles outlined above and an assessment of the individual projects and strategies that represented an aggressive, yet attainable plan. Strategy Package 7 was developed with the following elements for each of the systems / modes.

- **Arterial Operations**: on the State system - Full Operational Needs. On the Local system - Targeted Operational Needs and ITS Improvements.
- **Freeway Operations**: Full Operations Needs and System Management approaches.
- **Transit**: High investment scenario that includes *the Regional Transit Vision* study's "Moderate Transit Vision Scenario" with some additional new routes. Scenario includes moderate growth in the Demand Response system.
- **Demand Management**: Partial Travel Demand Management.
- **System Gaps**: Targeted (Partial) Gap Improvements
- **Safety**: in the Central City - address safety needs, including non-motorized safety needs. In Suburban Areas - address safety needs.
- **Bicycle and Pedestrian**: in the Central City - build the regional Bike and Pedestrian Plan. In Suburban Areas - build the highest priority regional Bike and Pedestrian Plan projects only.

The roadway and system gap projects associated with Strategy Package 7 are shown in **Figure 6.15**. The transit projects associated with Strategy Package 7 are shown in **Figure 6.16.**

Figure 6.15. Strategy Package #7 - Roadway and System Gap Projects

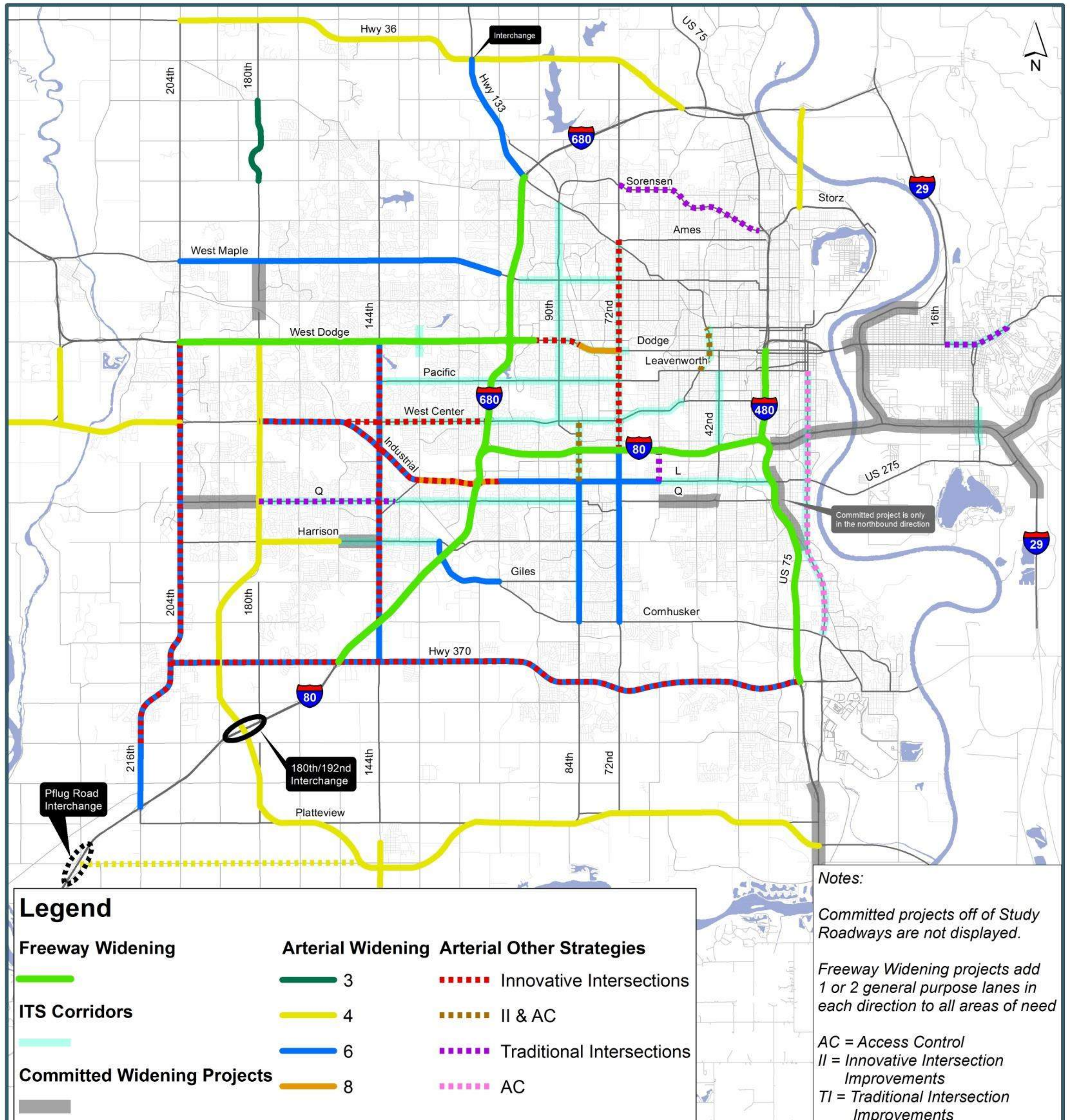
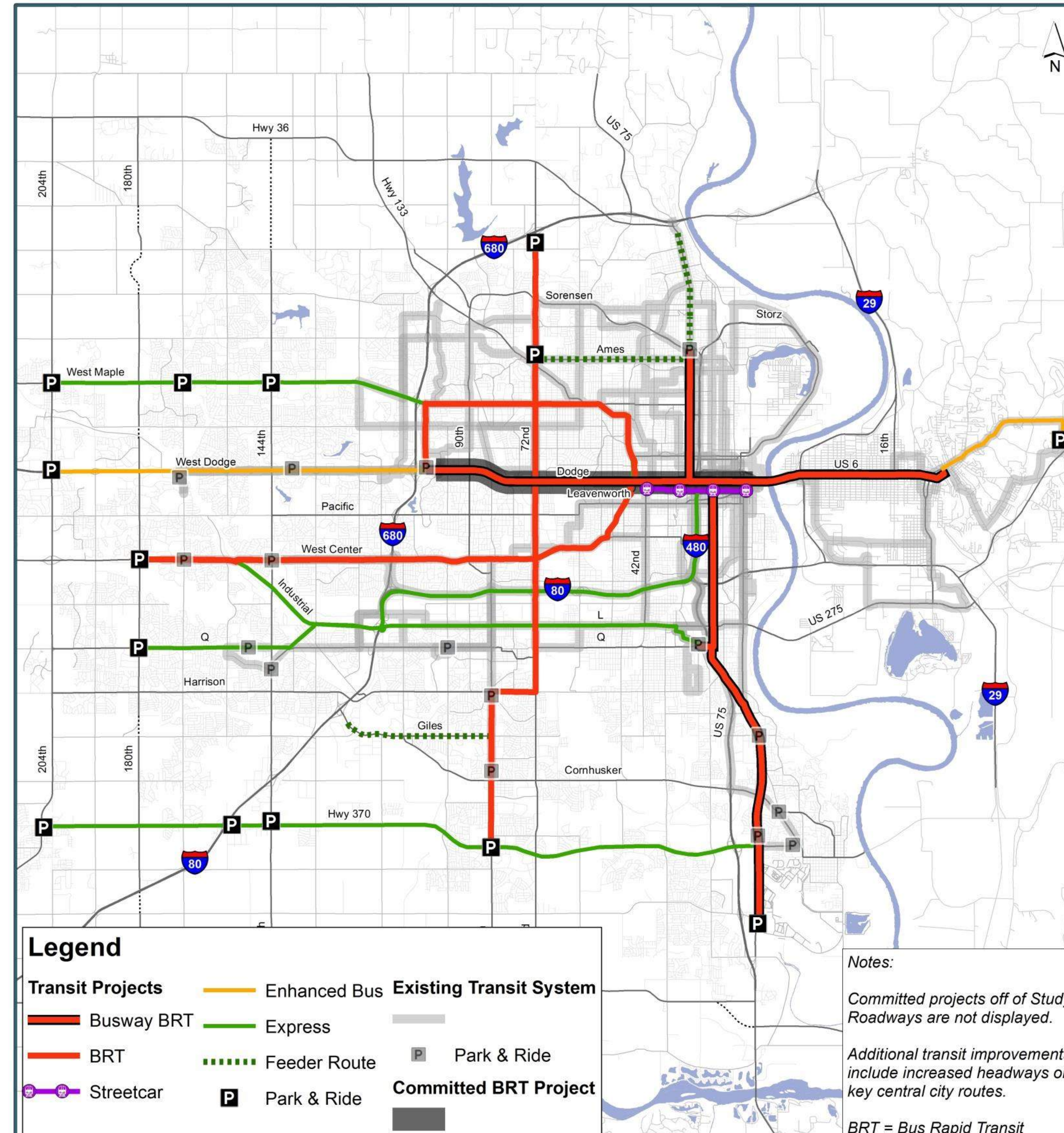


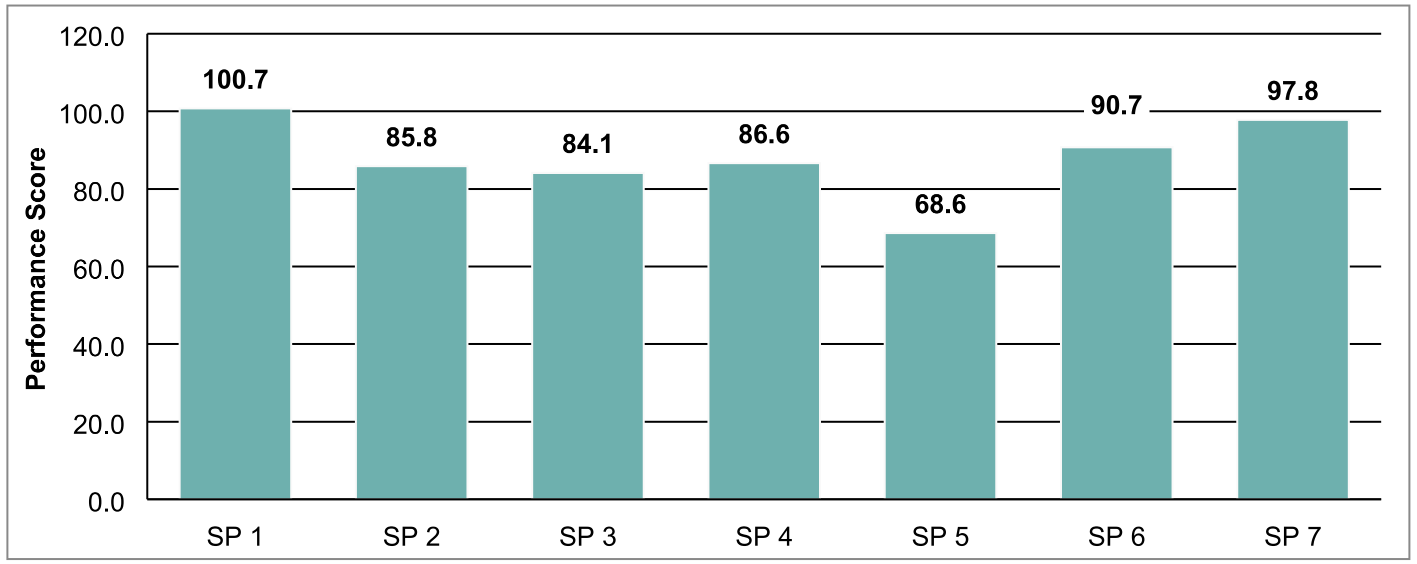
Figure 6.16. Strategy Package #7 - Transit Projects



Performance Assessment of Preferred Strategy Package

The performance measures and weights were applied to Strategy Package 7, and the results were evaluated against Strategy Packages 1 through 6. The results of the preferred strategy package performance assessment are shown in **Figure 6.17**.

Figure 6.17. Performance Scoring Results, Packages 1 through 7



As shown in **Figure 6.17**, Strategy Package 7's score is slightly less than Strategy Package 1 but has a cost savings of $452 Million compared to Strategy Package 1, shown in **Table 6.5**. **Table 6.6** provides additional details on the capital cost breakdown associated with Strategy Package 7.

Table 6.5. Strategy Package Cost Comparison ($ Millions YOE)[2]

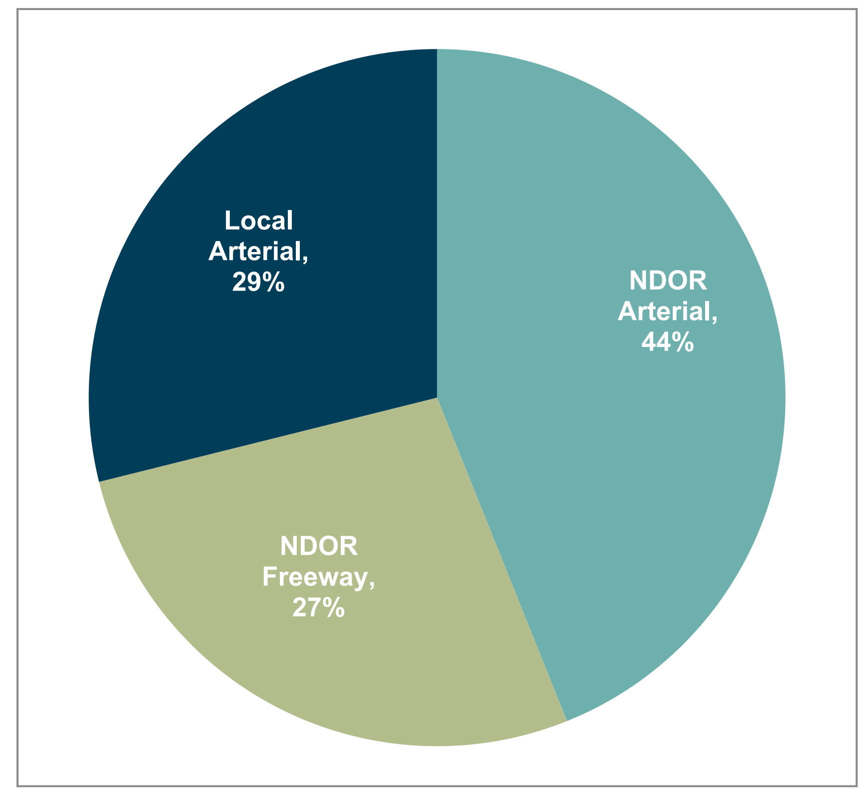
Strategy Package Number	Strategy Capital Costs	Pavement and Bridge System Preservation Costs	Transit O&M Costs	Total Cost
1	$4,776.0	$1,266.0	$1,832.8	$7,874.8
2	$3,242.2	$1,266.0	$1,085.5	$5,593.7
3	$4,229.5	$1,266.0	$1,133.9	$6,629.4
4	$4,422.0	$1,266.0	$3,114.8	$8,802.8
5	$1,932.4	$1,266.0	$1,071.0	$4,269.4
6	$4,586.8	$1,266.0	$2,104.5	$7,957.3
7	$4,323.6	$1,266.0	$1,832.8	$7,422.4

Table 6.6. Preferred Strategy Package Capital Cost Breakdown ($ Millions YOE)

Freeway	Arterial	Transit (Fleet & Capital)	Travel Demand Management	System Gaps	Safety (Freeway)	Safety (Arterial)	Bike/Ped	Roadway Total	Transit Total
$833.1	$2,044.9	$1,132.4	$32.0	$185.2	$1.3	$69.0	$25.7	$3,191.2	$1,132.4

A cost comparison between state and local routes was performed to gauge what levels of investment by facility jurisdiction would be needed for the freeway expansion, arterial expansion, and system gaps. This comparison is shown in **Figure 6.18**. State routes make up 71% of the overall roadway expansion costs. Note that the freeway expansion cost assumes lane additions rather than of full freeway reconstruction.

Figure 6.18. State vs. Local Roadway Expansion Cost Comparison



[2] Midtown to Downtown Streetcar project costs not shown. Direction per City of Omaha staff is that the Streetcar project will not be funded through traditional transportation revenues.

Comparison of System Benefits and Costs

In addition to the performance scoring of Strategy Packages, a Benefit-Cost analysis was completed to determine the relative economic benefits compared to the costs of each strategy package. The goal of the analysis is to put a dollar value (monetize) on the social benefits of an investment and compare that to the costs of the investment. For each strategy package, the Study Team evaluated the level of changes related to:

- **Vehicle Travel Time**: typically the largest benefit associated with a transportation investment. Vehicle travel time is measured as Vehicle-Hours Traveled (VHT), and includes the cost of time for drivers, passengers (in personal vehicles) and freight trucks separately.
- **Vehicle Operating Cost**: measured as Vehicle-Miles Traveled (VMT), and reflects the fuel consumption and depreciation ("wear and tear") costs of driving personal vehicles and trucks. Many roadway investments lead to more driving / longer routes and thus induce higher vehicle operating costs.
- **Crash Costs / Safety Benefits**: measured as number and severity of crashes. Safety improvement projects can reduce the number and severity of crashes, leading to societal benefits which are monetized in benefit-cost analysis. Guidelines from US DOT were used for the costs associated with major injury and fatal crashes.
- **Vehicle Emission Cost**: measured as the cost savings related to reductions in monetized air pollutant and greenhouse gas emissions from transportation sources.
- **Residual Capital Value**: measured as estimated value of infrastructure remaining at the end of the analysis period.

These factors focus predominantly on user benefits, not on any increased economic activity due to transportation investments. Thus, factors such as improved accessibility and its impact on regional productivity, or transit investments and their positive impact on land redevelopment values, are not reflected in this assessment. The benefit-cost analysis, along with the lifecycle costs, benefits, and net-present value (NPV) for each Strategy Package are shown in **Table 6.7**.

Table 6.7. Benefit-Cost Analysis by Strategy Package

Results Summary	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6	SP 7
Lifecycle Costs ($ Millions)	$2,944.9	$1,928.5	$2,390.0	$3,358.5	$1,338.4	$2,981.8	$2,743.4
Lifecycle Benefits ($ Millions)	$4,177.5	$2,684.1	$3,118.3	$4,291.6	$1,490.5	$3,797.5	$3,763.8
NPV ($ Millions)	$1,232.6	$755.7	$728.3	$933.1	$152.2	$815.7	$1,020.3
Benefit-Cost Ratio	**1.42**	**1.39**	**1.30**	**1.28**	**1.11**	**1.27**	**1.37**

While helpful, the benefit-cost does not reveal the entire performance benefits picture. The benefit-cost results in **Table 6.7** do not capture important regional performance measures including transit access to jobs, air quality, EJ access to jobs, and bicycle and pedestrian access. As shown in **Table 6.7**, some of the benefits associated with transit-heavy scenarios are not as clearly reflected in benefit-cost assessment. What the benefit-cost analysis does indicate is that Strategy Package 7 has similar benefit-cost results as the other high-performing packages.

Key Takeaways

A performance-based planning approach was used to develop and assess Regional Strategy Packages. Performance measures were developed for each of the performance goal areas:

- System Preservation Performance Measures
- Congestion Reduction Performance Measures
- Mobility & Accessibility
- Performance Measures Stewardship & Environment Performance Measures
- Safety Performance Measures

The performance-based planning process yielded Strategy Package 7 as the preferred regional package of transportation investments. The preferred strategy package reflected public and stakeholder preferences and balanced investments across all modes of travel.

Chapter 7 - Scenario Planning

There were two primary scenario planning efforts that involved evaluating the potential long-term regional travel impacts of:

- Different land development patterns.
- The adoption of autonomous vehicles and connected vehicles (AV/CV).

MAPA and NDOR embraced this scenario-planning approach as a way to understand the potential implications, risks, and benefits of market and technological forces. The scenario planning approach looked at potential land development and AV/CV market responses, and used the travel demand model to assess the potential system performance using the performance measures identified earlier in the project. The goal is to understand how future policies and market responses to both development patterns and vehicular technology might impact both:

- How we travel as a community.
- How MTIS' recommended projects and strategies perform under these alternative scenarios.

Land Use Sensitivity Scenarios

Three (3) different land use development scenarios were developed as a sensitivity test. All three land use scenarios assumed the same total number of future jobs and households by 2040, but allocated the new housing and employment locations differently from a spatial perspective. The numbers of 2010 and 2040 forecasted regional households and jobs is shown in **Table 7.1**.

Table 7.1. Household and Employment Totals for MTIS Study Area, 2010 and 2040 (All Scenarios)

Number of Units	2010	2040
Households	291,300	389,100
Employment	422,200	543,600

The goal was to understand how the overall system would potentially perform under these three (3) scenarios:

- **Heartland 2050 ("Balanced") Land Use Scenario**: This is the official / adopted version of the MAPA 2050 land development scenario, which came out of the Heartland 2050 initiative's public and stakeholder involvement process. This scenario represents the baseline land development assumption for MTIS, and all of the non-scenario results for 2040 assume this land development pattern is in place.
- **Transit-Oriented Development (TOD) Scenario**: This scenario had a smaller portion of new development in "greenfield" locations on the urban fringe than the Heartland 2050 Land Use Scenario, with additional infill land development assumed along planned transit lines, creating a more dense land development concept.
- **Sprawl Scenario**: This development scenario assumes limited infill development, with more low-density development occurring on the greenfield locations along the urban fringe.

The Balanced Land Use Scenario and the Sprawl Land Use Scenario were tested within the MAPA Travel Demand Model, on both the Strategy Package 5 (low investment) and Strategy Package 7 (vision plan) transportation networks.

Land Use Scenario Results

Key performance metrics that reflect overall regional travel patterns were assessed on a system-wide basis by scenario: VMT, VHT, and delay.

Average system speeds are also shown, simply calculated as the result of $\frac{System\,VMT}{System\,VHT}$. The performance results of the land use scenarios are illustrated in **Table 7.2**.

Table 7.2. Land Use Sensitivity Scenario Results

Performance Measures	Strategy Package 5		Strategy Package 7		
	Balanced Land Use	Sprawl Land Use	Balanced Land Use	Sprawl Land Use	TOD Land Use
Total VMT (Daily)	27,065,759	29,600,700	27,318,212	30,727,273	26,303,801
Total VHT (Daily)	734,762	884,821	703,116	826,568	663,352
Average System Speed	36.8	33.5	38.9	36.6	39.7
Total Hourly System Delay (Daily)	85,944	176,163	52,797	104,418	45,535

As shown in **Table 7.2**:

- Due to more dispersed development patterns, which lead to longer trips and more travel, the Sprawl Land Use scenario has higher VMT, higher VHT, lower speeds and more delay than the other two land use scenarios.
- Due to lower transportation investment levels, Strategy Package 5 has lower speeds and more delay than similar land use scenarios in Strategy Package 7.
- Due to more concentrated development patterns, focused on high-frequency transit lines, the TOD Land Use scenario has less VMT, less VHT, higher system speeds, and lower system delay.

Autonomous and Connected Vehicles (AV/CV) Scenarios

Overview of Potential AV/CV Impacts on Travel

There are a number of companies bringing autonomous and connected vehicles to market and testing them. The range of AV/CVs being tested for near term implementation includes commercial trucks, transit buses, and person automobiles. Many of these vehicles are expected to be commercially available in the next five years. When widely adopted, these technologies have the capability to radically impact our transportation system in a range of ways. The potential **benefits** from this technology shift include:

- **Improved Safety**: Over 90% of traffic crashes are the result of human error. When AV/CV technology is adopted throughout the vehicle fleet, the incidence of serious and fatal crashes is anticipated to drop dramatically.
- **Reduced Driver Costs**: There are several factors that are anticipated to reduce driver costs:
  - **Fuel Efficiency**: Connected cars should provide improved fuel efficiency through tight vehicle platoons for reduced wind drag and less "start and stop" conditions.
  - **Insurance Cost**: As the incidence of vehicle crashes reduce, insurance rates should decline significantly.
  - **Car Sharing**: As the ability to hail an AV/CV at a moment's notice increases, it is anticipated that many residents will own fewer automobiles, and only pay for automobiles when they need them.
- **Allow for "Productive Commutes"**: When cars do all of the driving tasks for their occupants, commuters that previously drove themselves to work have newly found time for work or leisure.
- **Wider-Reaching Mobility**: Statistics vary, but approximately 1/3 of Americans are believed to be unable to drive

due to age or disability. Many of those Americans live in areas with limited transit service. AV/CVs provide much greater mobility for these residents.

- **Efficient Roadway Use**: There are several ways in which AV/CVs will make more efficient use of our current roadway pavement. These more efficient use of existing roadways rely on automated vehicles being more accurate than human drivers. The benefits are predominately two types of more efficient use:
  - **Reduced headways between vehicles**: Autonomous and connected vehicles can use their sensors and communicate with one another in real time, and adjust vehicle speed and trajectory instantaneously to respond to proactively avoid collisions with other vehicles. As a result, AV/CVs should be able to follow cars more closely. Thus, a given segment of roadway lane should be able to fit more AV/CV autos than current autos without a reduction in operating speeds.
  - **Reduced horizontal separation between vehicles**: Current lanes typically range between 11 and 12 feet wide, while the typical vehicle is 6 to 7 feet wide (with heavy commercial vehicles being wider at 8 to 9 feet wide). There is the potential that lanes dedicated to AV/CV could be significantly narrower, potentially 8 feet wide in urban areas, and potentially just 9 to 10 feet for commercial vehicle automated lanes. This allows space to be used for other purposes.

With these potential benefits, come some **negative impacts**:

- **New Trips**: As travel becomes more efficient and more accessible, there is the potential that more trips will be made. People that currently drive will potentially make more trips, and people that are currently too young or are unable to drive will make more trips.
- **Empty Car Trips**: As cars can drive themselves without human interaction, there are several reasons why they might be traveling without people in them:
  - **Remote Parking**: It might become cheaper for people to travel to a high land-rent part of the city (like downtown), get dropped off at their destination, and then send their car to a lower land-rent part of the city to park. This "deadheading" trip by the car is a type of travel that cannot and does not currently happen.
  - **Car-Sharing Circulation Trips**: As cars are able to park themselves and pick up passengers efficiently, many residents will have fewer incentives to own a car. A shift from a car-ownership to car-sharing model will likely lead to additional driver-less circulation trips for cars picking up passengers.
- **Diluted Perception of the Time "Cost" of Traveling**: As travelers are no longer tied to the tasks associated with driving, they can spend their commute time on work or leisure tasks. Thus, the time spent during a trip will be perceived less negatively. As a result, travelers will be more apt to choose longer trips, or potentially even live farther from work or school. This will lead to longer average trip lengths as AV/CVs are adopted.

AV/CV Scenarios Assessed

The Study Team developed a series of AV/CV scenarios to test with the regional travel demand model. There were two primary capacity benefit scenarios developed (Scenarios 1 and 2), and then a series of cumulative sub-scenarios based on Scenario 2. These scenarios are summarized in **Table 7.3** and described as follows[3]:

- Scenario 1:
  - AV market penetration allows systemwide capacity increase by 30%.
- Scenario 2:
  - Higher market penetration than 1; 2040 capacity increase by 50%.
- Scenario 2B:
  - 2040 capacity increase = + 50%
  - Improved personal mobility leads to induced trips; systemwide trips are increased by 3%
  - Car sharing / remote parking become more widespread, leads to more "deadheading" trips; VMT is increased by 15%
- Scenario 2C:
  - 2040 capacity increase = +50%
  - System wide induced trip increase = +3%
  - Increase "deadheading" VMT = + 15%
  - Travel is perceived as less costly; the perceived value of time is reduced by 20%
- Scenario 2D:
  - 2040 capacity increase = +50%
  - Systemwide induced trip increase = +3%
  - Increase "deadheading" VMT = + 15%
  - Value of time = -20%
  - Transit vehicle automation leads to reduced bus system costs - allow increased transit service; headways ½ of current conditions)
- Scenario 3C:
  - Same as scenario 2C, except systemwide induced trips were increased by 15% instead of 3%.

Table 7.3. Summary of AV/CV Scenario Assumptions

Variables	Scenario						
	Base	1	2A	2B	2C	2D	3C
Induced Trips Change	-	-	-	+4%	+4%	+4%	+15%
Deadhead VMT Change	-	-	-	+15%	+15%	+15%	+15%
Value of Time Change	-	-	-	-	-20%	-20%	-20%
Capacity Change	-	+30%	+50%	+50%	+50%	+50%	+50%

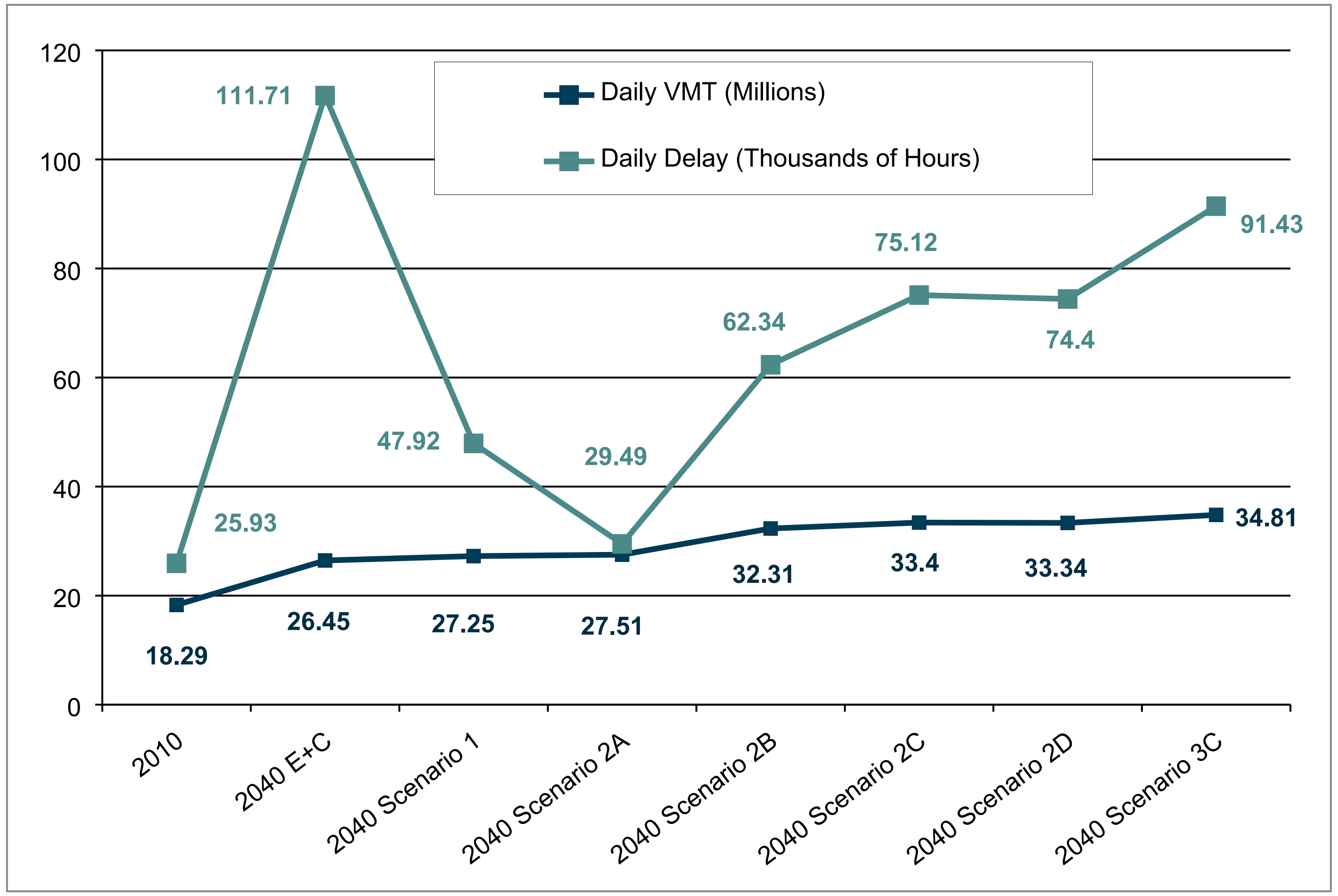
AV/CV Scenario Results

These AV/CV scenarios were evaluated with MAPA's regional travel demand model for both the 2040 existing-plus-committed (E+C) network and 2040 Strategy Package 7 network. Similar to the Land Use scenarios, key system-wide performance metrics that were assessed included: VMT, VHT, and delay. Results for the scenarios are shown in **Figure 7.1**.

[3] These scenarios were inspired by, and some elements adapted from the Activity-Based Modeling results and research of the Puget Sound Regional Council and Atlanta Regional Council:

- Childress, Nichols, Charlton, Coe. "Using an Activity-Based Model to Explore Possible Impacts of Automated Vehicles". TRB 2015 Annual Meeting.
- Kim, Rousseau, Freedman, Nicholson. "The Travel Impact of Autonomous Vehicles in Metro Atlanta through Activity-Based Modeling", 15th TRB National Transportation Planning Applications Conference, 2015.

Figure 7.1. Regional Delay and VMT Results of Automated Vehicle Scenarios[4]



As demonstrated in this section, there is significant uncertainty when it comes to the effects that Automated and Connected vehicles will have on the transportation system of the metro area. The Study Team's research and analysis indicate that there will likely be enough market penetration of these technologies by 2040, which will lead to significant increases in the vehicle throughput of our existing street system. However, some of these increases in corridor capacity will be offset by "induced" travel. The benefits of AV/CVs will encourage more trips, longer trips, and driverless "deadhead" trips, which have the potential to offset many of the capacity benefits of the technology.

Key Takeaways

The Land Use Sensitivity tests revealed the negative impacts on travel that low density, dispersed ("sprawl") development can have.

The autonomous vehicles and connected vehicle AV/CV scenario tests revealed that not all of our congestion issues will likely be solved by AV/CVs. While AV/CVs will allow more cars to efficiently use the same roadways, AV/CVs are also expected to create the demand for more trips and longer trips. With the expected increase in VMT associated with AV/CV, some of the capacity benefits from AV/CVs are anticipated to be diminished by induced

[4] These Automated Vehicle scenarios use the Existing-Plus-Committed (E+C) roadway and transit network as their baseline for comparison.

Chapter 8 - Regional Funding

This chapter summarizes the sources and uses of transportation funding for the Omaha-Council Bluffs Metro area through 2040, identifies the funding gap and considers alternative funding and financing sources that may bridge that gap. The scope of the analysis includes roads, bridges and transit. The funding gap is identified as the difference between the investment needs and the anticipated future funding levels. Non-traditional funding sources are highlighted in this document to address the funding gap required to achieve the transportation infrastructure vision within the region.

Traditional Funding Sources

There are two primary (formula-based) Federal program funding sources that MAPA uses for transportation projects in the region:

- **Surface Transportation Block Grant Program (STGB)**: provides funding for projects on any Federal-aid highway, bridge, pedestrian and bicycle facilities, and transit capital projects. This program was known as the Surface Transportation Program (STP) prior to the Fixing America's Surface Transportation (FAST) Act.
- **STBG program funding Transportation Alternatives (TA)**[5]: provides funding for projects including on-street and off-street pedestrian and bicycle facilities, improved access to transit, and safe routes to school projects. Some TA program funds the MPO receives are via their formula allocation, while other funds are awarded to the region competitively. Prior to the FAST Act, this funding source was known as both the Transportation Alternatives Program (TAP) and Transportation Enhancements (TE) program.

Other Federal funding programs that have been used on roadway improvements within the MPO area in the past include:

- **National Highway Performance Program (NHPP)**: funding for projects on roads that are part of the National Highway System (NHS), for both maintenance of the existing system and new facility construction.
- **Emergency Relief (ER) Program:** funding for repair or reconstruction of Federal-aid facilities which have suffered serious damage as a result of natural disasters.
- **Congestion Mitigation and Air Quality Improvement Program (CMAQ):** a funding program to reduce congestion, emissions, and improve air quality. On the Iowa side of the study area, the CMAQ funds are used for "Iowa's Clean Air Attainment Program" (ICAAP), which has similar goals of reduced emissions and improved air quality.
- **Highway Safety Improvement Program (HSIP):** a funding program that targets projects to achieve traffic fatality and serious injury reductions on public roads.

Anticipated Traditional Funding Levels

The MTIS Study Team used the 2040 LRTP as a starting point, and worked with MAPA and NDOR staff to identify anticipated Federal transportation funding. Additional adjustments were made based on updated information available, including Build Nebraska Act funding levels, and anticipated funding increases under the FAST Act. **Table 8.1** documents the anticipated transportation revenues from traditional sources through 2040.

Table 8.1. Anticipated Traditional Transportation Revenues by Source through 2040

Funding Source	2016-2019	2020-2025	2026-2030	2031-2035	2036-2040	Total
Nebraska						
Federal Revenues	$201,123,000	$335,311,000	$302,701,000	$310,901,250	$319,327,431	$1,469,363,681
Local Match of Federal Revenues	$50,280,750	$83,827,750	$75,675,250	$77,725,313	$79,831,858	$367,340,920
Additional Local Revenues for MTIS Routes	$0	$57,459,868	$23,200,468	$49,660,438	$109,859,789	$240,180,564
Transit Capital	$81,494,915	$77,063,078	$71,598,280	$79,050,286	$87,277,904	$396,484,463
Transit O&M	$76,738,113	$97,908,962	$121,584,990	$134,239,654	$148,211,424	$578,683,143
Build Nebraska Act	$0	$36,000,000	$60,000,000	$36,000,000	$0	$132,000,000
FAST Act Increase	$8,044,920	$13,412,440	$12,108,040	$12,436,050	$12,773,097	$58,774,547
Iowa						
Federal Revenues	$410,135,000	$190,356,000	$104,552,000	$88,213,275	$90,324,857	$883,581,132
Local Match of Federal Revenues	$102,533,750	$47,589,000	$26,138,000	$22,053,319	$22,581,214	$220,895,283
Additional Local Revenues for MTIS Routes	$0	$49,276,476	$67,703,299	$61,049,910	$79,385,751	$257,415,436
FAST Act Increase	$16,405,400	$7,614,240	$4,182,080	$3,528,531	$3,612,994	$35,343,245
Total	**$946,755,848**	**$995,818,814**	**$869,443,407**	**$874,858,025**	**$953,186,320**	**$4,640,062,415**
Excluding 2016 to 2019 Programmed Funds						
Nebraska	$166,277,948	$700,983,098	$666,868,028	$700,012,991	$757,281,503	$2,991,423,568
Iowa	$16,405,400	$294,835,716	$202,575,379	$174,845,035	$195,904,816	$884,566,346
Total	**$182,683,348**	**$995,818,814**	**$869,443,407**	**$874,858,025**	**$953,186,320**	**$3,875,989,915**

[5] TAP was authorized as a part of the MAP-21 transportation authorization, and replaces the Transportation Enhancements (TE) program that was discontinued under MAP-21.

Table 8.2 shows the gap between projected funding from traditional sources, and the investment needs associated with the preferred Strategy Package 7. As shown in **Table 8.2**, on the Nebraska side, the gap for this scenario is $3.956 billion

Table 8.2. Strategy Package 7 Investment Needs, Funding and Gaps through 2040 (In Millions of Dollars)

State	Strategy Capital Costs	Pavement and Bridge Costs	Transit O&M Costs	Total Costs	Projected Funding (Status Quo)	Estimated Funding Gap[6]
Iowa Elements	$72.0	$216.0	$94.7	$382.70	$884.6	-
Nebraska Elements	$4,251.6	$1,050.0	$1,738.1	$7,039.7	$2,991.4	($4,048.3)
Total Region	$4,323.6	$1,266.0	$1,832.8	$7,422.4	$3,876.0	($3,546.4)

Local Potential Funding

Before discussing innovative funding options, it is important to understand from a practical perspective how much the Nebraska Metro's $4.049B funding gap noted in **Table 8.2** represents in terms of local revenues. This section provides an illustration of how much local funding a sales and property increase in Douglas and Sarpy Counties could generate. The intent of this discussion is not to advocate for any of these potential revenue sources, but to illustrate the level of new revenues required to meet the anticipated transportation funding gap.

Sales Tax Scenario

According to the Nebraska Department of Revenue data, Douglas County had retail sales of $8.9 billion in 2016. A 1% retail sales tax could collect approximately $2.86 billion in revenue between 2017 and 2040[7]. Sarpy County had retail sales of $1.7 billion in 2016. A 1% retail sales tax could collect approximately $456 Million in revenue between 2017 and 2040.

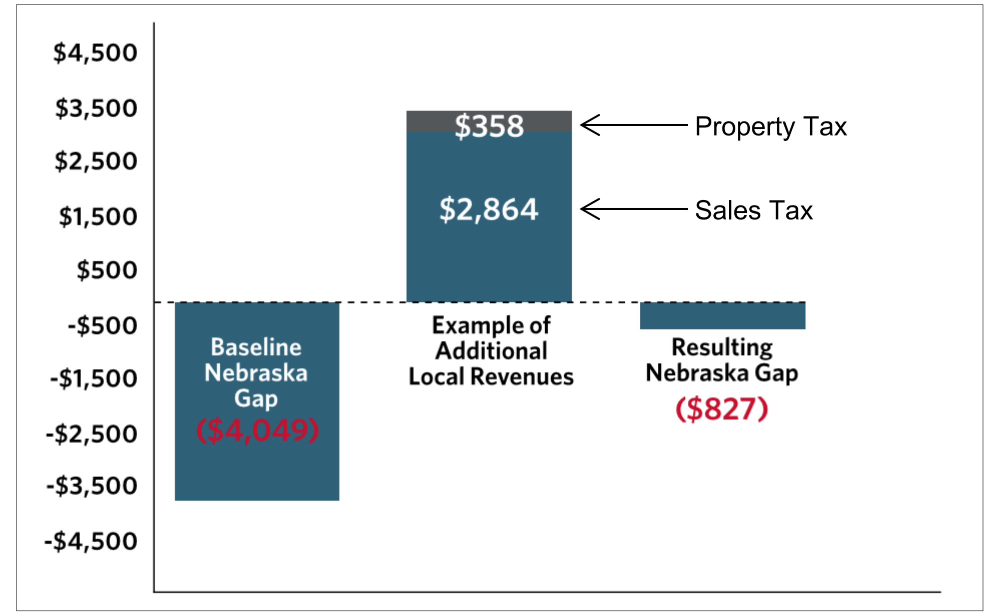
Property Tax Scenario

Based on county reports, in 2016 Douglas County had about $39.0 billion in assessed property value[8]. An additional levy of a ¼ mill (a 0.00025 % property tax levy) could raise $266 Million in revenue between 2017 and 2040. Sarpy County had about $13.6 billion in property-assessed value as of 2016. An additional levy of a ¼ mill could raise $92 Million in revenue between 2017 and 2040.

As shown in **Figure 8.1**, combining the sales and property tax increases illustrated above for Douglas and Sarpy counties could potentially yield about $3.22 billion by 2040, a majority of the identified Nebraska metro area funding gap.

[6] It is assumed that the "surplus" in Iowa is actually going to be spent on the Council Bluffs Interstate project and on non-MTIS roadways. The Iowa surplus funds cannot be used on the Nebraska side.
[7] Assuming a 1% per year growth in sales tax receipts and property tax valuations.
[8] Includes Personal, Residential, Commercial, Industrial, Recreation and Agricultural property

Figure 8.1. Example Illustration of Local Potential Funding, Douglas and Sarpy County, 2017-2040 in Millions of Dollars



In addition to sales and property taxes, additional potential City and County transportation funding options that are used in other regions nationwide and could be considered include: local option fuel taxes, transportation improvement district / value capture taxes, and vehicle excise tax.

Innovative Funding and Financing Sources

Much of the funding gap is driven by roadway and bridge projects. A selection of these projects may be suitable for "innovative funding" under certain conditions:

- Project has dedicated cash flows such as user fees, tolls or dedicated tax.
- Project revenue generates sufficient free cash flow after deduction of design, construction and ongoing operating & maintenance expenses to cover financing costs (debt and principal payments) and return on equity in the case of a private sector developer.
- Project risks can be allocated to private and public parties that are most able to manage such risks.
- Legal framework is in place to allow for "innovative funding" solutions.
- Project is likely to receive an investment grade rating from a nationally recognized credit rating agency.

The following sections provide an overview of common innovative funding approaches including State Infrastructure Banks, Loans and Credit Programs and Public-Private Partnerships.

Innovative Finance: 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 SIB funds were capitalized through federal sources provided under a pilot initiative 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 for infrastructure excepting highway projects, which have a sliding scale match. As project loans are repaid over time, the state's debt capacity increases allowing new loans to be issued for phased implementation of 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**.

Possible Funding from SIBs

The Nebraska Legislature recently passed a measure (Transportation Innovation Act) to infuse $450 Million over 17 years into the SIB. This money will be provided from a gas tax increase, which is projected to be $400 Million over the length of the Act, and $50 Million will be from the Nebraska Cash Reserve Fund.

This funding will be allocated to three categories: The Accelerated State Highway Capital Improvement Program, the County Bridge Match Program, and the Economic Opportunity Program.

The entire program has the potential for sourcing funds of $450 Million, with $40 Million dedicated to the County Bridge Match and $20 Million dedicated to the Economic Opportunity Program. Assuming funding trends are similar to the Build Nebraska Act (about 11% of the total funding allocated to the MAPA region), it is a reasonable expectation that available funding toward the MAPA is in the order of $50 Million or $3 Million per year for 17 years.

Legislative Bill 626 of the 104th Nebraska Legislature: Bridge Infrastructure Bank Fund

Bill 626, introduced January 21, 2015, was drafted to create a Nebraska Bridge Infrastructure Bank (NBIB) Fund similar to the State Infrastructure Banks (SIBs) with the intent to allocate exclusively for bridges. The new fund sources its capital from an unspecified amount of revenue from the current motor vehicle tax, fee, and registration payments. Bill 626 would also appropriate an unspecified amount of revenue from the General Fund for FY 2015/2016 and FY 2016/2017.

However, Bill 626 was labeled as "indefinitely postponed" on April 20, 2016 and this funding mechanism is currently not available.

Innovative Finance: Loans and Credit Programs

Build America Bureau

The FAST Act was enacted on December 4, 2015. Key to the FAST Act is the establishment of a National Surface Transportation and Innovative Finance Bureau (Sec 9001) to integrate programs, to develop and promote best practices for innovative financing of projects and to administer the program. The bureau was officially launched by the U.S. Department of Transportation (USDOT) on July 20, 2016 as the Build America Bureau (the "Bureau") (*transportation.gov/buildamerica*)

The Bureau will serve as an information and administrative resource for USDOT highway and highway credit and grant programs and will build on the outreach and project development tasks that the Build America Transportation Investment Center (BATIC) has performed. The BATIC is essentially absorbed into the new, larger bureau structure, and will continue to serve the purpose of outreach and project development, but now with more enhanced connections to the credit and grant functions.

Key Bureau responsibilities under the FAST Act include:

- Managing the Transportation Infrastructure Finance and Innovation Act (TIFIA) program;
- Managing the Railroad Rehabilitation and Improvement Financing (RRIF) program;
- Managing the Highway and surface freight transfer facility Private Activity Bonds PABs (cap remains at $15 billion);
- Developing standardized contracts and tools for analyzing and benchmarking alternative options for delivering Innovative Financing and Public-Private Partnership (or P3 discussed later in this chapter) procurements over the project lifecycle including unsolicited proposals;
- Reporting on implementation of identified administrative and legislative performance improvements to application process without diminishing federal oversight within 1 year; and
- Managing popular US DOT grant programs such as TIGER and FASTLANE.

The combined Bureau provides opportunities to incentivize private investment through P3 to finance and deliver transportation infrastructure projects under the credit and grant programs:

- Availability of funds for establishing innovative delivery offices to procure and administer P3 projects will kick start a long term view of P3 opportunities;
- Five-year reauthorization eases private finance appropriation risk and allows states to pursue larger infrastructure projects which in turn incentivizes and encourages private investment in P3 delivery;
- Federal fund use for a proposer stipend as well as during a projects O&M period will reduce appropriation risk in respect of funding requirements for financial close and availability payments.

Of note is the oversight and audit role of the Bureau regarding P3 procurements to ensure compliance with the credit and grant programs:

- Credit assistance for the selected funding option is predicated on public partner owner completing Value for Money (VfM) or comparable analysis (best value) to determine appropriate project delivery model;
- Focus on transparency of VfM analysis, key contractual terms and total level of federal assistance, which is required to be made publicly available at an appropriate time;
- Audit of Private Partner compliance with terms of P3 agreement within 3 years of project construction completion; and
- Audit of use of funds eligible to operate a P3 office under title 23 and chapter 53 of title 49 of the Surface Transportation Block Grant Program (Sec 1109).

For service-level planning studies, it is strongly suggested that comprehensive risk adjusted cost assessments be undertaken for potential projects. Not only is this best practice, but the FAST Act now states that credit assistance for the selected funding option is predicated on the owner completing a Value for Money or comparable analysis to determine the most appropriate project delivery model.

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 with low interest rates and long terms.

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 *cms.dot.gov/tifia/tifia-credit-program-overview*).

A TIFIA credit assistance is limited to 33 percent of reasonably anticipated eligible project costs (unless the sponsor provides a compelling justification for up to 49 percent). 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" (USDOT *cms.dot.gov/tifia/tifia-credit-program-overview*).

Possible Funding from TIFIA Loans

With the passing of the FAST Act, $1,435 Million has been authorized for TIFIA credit over the next five years. As of yet, Nebraska and Iowa have not requested nor received TIFIA loans in the past. With that in mind, the US DOT response to a Letter of Interest for credit assistance is difficult to predict with certainty and will be highly dependent on project scope and readiness for delivery.

Similar projects around the country have received various funding amounts. For example, SR 520 Floating Bridge in Washington received $300 Million (11%) in assistance on a $2,736 Million project. The Riverwalk Expansion project in Chicago received $99 Million (24%) in assistance on a $419 Million project.

PAB: Private Activity Bonds

PABs are debt instruments with State or local governments acting as conduit issuers for innovative finance of construction for projects having significant private involvement. They are a low-cost financing option that provides a public benefit through access to tax-exempt debt by private entities undertaking a project. PABs and TIFIA loans are commonly used together to bridge funding gaps for P3 projects.

Possible Funding from PABs and Example Projects

Some of the projects that have utilized PABs include: I-95 HOV/HOT Project, VA $589 Million; I-635 (LBJ Freeway), TX $615 Million; U.S. 36 Managed Lanes/BRT Phase 2, Denver Metro Area, CO $20 Million.

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 allows for faster completion with lower inflation costs. Another benefit of GARVEEs is that the cost of the credit facility is spread over the project's useful life rather than during the construction period.

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 *fhwa.dot.gov/ipd/finance/tools_programs/federal_debt_financing/garvees*).

Indirect GARVEE bonds are issued by states without Federal authorization, which makes the bond not only a non-Federal financing tool but also a method for a state to pledge its Federal funding to a project while reimbursement does not bind those funds to a specific project. **Table 8.3** illustrates the difference between direct and indirect GARVEE bonds.

Table 8.3. Direct GARVEE Bond vs. Indirect GARVEE Bond

Type	Eligible Project	FHWA Approval	Regulations	Flexibility in Using Bond Proceeds	Interest and Issuance Costs 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

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

Possible Funding from GARVEE Bonds

Currently, Nebraska and Iowa have not issued GARVEE Bonds. Other states have successfully used them for a variety of projects. Including: Phase II of the Twin 11th Street Bridge in Washington, D.C. which issued bonds for $42.94 Million; US68/KY80 Reconstruction in Kentucky which issued bonds for $106.85 Million; and various Highway and bridge projects in Ohio with $217.57 Million issued in bonds.

A current list of GARVEE activity can be found here:

fhwa.dot.gov/ipd/finance/tools_programs/federal_debt_financing/garvees/garvee_state_by_state.aspx

Public-Private Partnerships

Overview of Innovative Financing and P3 Models

Public-Private Partnerships (P3) 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 transport related assets.

There are a number of P3 alternative financing and delivery mechanisms with different contract structures, payment terms and other key variables but they all have in common the fact that a shortfall in debt capacity for a private investor's financing is equity.

For private financing to be successful, the level of available funding is based purely on the merits of the project and is not primarily dependent on the credit support of the public partner or the value of the physical assets involved. A lender is usually satisfied to look initially to the revenue profile and cash flow funding of the project from which debt will be repaid and to the assets of the project (private partner equity) as collateral.

Award criteria vary between public authorities involved with P3 projects and the percentage split between technical and financial evaluation of proposals is dependent on circumstances which are project and funding specific to each authority. The commentary in this section therefore relates to the financial impact of the various models discussed where innovative financing is required to supplement a public authority's funding.

Innovative Financing and P3 Procurement Models - Private Financing

The purpose for introducing the P3 model is to elicit private finance to bridge any funding gaps that cannot be immediately provided by the public partner, but where funds are likely to be available over time. Limitations may apply on the duration of a Public-Private Agreement (PPA) where the term is typically between 35 and 50 years within which time the lenders (bank debt/bond holders), private investors and shareholders will be expecting full repayment of their investment, including profit.

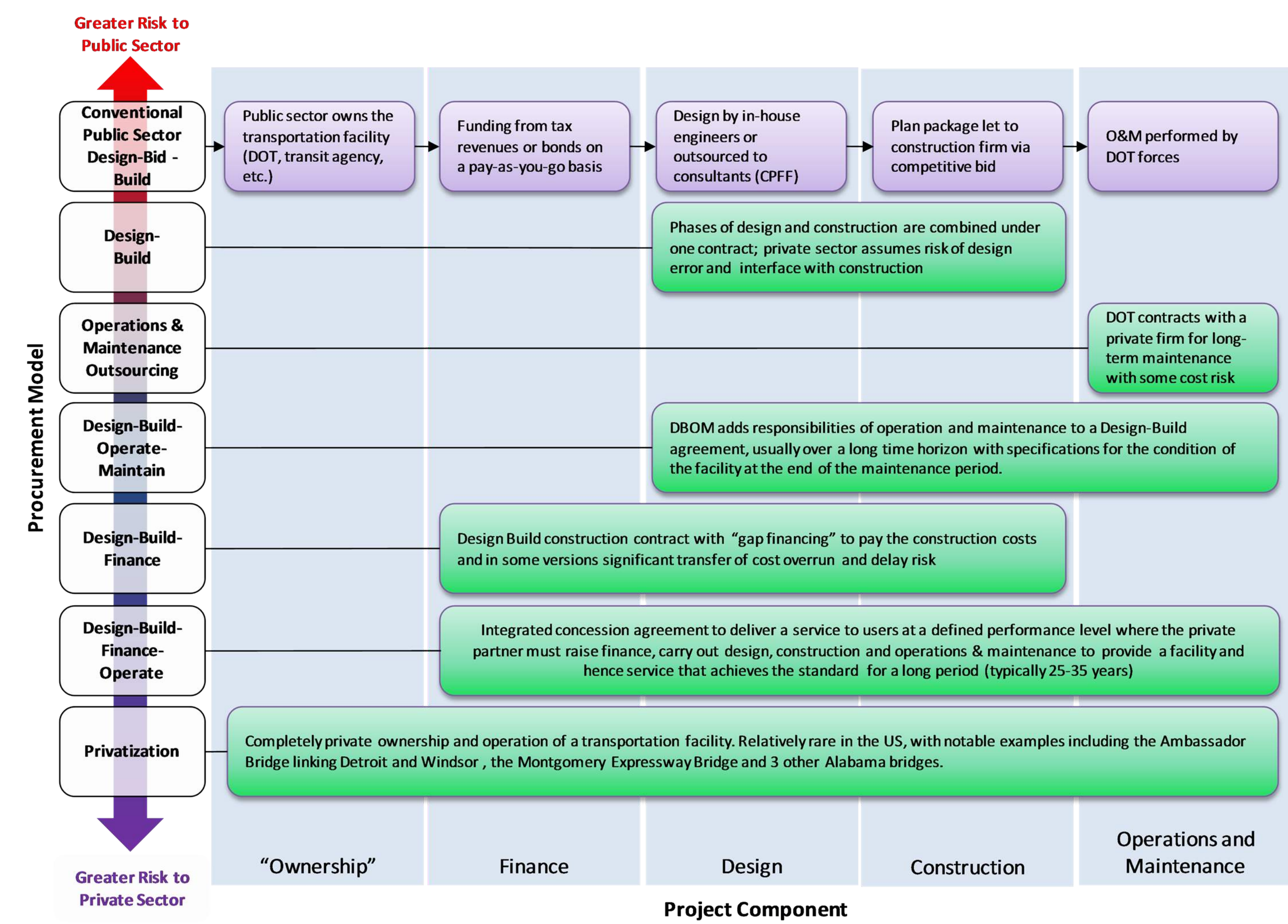
The public partner must optimize risk allocation under a PPA to achieve best value for delivery of a P3 project. However, the private partner's assumption of risk will determine its bid price while its ability to both manage risk effectively and reduce overall cost of financing, construction and operation is one of the key value drivers for P3. If the risk transferred is unmanageable, unfair, and unreasonable, the cost attributed to that risk by the private party becomes excessive compared to the benefit to the public partner.

The following P3 models all have the essential component of mobilizing private finance to develop infrastructure that would otherwise be delayed or not be considered as a priority for development. Although the options for Design-Build (DB), Design-Build-Operation-Maintain (DBOM) and other variations have not been discussed below, they form a vital element of every project evaluation to determine best value for the public authority taking into account the necessity to enact P3 legislation and the requirement to establish a P3 Office to manage and administer P3 projects. **Figure 8.2** shows the distribution of risk for various P3 options.

- **Design-Build-Finance**: Design-Build-Finance (DBF) adds up-front construction financing to the responsibilities of a conventional DB private partner.

  The private partner for a DBF provides some or all of the financing for construction, which is paid back through milestone or completion payments using public funds. These arrangements are typically short term in nature — lasting through construction completion or a short time later (5-10 years in Canada) — and thus are only beneficial where the public partner has a short-term funding gap. So beyond such a gap financing attribute, DBF's do not necessarily transfer operating or maintenance risk to the private partner but some versions transfer significant cost overrun and delay risk as well as an extended period of liability for patent and latent defects.

Figure 8.2. Distribution of Risk for Various Delivery Options



- **Design-Build-Finance-Operate-Maintain**: A Design-Build-Finance-Operate-Maintain (DBFOM) procurement offers full realization of risk sharing for design, construction, maintenance and finance between the public and private partners. While there are variants within the DBFOM concession definition, most combine the features and benefits of DB, performance-based O&M contracts, and private investor financing over long terms (with 50 years being a practical maximum length of term).

  The private investor receives compensation either through the right to collect revenue in the form of tolls, fares and ancillary revenue from customers using the project assets and/or through availability payments (payments made by the public partner from funding sources such as sales tax, federal and state funds). The revenue must ultimately cover the capital and operational expenditure (CAPEX and OPEX) and debt costs over the duration of the contract as well as providing a return on investment for the equity stakeholders.

  The private equity investors in a DBFOM typically create a special purpose vehicle (SPV) to manage delivery of the project as a concession company. The SPV receives project revenue which is leveraged to provide debt financing to pay for project development, operation and maintenance costs supported by equity contributions from the SPV.

The sharing of financial risks is a key feature of DBFOM P3s, depending on the revenue sources and agreement on risk allocation. If a private investor takes revenue risk, it assumes both the upside of demand and revenue growth, as well as the downside consequence of decline in demand. The demand/revenue risk has many facets, as customer volumes can change due to general economic conditions, the development of new competing facilities (highway/air/transit/highway), or customer diversion caused by toll/fare rate increases.

In all cases private partners are required to make direct equity investments into the SPV, typically 10 to 30 percent of the total investment, with the remaining funds leveraged in the capital market. Some private equity is infused into projects early in the construction period and replaced at or near the end of construction by capital investors with longer investment horizons and risk profiles more closely aligned with the revenue risks of the SPV. Equity investors hold a junior claim on project revenue and generate a return only if the concession covers its O&M costs, debt service, capital investments, and reserve obligations. This makes equity the most risky and most expensive form of capital, which requires a return in the order of 12 to 20 percent.

The public partner in a DBFOM retains both ownership of the transportation facility as well as significant responsibilities for regulation and oversight of the private partner's performance. Oversight responsibilities cover the scope of operation, maintenance and capital improvements made over the life of a concession. Examples include adherence to the maintenance standards established in the concession agreement which can often be more stringent than the maintenance standards used by the public partner and include a performance mechanism that permits the deduction of non-compliance liquidated damages arising from a specified failure to perform.

- **Design-Build-Finance-Operate**: A Design-Build-Finance-Operate (DBFO) alternative is similar in many respects to a DBFOM with the exception that the public partner maintains the facility upon revenue commencement with the private partner typically having a limited period of 1-2 years of liability for patent and latent defects in design and construction.

  However, the private partner's concession contract must require attention to whole life costing of the design elements to ensure the public partner understands the impact on its major and routine maintenance obligations. Amtrak is contracted in many states to perform maintenance on behalf of the public partner which can impact the private partner's ability to operate the asset in accordance with performance requirements. Relief from deductions in availability payments will likely be available, but the risk of delay and disruption then falls on the general public. In the event that the private partner has a right to collect and retain the customer paid revenue, the public partner may then be liable for compensation for the loss of revenue incurred by the private partner.

- **Design-Build-Finance-Maintain**: A Design-Build-Finance-Maintain (DBFM) alternative is also similar in many respects to a DBFOM with the exception that the public partner operates the facility upon service commencement. For this option it is essential that the public partner incorporates reasonable performance requirements that limit the effect of capital and routine maintenance activities on the service operations.

- **Privatization**: In contrast, a privatized transportation facility would be divested and sold to a private owner that would operate, finance and maintain the asset in perpetuity subject only to state regulations substantially in respect of safety and interoperability. This is rare in the U.S., with the exception of the freight highway system.

P3 Sources of Revenue

There are three basic sources of revenue support P3s: user fees, government funds and ancillary revenue.

- **User Fees**: A user or customer fee is a direct payment by public "riders/users" on a tolled highway or passenger service that is intended to cover the cost of operating the service. In many instances where the private partner has control of the fees collected under a P3 concession, the public partner subsidizes the fee rate charged which is regulated through a formula for limiting rate increases. The maximum increase in rates may be applied on an annual or multi-annual basis and is commonly tied to economic indicators such as the Consumer Price Index (CPI) or Gross Domestic Product (GDP) plus a defined percentage.

- **Government Funds**: Government funds play a large role in a P3 financial structure. Greater leverage and certainty of a public partner's annual revenue income plus state and federal appropriations can draw significant investment from a private partner. If a project has support from local private, city and county beneficiaries, it is possible that local government agencies could aid P3 funding via revenue from sales, income or property taxes.

- **Ancillary Revenues**: Ancillary revenues can be an important source of an overall financing package. An example would be advertising on safety patrol, buses, rail cars and maintenance vehicles. The typical spectrum of ancillary revenue may also include parking, gas, retail food and consumer goods concessions, advertising, development rights (air rights), utility rights, and sponsorships. In addition, consideration may be given to real estate development opportunities for underutilized buildings and vacant lots both within and outside the highway ROW.

P3 Payment Structures

Although user fee/customer revenue may cover the operation and maintenance expenditure costs for highway infrastructure projects, no-fee or highly regulated fee rates will require a public subsidy to cover all or part of the design and construction costs. The subsidy can take the form of upfront construction progress payments, milestone payments or payments spread over the life of a P3 concession period or a hybrid of all these forms of payment. Evaluation of proposer's financial submissions may require complex analysis of the proposed scheduling of payments to assess the lowest overall cost to the public partner. It is therefore incumbent on the public partner to disclose any restrictions on disbursement of funds and circumstances that may affect appropriation.

- **Construction Payments**: In the event the public partner has funding readily available and appropriated to cover the cost of construction, lump sum milestone payments or monthly percentage complete payments are common for public partners to pay for highway construction projects. Such direct payment regimes will be predicated on the P3 private partner self-certifying that the work has been completed in accordance with the technical requirements as well as identifying any non-conformance which has been, or will be, closed out over a pre-determined period.

  It is common that the services of an Independent Engineer are engaged to audit the private partner's compliance with a Quality Control and Assurance Management Plan that includes the process and procedures for managing and recording non-conformance and the rectification of defects. In addition, a payment mechanism used for highway projects under a PPA can be used to apply liquidated damage deductions in the event of persistent non-conformance or delayed rectification of defects.

Provided the private partner is taking customer revenue risk to cover debt obligations and operation and maintenance expenditure, evaluation of proposer's financial submissions is generally on the basis of the lowest design and construction cost.

- **Availability Payments (APs)** - Availability payments are a means to compensate a private investor for the provision of a transportation "service" which achieves a specified level of performance. A concession does not have to rely on the customer base, the private investor is paid over time by the public partner using tax revenues and federal funding. It is notable that under the FAST ACT, federal funds are no longer restricted to construction payments but may be utilized for operation and maintenance availability payments.

  Traditionally the private partner finances design and construction expenditure and is motivated to achieve service commencement as soon as possible in order to receive milestone availability payments (MAPs) for the construction costs and/or monthly availability payments (APs) over the life of the concession.

  The term "availability" refers to the facility being open for service and achievement of certain performance conditions, such as scheduling maintenance and renewal works outside of peak-hour customer demand and thus the system is said to be "available" and the corresponding APs are made without deductions. When the performance conditions are not fully met, such as a failure to achieve a reliable travel time requirement, the APs are reduced based on rules defined in the concession contract.

  It is important to note that the public partner disburses APs through funds sourced from its annual budget over the duration of a concession. As such, APs can be a liability not only to the private partner due to appropriation risk but also to the public partner as being counted against debt capacity. Moreover, by incurring APs with long terms, a public partner is inherently prioritizing those funds for a particular project over other projects (current, or future) that may be equally important.

  However, the disbursement of fixed APs does attach a significant degree of foreseeable certainty over the budget requirements for operating and maintaining a facility and can be used to cover capital maintenance and expansion costs which is then scheduled by the private partner.

  APs can be used to finance the entire project or to supplement P3 projects where user fees are subsidized to pay for operation and maintenance of the asset. Moreover, APs can be structured to reduce the variability of demand and revenue risks to make the project more attractive to private bidders. From the private partner's perspective, the credit quality of the project is primarily linked to the source of funds and appropriation procedure of the public partner, rather than on the achievement of forecast market demand. Evaluation of proposer's financial submissions is very often on the basis of the lowest annual AP submitted.

- **Construction and Availability Payment Hybrid**: This hybrid version has been used internationally in the event that federal as well as local private, city and county beneficiaries have appropriated a proportion of public funds primarily for construction. The total funds (not sources) are identified within the final RFP issued to proposers as being available as either milestone or progress payments during the design and construction of the project. Other restrictions on use may be disclosed such as a percentage being reserved for payment upon the date of revenue commencement. Proposers use this information to finalize their financing plan for MAP and AP disbursements and evaluation of financial submissions is made on the basis of the lowest overall cost to the public partner

A Note on Public-Private Partnerships in Nebraska

Although Nebraska has not passed legislation or executive orders to underpin P3 development, this source of innovative finance would be invaluable to the NDOR in bridging the funding gap for its pipeline of projects. The discussion on payment structures provides a basket of alternative finance options which may be considered for future procurement of infrastructure within the MAPA region and will drive the necessity for P3 legislative amendment.

In order for a project to demonstrate the best value selected option, a detailed analysis will be required to calculate a risk adjusted costs for the options considered. The key elements of whole life project design, construction, operation and maintenance cost as well as sources of funds, finance and revenue, will dictate the final selection of the best value delivery and payment structure. Other considerations to take into account will be market demand and competitive interest which will require a detailed evaluation of projects to the level of investment grade for demand and revenue as well as a financial model analysis of alternative funding and finance options.

The mechanism for final selection, to satisfy the requirements for federal credit assistance, will be a value for money (VfM) or comparable analysis to demonstrate the basis for the public partner's decision whether to procure a project as a P3 or to use a traditional public sector delivery method, such as Design-Bid-Build (DBB) or Design-Build (DB).

A P3 project must demonstrate value for money if it provides the lowest (or optimum) level of costs (adjusting for any differences in service quality and risks) over the whole asset life compared with procuring the project using a traditional delivery method

Key Takeaways

The assessment of traditional transportation funding sources for the region, compared to the estimated costs required for implementing Strategy Package 7, indicated a funding gap of approximately $4 billion by 2040. Based on a preliminary assessment of Strategy Package 7 by NDOR, there are no clear project candidates for an innovative funding approach. In that case, an immediate next step for NDOR might be to explore the local political appetite for incremental retail sales and property tax levies.

An aggressive increase in local funding sources has the potential to make up a large portion of the anticipated funding gap. If the tax levy approach is not feasible or insufficient, then NDOR may revisit the pavement and bridge projects included in Strategy Package 7 with the aim of identifying one or two pilot projects that may meet the features listed for Innovative Funding Sources, such as dedicated revenue sources. For example, can NDOR identify key bridge crossings and / or roads that may be candidate for tolling? Would the anticipated traffic volume (while considering demand elasticity) be enough to support credit instruments and / or public / private partnership arrangements?

Chapter 9 - Project Prioritization

The performance measure approach used to identify and assess the Regional Strategy Packages was the basis for prioritizing projects within the preferred Regional Strategy Package. The intent of this process was to identify which tier of projects and strategies do the best job of addressing regional performance goals. This project-level prioritization approach is critical for two purposes:

- Assisting NDOR and MAPA in identifying the order in which projects may be implemented based on funding levels.
- Providing a basis for determining which projects fit within the "fiscally-constrained" element of MAPA's upcoming 2050 LRTP. As outlined in **Chapter 8**, the costs of the preferred Regional Strategy Package outweigh the traditional anticipated transportation revenues for the region through the year 2040 (and 2050 for the purposes of the LRTP). Thus, only the highest priority projects should be included in the 2050 LRTP's fiscally-constrained plan.

Project Prioritization Methodology

Projects were prioritized based on the performance measures identified for the system (as discussed in **Chapter 6**). Measures appropriate for application at the project level were identified for each of the system-level performance measures. The project prioritization methodology can be summarized in these bullets:

- Projects were prioritized within modes, but not across modes. For instance, transit projects were prioritized against each other, but not against roadway projects.
- Not all project prioritization metrics were appropriate for all modes. Some are roadway specific, others pertain more directly to transit projects.
- By their nature, system-level weights and project-level weights are related, but there are opportunities to use slightly different measures with these different scales of analysis. Thus, the project-level performance metrics directly relate to the performance measures identified for the system in **Chapter 6**, but were tailored for project-level assessment. The weights for each of the performance metrics were consistent in terms of proportionality to their related system-level performance measure weights.
- Bicycle and pedestrian projects were not prioritized. Those projects identified in the regional Bicycle and Pedestrian Master Plan were carried forward into the MTIS vision plan.

Table 9.1 provides the scoring approach used for the roadway projects.

Table 9.2 provides the scoring approach used for the transit projects.

Table 9.1. Roadway Project Prioritization Scoring Methodology

Performance Metric	Description	Weight per Measure
Delay	Two (2) measures of corridor Delay: • Hours of Delay per Mile in 2040 without improvements • Hours of Delay per Mile improvement with project implemented.	66% (split evenly between two measures)
Accessibility Change	Two (2) measures of Accessibility: • Percentage of regional jobs accessible via 15-minute automobile commute (region-wide) • Percentage of regional jobs accessible via 15-minute automobile commute (EJ TAZs)	15% (6% all region, 9% EJ TAZs)
Travel Reliability	Evaluation of 2015 corridor reliability scores (80th percentile travel time compared to median travel time)	9%
Freight	2040 forecasted truck flows	6%
Pollutant Emissions	MOVES model estimated NOXs and VOC change with project.	4%

Table 9.2. Transit Project Prioritization Scoring Methodology

Performance Metric	Description	Weight per Measure
Development Density	Two (2) measures of development density: • Households per mile within ¼ buffer of transit route. • Jobs per mile within ¼ buffer of transit route	12%
Mode Share	Three (3) measures of ridership: • Daily route ridership (2040 forecasted) • Daily route ridership per mile (2040 forecasted) • Daily system ridership (2040 forecasted)	15%
Environmental Justice Proximity to Transit	Households from EJ TAZs within ¼ buffer of transit route.	23%
Accessibility Change	Two (2) measures of Accessibility: • Percentage of regional jobs accessible via 45-minute transit commute (region-wide) • Percentage of regional jobs accessible via 45-minute transit commute (EJ TAZs)	31% (12% all region, 19% EJ TAZs)
Delay	Change in systemwide delay due to transit project.	19%

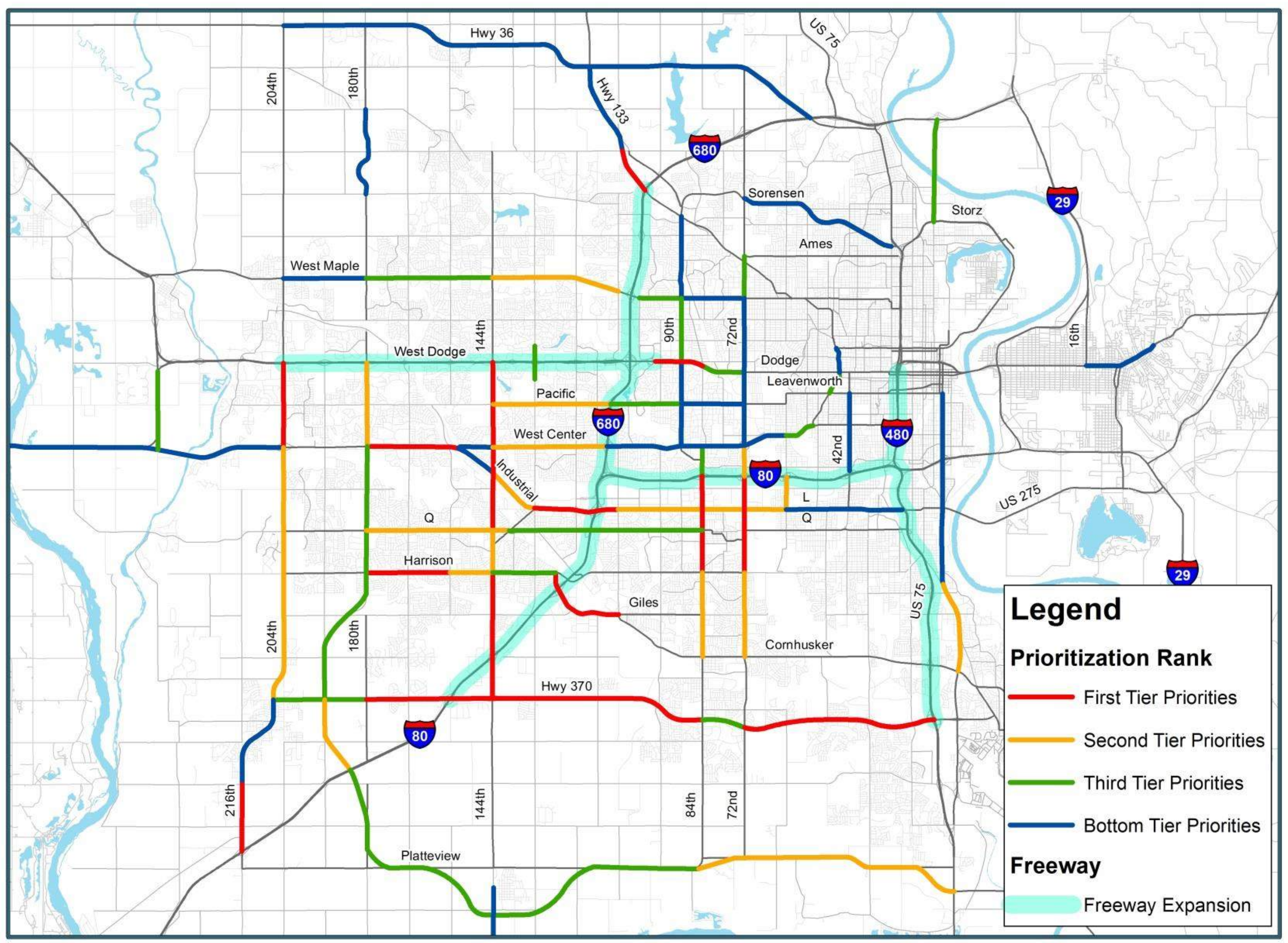
Prioritization Results

The MAPA regional travel demand model, Geographic Information Systems (GIS) datasets, and other tools and data were used to apply the prioritization methodology previously described. The results of the prioritization are shown in three separate figures:

- **Figure 9.1** illustrates the prioritization results for 93 non-freeway roadway projects included in Strategy Package 7. Non-freeway roadway prioritization results are shown by priority tier.
  - The top 20 priorities are shown as “First Tier Priorities”
  - Priorities 21-40 as “Second Tier Priorities”
  - Priorities 41-60 as “Third Tier Priorities”
  - Priorities 61-93 shown as “Bottom Tier Priorities”

  Note that these priorities are ranked based on the assumption that all freeway segments from Strategy Package 7 have been constructed.

Figure 9.1. Non-Freeway Roadway Prioritization Results

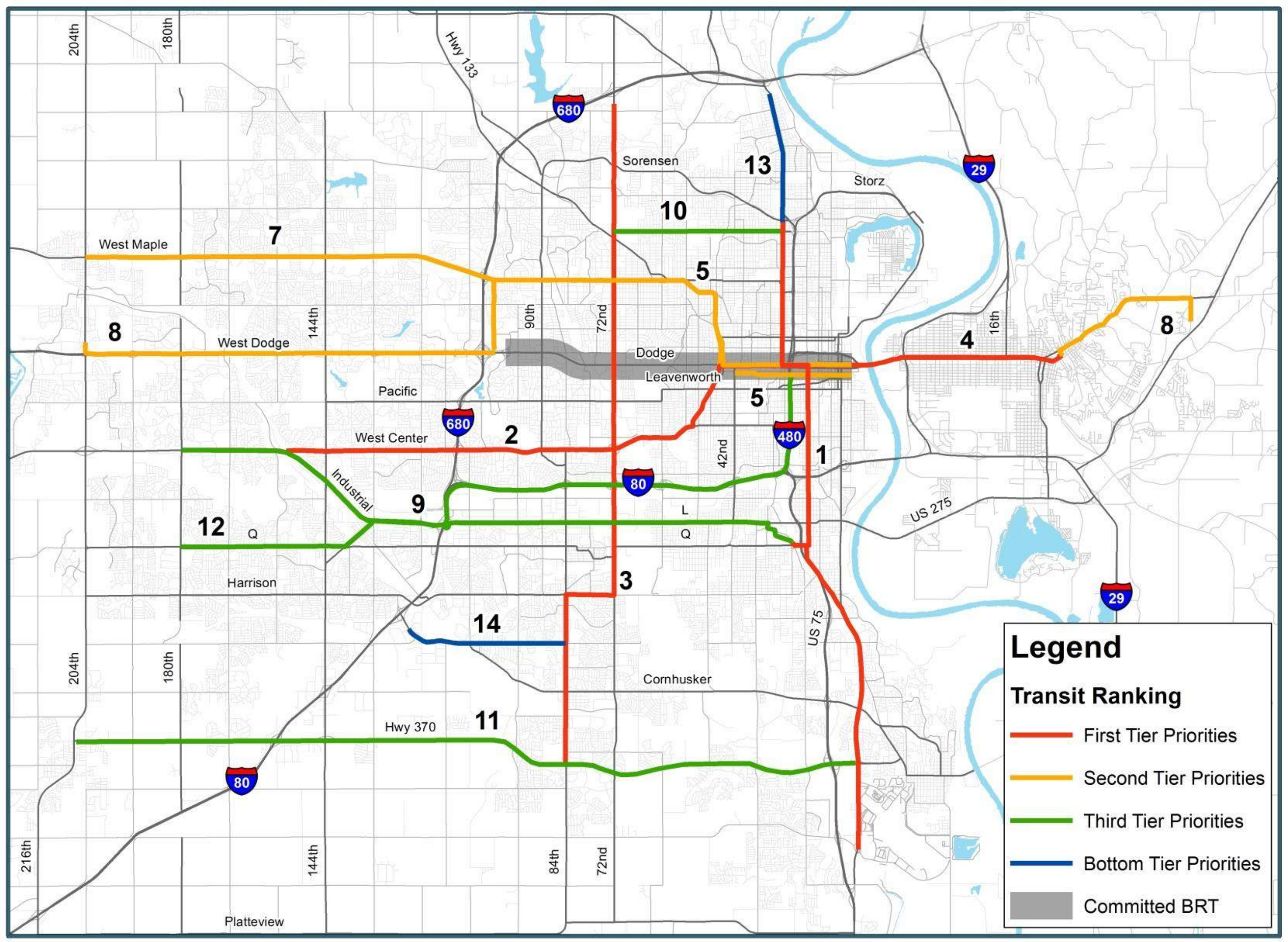


- **Figure 9.2** illustrates the prioritization results for the freeway corridors. Each of the 6 corridors were analyzed as a single entity. This is somewhat of a simplification, as these corridors will likely be a series of construction projects with different levels of benefits. Thus, the intent of the prioritization is to help identify which sets of corridor improvements generally are the most critical from a regional performance perspective. Note that these priorities are ranked based on the assumption that all non-freeway segments from Strategy Package 7 have been constructed.

Figure 9.2. Freeway Corridor Prioritization Results

- **Figure 9.3** illustrates the prioritization results for the transit projects. All of the transit projects were evaluated individually with only the existing bus routes and committed BRT line in place. Some of the lower-scoring projects such as the North 30th Street feeder extension, the Giles Southport feeder extension, and the Ames 24th-72nd Connector, were evaluated as stand alone projects. This was done for consistency with other projects. It should be noted that these projects, while secondary priorities in comparison to the core 24th Street and 72nd Street corridor projects they feed into, likely have some prioritization benefits that are somewhat under-represented in this analysis. However, in relative terms they are likely still on the lower end of overall system benefits / priorities.

Figure 9.3. Transit Project Prioritization Results



Key Takeaways

The projects in the preferred strategy package were prioritized, based on the performance measures used earlier in the study. The intent of this process was to identify which tier of projects and strategies do the best job of addressing regional performance goals. The prioritization results for arterials, freeways, and transit will be used to assist MAPA in narrowing down a project list to reach a fiscally constrained LRTP.

Chapter 10 - Focused Freeway Corridor Assessment

Phase 2 included the development and evaluation of initial freeway improvement concepts that are consistent with the Preferred Regional Strategy Package. The purpose of this effort was to identify improvement concepts that will be carried forward to Phase 3 where additional corridor-level alternative refinement, design and evaluation will be performed in order to identify recommended improvement options. Phase 3 will also include the development of an Implementation Plan for the freeway system that will address corridor prioritization, project prioritization, phasing plans and a funding plan for the recommended improvement options.

Traffic Forecast Refinement

Refined traffic forecasts were developed for the specific purpose of developing and evaluating the freeway improvement concepts. These forecasts reflect implementation of all of the projects included in the Preferred Regional Strategy Package (Strategy Package 7). Thus, the volumes used to develop and evaluate the freeway improvement concepts represent 2040 Build volumes. However, only one volume set was developed and used to test all Alternatives and Sub Options. The refined traffic forecasts also assumed symmetrical improvements in each direction in each corridor. For example, the traffic forecasts in the West Dodge Road corridor reflect freeway widening in the eastbound and westbound directions even though an alternative that considers improvements in the westbound direction only was developed and evaluated (discussed later in this chapter).

Forecasts of 2040 Build segment ADTs were developed using the existing segment ADTs in combination with 2040 travel demand model output for the Preferred Regional Strategy Package. A post-processing approach was used, whereby the level of base year model variation compared to observed base year traffic counts was applied to 2040 model output to provide a 2040 ADT forecast for each freeway segment.

Growth ratios from 2010 to 2040 were developed by dividing the 2040 Build segment ADTs described above by existing segment ADTs. The balanced set of base year volumes used for the existing traffic operations analysis in Phase 1 were then increased by these growth ratios. Ramp terminal turning movements were grown to match cross street and ramp forecasted volumes. The resulting peak hour 2040 Build volumes used to develop and evaluate the freeway improvement concepts are included in **Appendix B**.

Guiding Principles

A number of guiding principles were applied during the development of freeway improvement concepts. Some of these principles were articulated by NDOR early in the process while others “emerged” during on-going coordination with NDOR as the improvement concepts were developed and evaluated. A summary of the guiding principles includes the following:

- Regional Strategy Package 7 was originally developed to address the “full operational needs” of the freeway system, whereas some other packages were developed to address “targeted operational needs”. However, not all of the needs identified in Phase 1 are being addressed by the current freeway improvement concepts based on costs and impacts. Thus, the current concepts would be better described as addressing “targeted operational needs” in various corridors.
- Prioritization of the Omaha area freeway system is listed below. The corridor priority will be considered in evaluating the relative importance of maintaining traffic flow in accord with operational criteria (e.g. level of service).
    - I-80 (highest priority)
    - I-480 and I-680 (next highest priority)
    - West Dodge Road and US-75 (lowest priority)
- For the West Dodge Road corridor (US 6), a higher emphasis is placed on expanding US 6 (in the WB direction) to move traffic away from I-680 to minimize the potential for traffic to back onto I-680. A lesser emphasis is placed on expanding US 6 (in the EB direction) which would likely result in pushing more traffic towards I-680.
- Desirable HCM Level of Service ‘D’ or better.
- Potential Improvements with high costs or ROW impacts must show significant improvements in operations to be carried forward for consideration. In most cases, traffic operations would need to improve to Level of Service ‘C’. Some preliminary concepts were eliminated based on traffic operations criteria before further development of the concept.
- If desired LOS can’t be provided on both the mainline and adjacent collector-distributor (C-D) road, traffic operations on the mainline is a higher priority than traffic operations on the C-D road.
- Barriers that would restrict or redirect access to the freeway system from service interchanges are not desirable because they would restrict such access during off-peak periods when entering traffic is reduced and traffic operations are acceptable.
- Where partial cloverleaf (parclo) interchange configurations are preserved but impacted by mainline widening, existing loop ramp radii should be maintained if possible.
- Selective ramp metering may be employed to control the amount of traffic entering the freeway system which may require that traffic use alternate routes or alternate interchanges.
- The closure of select service interchanges and/or service interchange ramps (permanent or peak period only) may be employed to maintain freeway operations.
- Based on the study horizon traffic forecasts (Year 2040), major system interchange improvements are not needed within the MTIS planning period.

Non-Traditional Corridor Strategy Assessment

In addition to widening concepts, a number of non-traditional corridor strategies were considered in Phase 2 including:

- Managed Lanes
- Ramp Metering
- Hard Shoulder Running
- Bus on Shoulder
- Dynamic Lane Use / Merge Control
- Ramp Closures

Managed Lanes

The concept of managed lanes may vary in specific definition from one agency to the next, but all the definitions have common elements:

- The managed lane concept is typically a "freeway-within-a-freeway" where a set of lanes within the freeway cross section is separated from the general-purpose lanes.
- The facility incorporates a high degree of operational flexibility so that over time operations can be actively managed to respond to growth and changing needs.
- The operation of and demand on the facility is managed using a combination of tools and techniques in order to continuously achieve an optimal condition, such as free-flow speeds.
- The principal management strategies can be categorized into three groups: pricing, vehicle eligibility, and access control.

The types of managed lanes considered during Phase 2 included HOV lanes, HOT lanes, reversible lanes (free or tolled) and dedicated truck lanes. Each of these concepts offers unique benefits depending on project goals such as increasing transit use, providing choices to the traveling public, or generating revenue. The appropriateness of a lane management strategy may vary depending on the following factors:

- Whether the strategy is intended as a long-term solution or an interim solution
- Whether the strategy is implemented on new capacity or an existing facility
- The availability of ROW
- Current physical and operational characteristics in the corridor
- Environmental and societal concerns.

Source: FHWA

Based on existing and future congestion levels, the applicability of managed lanes in the Omaha metropolitan area was limited to the I-80 and West Dodge Road corridors. A planning-level assessment of the applicability of managed lanes in these corridors was conducted. The findings are summarized in **Table 10.1**.

Table 10.1. Managed Lane Applicability

Managed Lane Concept	Applicability on I-80	Applicability on West Dodge Road
Reversible Lanes (Free and Tolled)	Likely limited benefit Peak directional factors are close to 50%/50% between I-680 and I-480. Peak directional factors between Giles Road and I-680 are 55%/45% (PM) and 59%/41% (AM). The latter is close to the target range for reversible lanes.	Likely limited benefit ROW is limited. A reversible lane requires more lateral width (separation barriers, shoulders, etc.) than a General Purpose Lane. Peak directional factors east of 144th Street are in the 55% to 60% range.
HOV Lanes / HOT Lanes	Potential benefit Planning-level assessment indicates that by 2040, adding a tolled lane on I-80 (216th to I-480) might be effective in the peak direction compared to No-Build. For toll users, it could save 19 minutes and cost $1.80 while a new General Purpose Lane could save 10 minutes.	Potential benefit Planning-level assessment indicates that by 2040, adding a tolled lane on West Dodge Road (204th to I-680) might be effective in the peak direction compared to No-Build. For toll users, it could save 10 minutes and cost $1.20 while a new General Purpose Lane could save 7 minutes.
Dedicated Truck Lanes	Likely limited benefit 6%-7% heavy trucks through highest volume portion of I-80.	Likely limited benefit 2% heavy trucks through highest volume section of West Dodge Road.

Additional considerations regarding managed lanes include:

- It would be extremely difficult to carry managed lanes through the I-80/I-680 System Interchange and the I-80/I-480 System Interchange based on the current configuration of these interchanges.
- Without the ability to carry a managed lane through a system interchange, the subsections of I-80 west and east of the I-80/I-680 system interchange are likely not of adequate length to attract users.
- There are few opportunities for provide direct connections within System Interchanges to other freeway corridors which would also limit the attractiveness of the managed lanes to users.
- Based on a telephone survey conducted in Phase 1, the public is generally not supportive of tolled facilities.

For the reasons mentioned previously, managed lane concepts were ultimately removed from further consideration in Phase 2.

Ramp Metering

Ramp metering is a potential tool to address commonly occurring congestion and safety issues. Despite initial opposition and skepticism from various stakeholders, ramp metering has been deployed, sustained, and even expanded in many metropolitan areas across the United States.

Ramp meters are traffic signals installed on freeway entrance ramps to control the frequency at which vehicles enter the flow of traffic on the freeway. Ramp metering reduces overall freeway congestion by managing the amount of traffic entering the freeway and by breaking up platoons that make it difficult to merge onto the freeway. Vehicles traveling from an adjacent arterial onto the ramp form a queue behind the stop line. The vehicles are then individually released onto the mainline, often at a rate that is dependent on the mainline traffic volume and speed at that time. The configuration can be altered to accommodate transit and HOV policies or existing geometric limitations. Other typical features of ramp metering include the following:

Hours of Operation

- Typically by time of day
- Sometimes based on traffic operations

Metering Rate

- 240 - 1000 vehicles per hour (vph)

Multi-Lane Release Sequence

- Typically alternating
- Sometimes both lanes simultaneously

Queue Management

- Can provide additional queue storage on the arterial
- Dumping the entire queue is not recommended.
- Use detection to increase the metering rate to reduce the queue

Criteria for Implementing Ramp Meters

- Mainline flow of at least 1200 vehicles per hour per lane (vphpl)
- Ramp flow of at least 240 vph for 1-lane ramp and 400 vph for a 2-lane ramp
- Mainline speed of less than 30 mph in the peak hour
- Accident rate in the vicinity of the ramp in excess of 80 per hundred million vehicle miles

Source: FHWA

Queue Storage Requirements

- Minimum of 450 feet
- New ramp construction - able to store 10% of the design year peak hour traffic on the ramp
- Retrofit - able to store 5% of the current peak hour volume on the ramp
- Some applications may also require stopping distance for traffic approaching the back of the queue.

Merging Speed/Length

- Measured from the meter stop bar to the painted nose.
- Most states require that the merging speed be within 5 mph of the freeway mainline operating speed.
- Operating speed defined as the speed at which vehicles are observed operating during free flow conditions. The 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed. Posted speed can also be used.

Planning-level traffic analysis were conducted in Phase 2 to determine the potential benefits of ramp metering in each of the freeway corridors. The analyses showed that all of the freeway corridors could benefit operationally from ramp metering during peak periods and in the peak traffic direction. Implementation could occur on a wholesale basis across the entire region or in targeted corridors and at targeted interchanges (NDOR preference). A primary consideration will be the availability of adequate ramp length to provide minimum storage requirements. In the West Dodge Road corridor, for example, many of the existing entrance ramps between 156th Street and 132nd Street are relatively short. In these cases, implementation would involve ramp widening upstream of the ramp meter signal to provide queue storage. However, there would still exist the potential for a storage shortfall even with widening and thus requiring additional storage be provided on the arterial to prevent spillback into the arterial through lanes.

Based on the preliminary analyses conducted in Phase 2, ramp metering strategies will be carried forward to Phase 3 for further analysis and consideration.

Hard Shoulder Running

Part-time shoulder use, often called Hard Shoulder Running (HSR), may be an effective strategy for operations reliability of a facility in particular situations. In this context, part-time shoulder use is defined as:

- The shoulder is used for travel only during those times of day when the adjoining lanes are likely to be heavily congested (e.g., during peak hours, when congestion is detected, or when general purpose lanes are closed for construction or incidents).
- When not needed as an additional travel lane, the shoulder will be restored to its original purpose as a “shoulder,” and the basic physical characteristics of the shoulder are retained and recognizable.

The term “part-time” does not require that the use of shoulders be “short-term” or that it be discontinued by some fixed date. Although part-time shoulder use may be used as an interim treatment while a conventional project (e.g., construction of additional lanes) awaits funding or completion, it may also be used indefinitely. Other considerations and features include the following:

Shoulder Option

- Right shoulder
- Left shoulder

Vehicle-Use Options

- Open shoulder to transit vehicles only
- Open shoulder as an HOV lane that permits carpools and transit vehicles to use it
- Open shoulder as a HOT lane that allows vehicles to pay a toll to use it if they don’t meet HOV occupancy requirements
- Open shoulder to all vehicles except trucks
- Open shoulder to all vehicles
- Open shoulder to slow moving trucks in rural mountainous areas

Source: FHWA

Operating Options

- Dynamically open shoulder when certain congestion thresholds are reached
- Statically open shoulder during specified historical peak periods (time of day)

Speed Control Options

- Same speed limit as other lanes (at posted speed limits).
- Same speed as other lanes (at a reduced speed relative to normal posted speed limits)
- Lower speed limit than other lanes.

Based on existing and future congestion levels, the applicability of HSR in the Omaha metropolitan area was limited to the I-80 and West Dodge Road corridors. A planning-level assessment of the applicability of HSR in these corridors was performed. The following issues were identified as obstacles to the implementation of HSR:

Design Issues

- The existing shoulder widths on I-80 and West Dodge are inadequate to accommodate HSR. The existing width of the right shoulder is generally 10.0 feet in the I-80 and West Dodge Road corridors. The width of the left shoulder is generally 12.5 feet on I-80 and 9.0 feet on West Dodge Road (measured to the face of the barrier). In both corridors, storm drain inlets are located within the left shoulder.
- HSR on the right shoulder is not compatible with two-lane exit ramps which exist in large numbers in both corridors.
- Loop entrance ramps that add an auxiliary lane present unique challenges with HSR on the right shoulder.
- Carrying HSR through system interchanges can be difficult especially if shoulder width is already non-standard.
- Clear zone protection may need to be redesigned and reconstructed to accommodate vehicles on the shoulder.
- Shoulder pavement depth must be able to handle normal traffic.

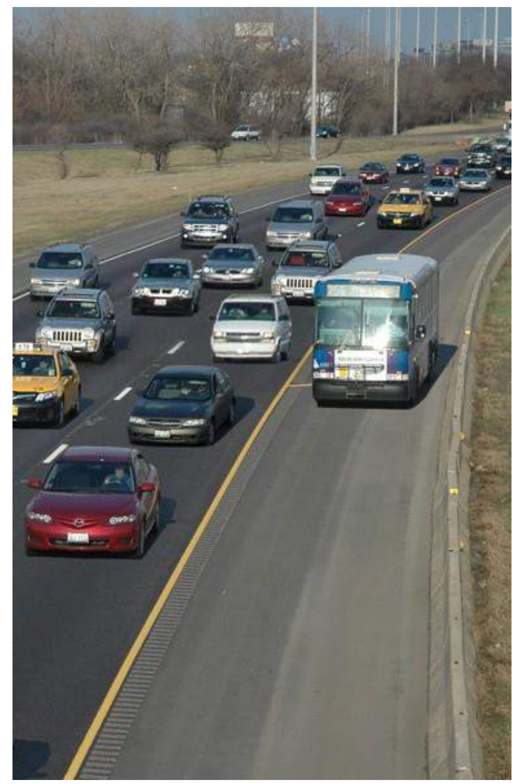
Other Potential Issues

- Regular sweeping would be necessary to prevent the accumulation of debris on the shoulders.
- Snow removal methods and policies may need to be modified.
- During HSR operation, disabled vehicles and emergency situations would limit the effectiveness of HSR.
- Law enforcement stops during HSR would need to take place at other locations.
- Need to address potential weaving at the end points of HSR.

For the reasons cited previously, HSR (open to all vehicles) was ultimately removed from further consideration in Phase 2.

Bus on Shoulder

Another subset of part-time shoulder use, Bus on Shoulder (BOS) operation, allows authorized transit vehicles to use the shoulder to avoid congestion in the general purpose lanes. This application improves person-throughput along a corridor and incentivizes the use of mass transit. BOS is unique from other part-time shoulder use strategies, as low volumes on the shoulder (compared to opening the shoulder to general traffic) minimize the need for updated signing, pavement markings, and ITS equipment. BOS also minimizes the impacts for emergency response to incidents and storage of broken down vehicles. While most BOS applications utilize the right shoulder, systems in Chicago, Cincinnati, and Columbus utilize the left shoulder.

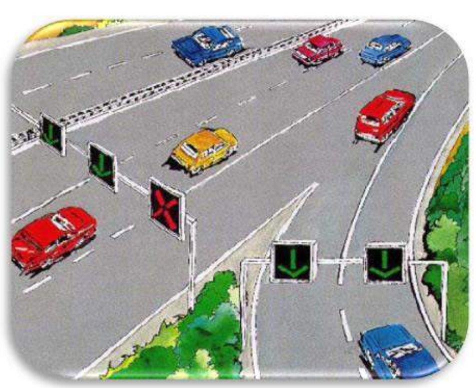


Source: FHWA

MAPA and Metro have expressed interest in BOS operations on I-80 and West Dodge Road. In particular, Metro believes that BOS could make transit very attractive in these corridors and that implementation costs would be relatively low. Left-shoulder running is far more attractive from an operational standpoint to avoid the interference between buses and other vehicles merging and diverging at interchanges. Metro also believes that BOS could be justified during all hours of transit operations as opposed to peak periods only.

Although BOS would face similar challenges to those identified for HSR in the previous section, these challenges would be partially offset or mitigated by the relative infrequency of buses using the shoulder and by requiring that bus drivers be trained in the use of BOS. Given the strong interest expressed by MAPA and Metro, BOS will be considered further in Phase 3.

Dynamic Lane Use / Merge Control



Source: FHWA

Dynamic Lane Use / Merge Control was investigated in Phase 2 as a means to address congestion in areas where adding additional lanes may be challenging. This concept is applicable to situations where the peaking characteristics of two merging traffic streams are opposed to one another. That is, one traffic stream may exhibit high traffic volumes in the morning peak period but not in the afternoon peak hour while the other traffic stream exhibits high traffic volumes in the afternoon peak period but not in the morning peak period.

The concept involves “passively” closing lanes that are not needed during peak periods to allow heavier movements to merge easily with traffic stream. In the figure shown on the left, the right mainline lane is passively closed using a dynamic overhead lane use sign during a peak period when this lane is not needed. During this same peak period, both lanes on the merging ramp are needed. The operations would be reversed during the other peak period. Since passive control will not physically prevent a vehicle from using the closed lane, it is possible that some vehicles may continue to use the closed lane. This would result in some degree of low-volume merging. This strategy was considered at the following locations on the freeway system and are described in greater detail later in this chapter:

- Merge of the northbound US-75 ramp to westbound I-80 with the ramp from southbound I-480 to westbound I-80
- Merge of southbound I-680 with the ramp from westbound West Dodge Road to southbound I-680

Based on the potential operational benefits and potential construction cost savings, this strategy will be investigated further in Phase 3.

Ramp Closures

Ramp closure involves the closure of a freeway ramp or ramps on a temporary, intermittent, or permanent basis. The closure of specific ramps and/or interchanges was considered in Phase 2 as a means of providing improved traffic flow in situations where the proximity of a ramp or interchange to an adjacent ramp or interchange results in poor mainline or weaving operations.

According to FHWA, ramp closure has the greatest potential impact on existing traffic patterns and but is rarely implemented as a long-term strategy. The potential for significant impact is especially true for full or permanent ramp closures, where access to the ramp is no longer provided, requiring traffic to seek alternative routes to access the freeway. In many cases, full ramp closure involves the physical removal of the ramp roadway so as not to give the false impression that the ramp will be re-opened. Temporary or intermittent ramp closures usually involve deploying automatic gates or manually placing barriers at the ramp entrance to prevent access to the ramp. Due to the relatively high impact on existing traffic patterns, ramp closures are seldom considered for deployment if other viable options are available. Full ramp or interchange closure is best applied as a last resort for severe operational or safety problems.

Permanent or peak period closure of the following ramps or interchanges was considered in Phase 2:

- I-80 & 42nd Street (to/from the east only) due the proximity of 42nd Street to the I-80/I-480/US-75 System Interchange
- US-75 & F Street (entire interchange or to/from the north only) due to the proximity of F Street to the I-80/I-480/US-75 System Interchange
- I-480 & Martha Street (to/from the south only) due to the proximity of Martha Street to the I-80/I-480/US-75 System Interchange
- I-680 & Pacific Street (to/from the north only) due to the proximity of Pacific Street to the I-680/West Dodge Road System Interchange
- West Dodge Road & 137th Street (entire interchange) due to the proximity of 137th Street to 144th Street and to 132nd Street
- West Dodge Road & 150th Street (entire interchange) due to the proximity of 150th Street to 156th Street and to 144th Street

Ramp or interchange closures at the West Dodge Road interchanges with 137th Street and with 150th Street are no longer being considered due to commitments made by NDOR. However, based on the potential operational benefits, ramp or interchange closures will be investigated further in Phase 3 for the remaining locations noted above.

Corridor Alternatives and Sub Options

Corridor Alternatives and Sub Options that were developed and evaluated in Phase 2 and will be carried forward to Phase 3 are summarized in this section. These Alternatives and Sub Options generally add capacity to the corridors through the addition of mainline general purpose lanes and/or auxiliary lanes or address weaving or other operational issues through the reconfiguration of interchanges and/or ramp configurations. For the purposes of this report, Alternatives are defined as strategies applied to an entire corridor or substantial length of a corridor. Sub Options are defined as strategies applied to a specific area within a corridor.

A high-level summary of interchange configurations is included in this section. Additional discussion of interchange needs and alternatives is provided in subsequent sections beginning on **Page 64**. Concept drawings, typical sections, operational figures and evaluation summaries are included in the Appendices for each Alternative and Sub Option.

I-80 Corridor

Alternatives and Sub Options for the I-80 corridor are shown in **Table 10.2**.

Table 10.2. I-80 Alternatives and Sub Options

I-80		
Alternative	**Name**	**Description**
1	Mainline Widening	Addition of 1 or 2 mainline lanes plus auxiliary lanes depending on location. DDI's at N-31, N-370, N-50 and 42nd Street
2	Collector-Distributor System	Equal to Alt. 1 except CD Roads instead of additional mainline lanes from west of 84th Street to west of 42nd Street Inside = 3 lanes, Outside = 3 lanes + aux lanes; Ramps to the west of 42nd Street tie into the CD roads Ramps to the east of 42nd Street tie into the mainline
Sub Option	**Name**	**Description**
A	7 lane widening over 42nd Street (Both Directions)	Widen EB/WB I-80 to 7 lanes over 42nd Street
B	EB I-80 5 lane Diverge to I-480 / US-75	7 lanes to 3 lanes & 5 lanes at I-80 / I-480 diverge 5 lanes to 3 lanes & 2 lanes at I-480 / US-75 diverge
C	SB I-480 / NB US-75 Dynamic Merge to WB I-80	Interior merge with dynamic lane assignment
D	42nd Street Ramp Closure	Permanently close 42nd Street ramps to/from the east
E	Ramp Metering	Candidate locations: AM & PM: All entrance ramps at 84th Street, 72nd Street, 60th Street & 42nd Street
F	Additional DDI Interchanges	DDI's at 84th Street, 72nd Street and 60th Street

Note: All I-80 Sub Options are shown using Alternative 1 as the base but would also be compatible with Alternative 2.

Alternative 1

Alternative 1 would widen I-80 between the I-80 interchange with N-370 and the I-80/I-480/US-75 System Interchange. Key features include:

- One (1) additional EB and WB through-lane between N-370 and the I-680 Interchange.
- WB auxiliary lane added between Giles Road and Q Street.
- Two (2) additional EB through-lanes between I-680 and 42nd Street.
- Two (2) additional WB through-lanes between I-680 and 60th Street.
- One (1) additional WB through-lane between 60th and 42nd Streets.
- Additional arterial street through-lanes provided at most service interchanges.
- N-31, N-370, N-50, & 42nd Street interchanges converted to diverging diamond interchange (DDI) configurations.
- L, 84th, 72nd, & 60th Street interchange parclo and full cloverleaf configurations perpetuated.

Alternative 2

Alternative 2 is identical to Alternative 1 in most areas of the corridor but would provide a Collector-Distributor Road System from west of 84th Street to west of 42nd Street. Key features include:

- Alternative 2 is identical to Alternative 1 west of the I-80/I-680 System Interchange.
- Two (2) additional EB and WB through-lanes between the I-680 and 84th Street interchanges.
- An EB collector-distributor (C-D) road runs from just west of 84th Street to just west of 42nd Street. Three (3) EB mainline through-lanes are barrier separated from three C-D road lanes plus auxiliary lanes.
- A WB C-D road runs from 84th Street to 42nd Street. Three (3) WB mainline through-lanes are barrier separated from three C-D road lanes plus auxiliary lanes.
- 84th, 72nd, & 60th Street interchange partial clover leaf configurations perpetuated.
- 42nd Street converted to a diverging diamond configuration.

Sub Option A

Sub Option A focuses on the section of I-80 between 42nd Street and the I-80/I-480/US-75 System Interchange. The purpose of this Sub Option is to provide an additional EB mainline lane approaching the I-480/US-75 fork as well as an additional WB mainline lane over 42nd Street to reduce potential backups into the I-80/I-480/US-75 System Interchange (compared to Alternatives 1 and 2). Key features include:

- One (1) additional EB through-lane between 42nd Street and the I-480 fork for a total of seven EB lanes.
- Lane balance is not provided at EB I-80/I-480 major fork.
- Three (3) EB I-80 through-lanes and four I-480 exit lanes at major fork.
- One (1) additional WB through-lane over 42nd Street

Sub Option B

Sub Option B also focuses on the EB major diverge at the I-80/I-480/US-75 System Interchange. The purpose of this Sub Option is to provide another option for providing an additional mainline lane approaching the diverge (compared to Alternatives 1 and 2). Key features include:

- One (1) additional EB through-lane between 42nd Street and the I-480 fork for a total of seven EB lanes.
- Lane balance is provided at EB I-80/I-480 major fork.
- Three (3) EB I-80 through-lanes and five I-480 exit lanes at major fork.
- Downstream I-480 NB/US-75 SB fork is not balanced.

Sub Option C

Sub Option C focuses on the NB US-75 & SB I-480 to WB I-80 merge area. The purpose of this Sub Option is to avoid dropping the outside (8th) mainline lane downstream of the merged as is shown in Alternatives 1 and 2. Key features include:

- Dynamic/managed interior merge between NB US-75 and SB I-480 traffic entering WB I-80.
- Two (2) lanes are provided for the US-75 NB to I-80 WB ramp and two lanes are provided for the SB I-480 to I-80 WB ramp during the AM peak.
- One (1) lane is provided for the US-75 NB to I-80 WB ramp and three lanes are provided for the SB I-480 to I-80 WB ramp during the PM peak.

Sub Option D (Note: Concept drawings not developed.)

Sub Option D focuses on the ramps on the east side of the 42nd Street interchange. The purpose of this Sub Option is to reduce weaving congestion in both directions of I-80 between 42nd Street and the I-80/I-480/US-75 System Interchange. Key features include:

- Closure of WB I-80 exit to 42nd Street.
- Closure of 42nd Street entrance loop to WB I-80.
- Closure of 42nd Street entrance loop to EB I-80.
- Closure of 42nd Street entrance ramp to EB I-80.

Sub Option E (Note: Concept drawings not developed.)

Sub Option E would implement ramp metering on the entrance ramps at the I-80 interchanges at 84th Street, 72nd Street, 60th Street and 42nd Street. The purpose of this Sub Option is to improve operations on I-80 between the I-80/I-680 System Interchange and the I-80/I-480/US-75 System Interchange.

Sub Option F

Sub Option F focuses on the ramps in the area of I-80 between I-680 and 42nd Street. The purpose of this Sub Option is to improve operations at arterial interchanges on I-80 between the I-80/I-680 System Interchange and the I-80/I-480/US-75 System Interchange. Key features include:

- Two (2) additional EB through-lanes between I-680 and 42nd Street.
- Two (2) additional WB through-lanes between I-680 and 60th Street.
- One (1) additional WB through-lane between 60th and 42nd Streets.
- 84th, 72nd, and 60th Street Interchanges converted to diverging diamond configurations.

I-680 Corridor

Alternatives and Sub Options for the I-680 corridor are shown in **Table 10.3**.

Table 10.3. I-680 Alternatives and Sub Options

I-680		
Alternative	**Name**	**Description**
1	Mainline Widening	Addition of 1 or 2 mainline lanes. Follows NDOR's IJR recommendation between West Maple Road through Blair High Road (with parclos at Fort Street and Blair High Road). DDI at Pacific Street
2	Mainline Widening plus Expanded CD Road	Reconfiguration of CD road from I-80 to Pacific Street Pacific Street NB On-Ramp Channelization
Sub Option	**Name**	**Description**
A	SB I-680 Dynamic Merge at West Dodge Road	Improve PM merge operations by shifting I-680 SB traffic to left 2 lanes to provide gaps for merging traffic
B	Pacific Street Ramp Closure	Permanently close Pacific Street ramps to/from the north
C	Ramp Metering	Candidate locations: AM & PM: All entrance ramps at West Center Road and Pacific Street AM Only: Potentially WB West Dodge Road to I-680 SB

Note: Alternative 2 is identical to Alternative 1 North of West Dodge Road.

Alternative 1

Alternative 1 would widen I-680 between the I-80/I-680 System Interchange and the I-680 interchange with Blair High Road. Key features include:

- One (1) or two additional mainline lanes in each direction.
- Consistent with NDOR's IJR recommendation between West Maple Road and Blair High Road.
- Parclo interchange configurations at I-680 interchanges with Fort Street and Blair High Road.
- DDI at I-680 interchange with Pacific Street.

Alternative 2

Alternative 1 would widen I-680 between the I-80/I-680 System Interchange and the I-680 interchange with Blair High Road and expand the existing Collector-Distributor Road System. Key features include:

- Reconfiguration of CD road from the I-80/I-680 System Interchange to Pacific Street
- Pacific Street NB On-Ramp Channelization

Sub Option A

Sub Option A focuses on the merge of southbound I-680 with the ramp from westbound West Dodge Road to southbound I-680. The purpose of this Sub Option is to improve operations at this merge through the implementation of a Dynamic Lane Use / Merge Control / Lane strategy. Key features include:

- Improve PM merge operations by shifting I-680 SB traffic to left two lanes to provide gaps for merging traffic

Sub Option B (Note: Concept drawings not developed.)

Sub Option B focuses on the ramps on the north side of the Pacific Street interchange. The purpose of this Sub Option is to improve operations between Pacific Street and the I-680/West Dodge Road System Interchange. Key features include:

- Closure of NB I-680 exit to Pacific Street.
- Closure of Pacific Street entrance ramp to NB I-680.

Sub Option C (Note: Concept drawings not developed.)

Sub Option C would implement ramp metering on the entrance ramps at the I-680 interchanges at West Center Road, Pacific Street and potentially the entrance to SB I-680 from WB West Dodge Road. The purpose of this Sub Option is to improve operations on I-680 between the I-80/I-680 System Interchange and the I-680/West Dodge Road System Interchange.

I-480 Corridor

Alternatives and Sub Options for the I-480 corridor are shown in **Table 10.4**.

Table 10.4. I-480 Alternatives and Sub Options

I-480		
Alternative	**Name**	**Description**
1	Mainline Widening	Addition of 1 mainline lane
Sub Option	**Name**	**Description**
A	Martha Street Ramp Closure	Permanently close Martha Street ramps to/from the south
B	Ramp Metering	Candidate locations: AM: NB entrance ramp at Martha PM: SB entrance ramps at Cuming, 30th, Harney, Leavenworth, & Martha

Alternative 1

Alternative 1 would widen I-480 between the I-80/I-480/US-75 System Interchange and approximately Harney Street. Key features include:

- One (1) additional mainline lane on SB I-480 between Harney Street and the I-80/I-480/US-75 System Interchange.
- Lane balance at the SB I-480 split to WB I-80 and SB US-75/EB I-80.
- No lane balance at the SB I-480 split to SB US-75 and EB I-80.
- One (1) additional mainline lane on NB I-480 between Martha Street and Leavenworth Street

Sub Option A (Note: Concept drawings not developed.)

Sub Option A focuses on the ramps on the south side of the Martha Street interchange. The purpose of this Sub Option is to reduce weaving congestion in both directions of I-480 between Martha Street and the I-80/I-480/US-75 System Interchange. Key features include:

- Closure of NB I-480 exit to Martha Street.
- Closure of Martha Street entrance ramp to SB I-480.

Sub Option B (Note: Concept drawings not developed.)

Sub Option B would implement ramp metering on the entrance ramps at the I-480 interchanges at Cuming Street, 30th Street, Harney Street, Leavenworth Street and Martha Street. The purpose of this Sub Option is to improve operations on I-480 between the I-80/I-480/US-75 System Interchange and the I-480/US-75 System Interchange.

West Dodge Road Corridor

Alternatives and Sub Options for the West Dodge Road corridor are shown in **Table 10.5**.

Table 10.5. West Dodge Road Alternatives and Sub Options

West Dodge Road		
Alternative	**Name**	**Description**
1	Mainline Widening West of 120th St with 4 Lane WB Expressway Bridge	Addition of 1 lane in each direction plus auxiliary lanes depending on location. Narrow lanes and shoulders to provide 4 WB lanes on elevated portion of Expressway (2 lanes from Dodge, 2 lanes from I-680). DDI at 192nd St.
2	Mainline Widening West of 120th Street Only	Equal to Alt. 1 but retains current 3 WB lanes on elevated portion of Expressway (1 lane from Dodge, 2 lanes from I-680 per NDOR interim project)
3	Mainline Widening in WB direction Only	No improvements in the EB direction. Equal to Alt. 1 for WB.
Sub Option	**Name**	**Description**
A1	I-680 / WB Dodge System Interchange Weave Improvement	Eliminate weaving section & provide 4 WB lanes on elevated portion
A2		Eliminate weaving section & provide 3 WB lanes on elevated portion
B	I-680 / EB Dodge System Interchange Weave Improvement	Eliminate existing weaving section
C1	Dodge Channelization between 132nd Street & 120th Street	ONLY EB on-ramp traffic from 132nd is channelized to “lower” Dodge
C2		EB on-ramp traffic from 132nd is channelized to “lower” Dodge WB traffic from elevated expressway to 132nd WB off-ramp not allowed (barrier)
D	WB Dodge Mainline Expansion (2 Lanes) from 132nd St to 156th St	Additional lanes to mitigate poor LOS operations in WB direction only
E	150th Street & 137th Street Ramp Closures	Permanent or Peak Hour closures at ½ mile interchanges at 150th and 137th St.
F	Ramp Metering	Candidate locations: AM: All EB entrance ramps from 192nd through 132nd (& Old Mill EB) PM: All WB entrance ramps from 120th through 156th (& Old Mill EB)

Note: All Sub Options are illustrated using Alternative 1 except A2 & C2 which are illustrated using Alternative 2.

Alternative 1

Alternative 1 would add one additional mainline lane in each direction to West Dodge Road between 204th Street and 120th Street and provide one additional lane in the westbound direction of the elevated portion of the expressway. Alternative 1 does not provide an additional lane in the eastbound direction of the elevated portion of the expressway because pushing more traffic to I-680 was deemed undesirable by NDOR. Key features include:

- One (1) additional continuous through-lane eastbound and westbound
- One (1) additional through-lane on westbound viaduct
- Eastbound auxiliary lane between 204th Street and 192nd Street
- Auxiliary lanes between 168th Street and 156th Street
- North Frontage Road between 132nd Street and 120th Street shifted outward to accommodate additional westbound through-lane
- Lane balance maintained at arterial interchange ramps
- Ramp connection from I-680 interchange to westbound viaduct expanded from one lane to two lanes

Alternative 2

Alternative 2 is identical to Alternative 1 in most areas of the corridor but would retain the current 3 WB lanes on elevated portion of Expressway (1 lane from Dodge, 2 lanes from I-680 per NDOR interim project). Key features include:

- Alternative 2 identical to Alternative 1 west of 132nd Street
- No additional lanes on viaducts
- No impact to North Frontage Road between 132nd Street and 120th Street
- Ramp connection from I-680 interchange to westbound viaduct expanded from one lane to two lanes
- Westbound Local West Dodge Road connection reduced from two lanes to one lane

Alternative 3

Alternative 3 is identical to Alternative 1 in the WB direction but does not include any improvements to the EB direction of West Dodge Road. This alternative was proposed in recognition that any improvements to EB West Dodge Road have the potential to worsen traffic operations approaching and within the I-680/West Dodge Road System Interchange. Key features include:

- One (1) additional continuous through-lane, westbound only
- One (1) additional through-lane on WB viaduct
- Westbound auxiliary lane between 168th Street and 156th Street
- North Frontage Road between 132nd Street and 120th Street shifted outward to accommodate additional westbound through-lane
- Lane balance maintained at arterial interchange ramps
- Ramp connection from I-680 interchange to westbound viaduct expanded from one lane to two lanes
- No eastbound improvements

Sub Option A1

Sub Option A1 focuses on the ramps from NB and SB I-680 to WB West Dodge Road and is compatible with providing one additional through-lane on the westbound viaduct (4 total). The purpose of this Sub Option is to reduce congestion on this connector between I-680 and West Dodge Road. Key features include:

- Southbound I-680 ramp to westbound expressway is braided beneath north directional ramp
- Northbound I-680 ramp to westbound expressway is barrier separated from Local West Dodge Road movements.
- Southbound I-680 ramp to westbound expressway merges with westbound Local West Dodge Road connection.

Sub Option A2

Sub Option A2 also focuses on the ramps from NB and SB I-680 to WB West Dodge Road and is compatible with retaining the existing 3 lanes on the westbound viaduct. The purpose of this Sub Option is to reduce congestion on this connector between I-680 and West Dodge Road. Key features include:

- Southbound I-680 ramp to westbound local West Dodge ramp is braided beneath north directional ramp.
- Northbound I-680 ramp to westbound expressway is barrier separated from Local West Dodge Road movements.
- Southbound I-680 ramp to westbound expressway merges with north directional ramp traffic.

Sub Option B

Sub Option B focuses on the ramps from EB West Dodge Road to I-680. The purpose of this Sub Option is to reduce congestion on this connector between I-680 and West Dodge Road. Key features include:

- Eastbound expressway ramp to southbound I-680 is barrier separated from eastbound local West Dodge Road ramp to I-680.
- Eastbound expressway ramp to northbound I-680 diverges from at-grade West Dodge Road.

Sub Option C1

Sub Option C1 focuses on weaving issues on EB West Dodge Road between 132nd Street and 120th Street. The purpose of this Sub Option is to reduce congestion in this weaving section. Key features include:

- 132nd Street eastbound entrance ramp traffic is barrier separated from eastbound expressway traffic up to the 120th Street exit. Thus, traffic from 132nd Street must use Local West Dodge Road.
- Five (5) total lanes maintained between 132nd Street and 120th Street with four lanes dedicated to expressway traffic.

Sub Option C2

Sub Option C2 focuses on weaving issues on WB West Dodge Road between 120th Street and 132nd Street. The purpose of this Sub Option is to reduce congestion in this weaving section. Key features include:

- Westbound connection from Local West Dodge Road to 120th Street is barrier separated from westbound expressway traffic and no exit is provided from the westbound expressway to 132nd Street. Thus, traffic destined to 132nd Street must use Local West Dodge Road.
- Traffic from 120th Street enters the westbound expressway beyond the existing westbound 132nd Street exit.

Sub Option D

Sub Option D focuses on westbound West Dodge Road between 132nd Street and 156th Street The purpose of this Sub Option is to reduce congestion in this section. Key features include:

- Identical to Alternative 1 except that two westbound through lanes (instead of one) are added from 132nd Street to 156th Street.
- Lane balance maintained at all interchanges except the westbound exit to 132nd Street.

Sub Option E (Note: Concept drawings not developed.)

Sub Option E focuses on the half-mile interchanges located at 150th Street and at 137th Street. The purpose of this Sub Option is to reduce congestion in this area that features half-mile interchange spacing. Key features include:

- Permanent closure and removal of ramps for all movements at the 150th and 137th Street interchanges.

(Note that ramp or interchange closures at the West Dodge Road interchanges with 137th Street and with 150th Street are no longer being considered due to commitments made by NDOR.)

Sub Option F (Note: Concept drawings not developed.)

Sub Option F would implement ramp metering on the entrance ramps at the West Dodge Road interchanges at 132nd Street, 137th Street, 144th Street, 150th Street, 156th Street, 168th Street, 180th Street and 192nd Street. The purpose of this Sub Option is to improve operations on West Dodge Road between the 192nd Street and 132nd Street.

US-75 (Kennedy Freeway) Corridor

Alternatives and Sub Options for the US-75 corridor are shown in **Table 10.6**.

Table 10.6. US-75 Corridor Alternatives and Sub Options

US-75		
Alternative	**Name**	**Description**
1	Kennedy Freeway Recommended Plan	Follows recommendations from the Kennedy Freeway Planning Study except: - Full interchange at Q Street with minor side street reconfiguration - DDI at Cornhusker Road - Keep F Street Interchange and retain SB divided geometry
Sub Option	**Name**	**Description**
A	F Street Interchange Closure	Permanently close F Street interchange
B	Ramp Metering	Candidate locations: AM: NB entrance ramps at Q, L, & F PM: SB entrance ramps at Q, L, & F

Alternative 1

Consistent with the Kennedy Freeway Planning Study completed in 2002, Alternative 1 would add one additional mainline lane in each direction on US-75 N-370 and the I-80/I-480/US-75 System Interchange. Key features include:

- Full interchange at Q Street with minor side street reconfiguration
- DDI at Cornhusker Road
- Keep F Street interchange open and retain the existing barrier separation on southbound US-75 between the I-80/I-480/US-75 System Interchange and F Street.

Sub Option A (Note: Concept drawings not developed.)

Sub Option A focuses on the F Street interchange. The purpose of this Sub Option is to improve weaving operations between F Street and the I-80/I-480/US-75 System Interchange. Key features include:

- Permanent closure and removal of ramps for all movements at the F Street interchange.

Sub Option B (Note: Concept drawings not developed.)

Sub Option F would implement ramp metering on the entrance ramps at the US-75 interchanges at Q Street, L Street and F Street. The purpose of this Sub Option is to improve operations on US-75 between Q Street and the I-80/I-480/US-75 System Interchange.

Interchange Alternatives Assessment

Freeway interchange improvements that were considered during Phase 2 are summarized below by corridor.

I-80

Note that I-80 interchanges with 216th Street (N-31), N-370 and 144th Street (N-50) are discussed in a later section dedicated to the assessment of a potential new I-80 interchange in Sarpy County.

Giles Road

As shown in the concept drawings in **Appendix D**, the existing parclo configuration was retained for the Giles Road Interchange. Recommended improvements to the parclo include:

- One (1) additional through lane (in each direction) on Giles Road to match the non-freeway improvements included in Strategy Package 7.
- Additional turn bays to improve ramp terminal and cross street operations.

A DDI was studied as a potential interchange improvement. A DDI would improve the SB lane utilization upstream of the loop ramp that exists today along Giles Road by spreading traffic destined for EB I-80 across two lanes. A DDI would relieve some of this poor lane utilization but would require a two-lane on-ramp onto EB I-80.

The existing parclo configuration was selected due to the mainline implications of bringing a two-lane on-ramp onto EB I-80. Both options will be considered further in Phase 3.

Q Street

No changes needed other than signal timing modifications.

L Street (US 275)

As shown in the concept drawings in **Appendix D**, the existing cloverleaf configuration was retained for the L Street Interchange. Recommended improvements to the cloverleaf include:

- One (1) additional through lane (in each direction) on L Street to match the non-freeway improvements included in Strategy Package 7.
- Two-lane SB off-ramp to L Street WB to improve lane utilization on the SB CD road.

A DDI was studied as a potential interchange improvement. In microsimulation, a DDI is able to serve all of the 2040 peak hour traffic at the L Street interchange. It would also have some constructability advantages and bridge cost savings since the bridge length could be shortened with a DDI.

The existing cloverleaf configuration was selected since a DDI didn't show a major improvement in traffic operations compared to the cloverleaf. Both options will be considered further in Phase 3.

I Street

No changes needed other than signal timing modifications.

84th, 72nd, and 60th Street

As shown in the concept drawings in **Appendix D**, the existing parclo configurations were retained for the three interchanges. Recommended improvements to the parclo interchanges include:

- Lengthening of turn bays to accommodate additional traffic.
- One (1) additional through lane on 72nd Street (in each direction – to the south) to match the non-freeway improvements included in Strategy Package 7.

A standard diamond interchange was studied as a potential interchange improvement. The standard diamond was not selected for the following reasons:

- An additional signal phase is needed for the protected NBL or SBL movements that does not exist in the parclo or DDI configurations. This phase would take green time away from the off-ramp and NBT / SBT movements which causes all three interchanges to provide worse LOS than the parclo or DDI configurations.
- Reconstruction of the bridges at 84th, 72nd, and 60th Streets would be needed to accommodate the storage requirements for the NBL and SBL dual turn bays.
- A standard diamond combines traffic that is spread across two ramps today. Some of the on-ramps would be approaching the capacity for a one-lane on-ramp when the traffic is combined onto one ramp.

A DDI was also studied as a potential interchange improvement. This concept also combines the on-ramp volume onto one ramp similar to the standard diamond which may cause some capacity issues on various on-ramps. Benefits of a DDI include:

- Improved lane utilization approaching I-80 along 84th, 72nd, and 60th Streets.
- Improved management of the system (in terms of ramp metering) by only metering one on-ramp instead of two with the parclo configuration.
- Decreased bridge widening costs by utilizing existing bridge width that is currently used for loop ramps.

The existing parclos were selected since a DDI wouldn't provide a major improvement in traffic operations compared to the parclo. Both options will be considered further in Phase 3.

42nd Street

As shown in the concept drawings in **Appendix D**, a DDI configuration was selected for the 42nd Street Interchange. The need for a DDI was governed by mainline lane continuity and lane balance needs on I-80. The existing parclo was not selected for the following reasons:

- EB direction: A loop ramp would add a seventh lane that would continue to the I-80 / I-480 / US-75 interchange. The seven lanes would split to three EB I-80 lanes and four lanes to I-480 / US-75 with no lane balance. This option does not provide acceptable EB I-80 mainline operations.
- WB Direction: To provide acceptable WB I-80 mainline operations, seven WB lanes need to be provided over 42nd Street. A loop ramp would add an eighth lane that would continue to the 60th Street exit. Either lane balance would not be provided at 60th, or a lane drop would need to occur before or after the 60th Street off-ramp to get to a six-lane basic freeway with one auxiliary lane section west of 60th Street.

A standard diamond interchange was also studied as a potential interchange improvement that corresponds with the I-80 lane continuity and lane balance needs. The standard diamond was not selected for the following reasons:

- A DDI would provide better operations along 42nd Street.
- Bridge reconstruction would be needed to accommodate the storage requirements for the NBL and SBL dual turn bays for a standard diamond.

NDOR has expressed concerns that combining traffic from both ramps onto one ramp while shortening the weave distance approaching a system interchange will cause slowdowns on I-80. Metering of the EB on-ramp may offer a solution to this concern that doesn't involve closing the ramp during peak hours.

Note that a DDI provides acceptable cross street operations along 42nd Street.

24th Street

No changes needed other than signal timing modifications to accommodate the proposed 24th Street road diet.

13th Street

As shown in **Appendix D**, the existing interchange configuration was retained with slight off- ramp modifications to provide lane balance (per NDOR Interchange Justification Report (IJR), 2017). The off-ramp modifications will improve weekend operations (for zoo traffic) at the south ramp terminal by providing dual EBR turn lanes.

I-680

Blair High Road (N-133) and Fort Street

As shown in the concept drawings in **Appendix E**, a parclo configuration was selected for both interchanges (per NDOR IJR, 2013). As directed by NDOR, no additional interchange alternatives were investigated.

West Maple Road (N-64)

No changes needed other than signal timing modifications and adding an additional turn bays for the SB off-ramp.

Pacific Street

As shown in the concept drawings in **Appendix E**, a DDI configuration was selected for the Pacific Street Interchange. Benefits of a Pacific Street DDI include:

- The existing bridge may be able to accommodate the required lanes needed for a DDI configuration to operate at an acceptable LOS. Phase 3 will consider the existing bridge in more detail.
- A DDI would provide better operations than a standard diamond configuration.

An expanded diamond was also studied as a potential interchange improvement but was not selected. The addition of dual WBL turn bays would require the bridge to be widened to accommodate an additional lane.

Any interchange options that would require loop ramps were also eliminated due to potential ROW impacts to surrounding neighborhoods and overall cost.

West Center Road

No changes needed other than signal timing modifications.

Note that I-680 Corridor Alternative 2 includes ramp modifications. The interchange configuration would remain the same, but the west terminal would be shifted 200 feet to the east.

I-480

30th Street

As shown in the concept drawings in **Appendix F**, the existing configuration was retained for the 30th Street on/off-ramps. A reconfiguration of the on/off-ramps was also studied as a potential improvement including:

- Combining the SB US-75 off-ramp to 30th Street and the WB I-480 off-ramp to 30th Street into one ramp that would connect to the intersection of 29th Street & Dodge Street.
- Removing the 30th Street on-ramp to SB I-480.
- Providing a dual on-ramp from 29th Street, south of Harney Street onto SB I-480.

This option was initially considered in response to proposed land use redevelopment along 30th Street between Dodge Street and Cuming Street. However, given the speculative nature of the redevelopment proposal, the improvements listed above were not included in the concept drawings. These improvements could be considered further in Phase 3 depending on the status of the redevelopment proposal.

Harney Street

As shown in the concept drawings in **Appendix F**, the existing configuration was retained for the Harney Street interchange. An additional SB on-ramp lane was also studied as a potential interchange improvement. The additional lane would improve the SB lane utilization along 29th Street and at other adjacent intersections around the Harney Street interchange. The additional SB on-ramp lane would be carried to the Martha Street interchange and dropped with a two-lane off-ramp (with lane balance). Due to the additional costs associated with the two-lane on-ramp at Harney Street, the existing configuration was selected. Both options will be considered further in Phase 3.

Leavenworth Street

No changes needed other than signal timing modifications.

Martha Street

No changes needed other than signal timing modifications.

West Dodge Road

204th Street (N-31)

As shown in the concept drawings in **Appendix G**, the existing Single Point Urban Interchange (SPUI) was retained with slight modifications including:

- Additional turn bays.
- Providing a dual EB on-ramp.

No additional interchange configurations were investigated due to the effectiveness of a SPUI in serving heavy left-turning movements.

192nd Street

As shown in the concept drawings in **Appendix G**, a DDI configuration was selected for 192nd Street (per NDOR direction). Other interchange configurations and improvements are currently being studied by others as part of a proposed development on the south side of West Dodge Road. The findings of this study will be considered further in Phase 3.

180th, 168th, 156th, and 144th Street

As shown in the concept drawings in **Appendix G**, the existing SPUI configuration was retained at all four of these interchanges. Improvements to the SPUIs include:

- Lengthening of turn bays to accommodate additional off-ramp traffic.
- Additional turn bays.
- One (1) additional through lane on 144th Street (in each direction) to match the non-freeway improvements included in Strategy Package 7.

A standard diamond interchange was studied as a potential interchange improvement that would accompany other ramp / freeway improvements (i.e. ramp weaves or ramp consolidation to improve mainline operations). In microsimulation, the standard diamond interchanges were not able to handle the heavy turning movements and additional traffic resulting from ramp consolidation.

150th Street

No changes needed. The addition of a new EB off-ramp to 150th Street is being considered by NDOR as part of a new development on the south side of West Dodge Road. If approved by NDOR, the 150th Street interchange may require signalization of the ramp terminals due to increased traffic volumes. These improvements will be considered further in Phase 3.

137th Street

No changes needed other than signal timing modifications.

132nd Street

As shown in the concept drawings in **Appendix G**, the existing diamond interchange was retained. Other interchange configurations were investigated including an expanded diamond and a DDI. While both of these options would improve operations along 132nd Street, there would likely be adverse impacts to mainline operations.

Peak hour EB mainline operations between 132nd Street and 120th Street are LOS ‘F’ / ‘E’ in the AM / PM peak hour respectively for West Dodge Road Alternative 1. Any additional traffic from the 132nd EB on-ramp would worsen the weave between 132nd Street and 120th Street.

Peak hour WB mainline operations may be impacted by backups occurring on the WB off-ramp at 132nd Street. If this queue continues to worsen by 2040, some mitigation will be necessary.

Adaptive traffic signals are planned to be installed on the 132nd Street corridor adjacent to West Dodge Road in the near future. Adaptive signals will improve traffic progression, help manage the traffic fluctuations that occur in the corridor, and improve LOS. The interchange should be reassessed after the adaptive signals are implemented.

120th Street

As shown in the concept drawings in **Appendix G**, the existing intersection was retained. Similar to the 132nd Street interchange, any improvement to the 120th Street & West Dodge Road intersection may have adverse impacts to mainline operations (in the WB direction).

PM peak hour mainline operations between 120th Street and 132nd Street may worsen as additional WB traffic gets through the 120th Street and West Dodge Road intersection.

Additionally, it may be difficult to provide an innovative intersection design given the closely spaced adjacent intersections (to the north and south) and the existing bridge piers surrounding the intersection.

US-75

F Street

No changes needed other than signal timing modifications.

L Street (US 275) and Q Street

As shown in the concept drawings in **Appendix H**, the ramps at L Street (to the south) were removed and both Q Street and L Street were combined into a split diamond interchange. Traffic that (today) uses L Street to access US-75 SB will have to divert to F Street or Q Street interchanges. This additional traffic at Q Street may require widening the Q Street bridge when it is replaced to accommodate longer left-turn bays for heavier left-turn movements.

Chandler Road

No changes needed other than signal timing modifications.

Cornhusker Road

As shown in the concept drawings in **Appendix H**, a DDI configuration was selected for the Cornhusker Road Interchange. Benefits of a Cornhusker Road DDI include:

- The existing bridge may be able to accommodate the required lanes needed for a DDI configuration to operate at an acceptable LOS. Phase 3 will consider the existing bridge in more detail.
- A DDI would provide better operations than a standard diamond configuration.

An expanded diamond was also studied as a potential interchange improvement but was not selected. The addition of dual EBL / WBL turn bays would require the bridge to be widened to accommodate the additional lanes.

N-370

As shown in the concept drawings in **Appendix H**, the existing parclo configuration was retained for the N-370 Interchange. Improvements to the parclo include:

- One (1) additional through lane (in each direction - to the west) to match the non-freeway improvements included in Strategy Package 7.
- Additional turn bays to improve ramp terminal and cross street operations.

A DDI was also studied as a potential interchange improvement. A DDI would improve the lane utilization approaching the N-370 interchange, but this concept was removed for the following reasons:

- This concept would combine the on-ramp volume onto one ramp which may cause some capacity issues on various on-ramps.
- A local access exists across from the NB off-ramp. This access would need to be removed since through movements from off-ramps are prohibited in a DDI configuration.

Capehart Road

No changes needed other than signal timing modifications

Fairview Road

As shown in **Appendix H**, a diamond configuration was selected for Fairview Road to be consistent with improvements that will be completed in the near future. No additional interchange alternatives were investigated.

New Sarpy County I-80 Interchange Assessment

Phase 2 also included a subarea study to determine the need for a new interchange or interchanges along I-80 in Sarpy County. The methodologies and findings from this subarea study are documented in a Technical Memorandum titled “Sarpy County I-80 Interchange Assessment” dated April 2017 and summarized below.

Background

The subarea study was conducted to supplement a larger study being conducted by Sarpy County that is evaluating the 180th/192nd Street corridors from Harrison Road to Platteview Road in order to identify a potential continuous north-south corridor in this area.

The Sarpy County study assumed an interchange with I-80 but did not evaluate the justification for an interchange. The MTIS subarea study evaluated the need for a new interchange between 180th Street and 192nd Street based on 2040 traffic volumes and operations at the existing I-80 interchanges at N-31, N-370 and N-50. The premise for this evaluation was the assumption that a new interchange or interchanges will not be approved for I-80 unless it shown that the existing interchanges (as built or improved) will not be able to serve future traffic demands.

Methodologies

The roadway network used to develop future year traffic volumes included all projects selected for the Preferred Regional Strategy Package (e.g., N-370 is assumed to be widened to a 6-lane section through the interchange with I-80). The subarea study also included the addition of two non-MTIS projects on Schram Road and Capehart Road. It was determined through technical analyses and discussions with MAPA and Sarpy County staff that these non-MTIS projects will be necessary to support mobility in the area given the anticipated development in the area.

Peak hour volumes were developed using existing segment ADT in combination with the MAPA 2040 travel demand model output. LOS analyses were performed using procedures from HCM 2010.

Results

216th (N-31)

Without the 180th/192nd Interchange, a DDI will be needed to provide acceptable LOS in 2040. This concept is shown in **Appendix D**. Other interchange configurations were analyzed including:

- Expanded Diamond Interchange
  - This interchange would not provide acceptable LOS in 2040.
  - Additional SBL turn bays would require widening of the N-31 bridge over I-80.
- Parclo Interchange
  - This interchange would not provide acceptable LOS in 2040.
  - A loop ramp in the SW quadrants would likely have significant ROW impacts.

A DDI was selected since it would provide the best LOS compared to the other alternatives. It would also stay within the existing cross section of the N-31 bridge and will not need any significant ROW acquisition.

With the 180th/192nd Interchange, enough volume would divert from the N-31 interchange to the new 180th / 192nd Interchange that no reconstruction will be needed to accommodate 2040 peak hour volumes. Since the 180th/192nd Interchange is not shown in the concept drawings, the N-31 DDI concept is shown.

N-370

Without the 180th/192nd Interchange, a DDI will provide the best LOS in 2040 compared to the other interchange concepts. This concept is shown in **Appendix D**. Other interchange configurations were analyzed including:

- Expanded Diamond Interchange

- This interchange would not provide acceptable LOS in 2040 due to the heavy left turning vehicles onto EB I-80 with heavy opposing through movements.

- Parclo Interchange
  - The parclo interchange would not provide acceptable LOS in 2040 due to poor lane utilization upstream of the loop ramp onto EB I-80. This causes the WB ramp terminal and adjacent intersection at 156th Street to have failing operations.
  - A loop ramp in the SE and NW quadrants would likely have significant ROW impacts.

A DDI was selected since it provides the best lane utilization upstream of the heavy EBL movement onto EB I-80. It also doesn't require any significant ramp reconstruction that would occur with a parclo.

With the 180th/192nd Interchange, a DDI is the only configuration that would provide acceptable LOS. The 180th/192nd Interchange would divert enough volume from the N-370 corridor to allow the DDI to improve operations from a LOS 'E' to a LOS 'C'.

144th (N-50)

The 180th/192nd Interchange would not be expected to have a significant impact on traffic volumes at the N-50 interchange. For both scenarios (with and without 180th/192nd Interchange) all three (3) concepts that were analyzed provide acceptable LOS. The DDI concept is shown in **Appendix D**. The following interchange configurations were analyzed:

- Diverging Diamond Interchange
  - This interchange would provide acceptable LOS for both scenarios.
- Expanded Diamond Interchange
  - This interchange would provide acceptable LOS for both scenarios.
  - A wider bridge may be required (compared to the DDI concept) to accommodate dual SBL turn bays to EB I-80.
- Parclo Interchange
  - This interchange would provide acceptable LOS for both scenarios.
  - A loop ramp in the SW quadrants would likely have significant ROW impacts.

Per direction from the Management Committee, a DDI was selected as the preferred interchange configuration and was included in the concept drawings.

Summary

The 180th/192nd Interchange would primarily relieve congestion at the I-80 interchanges at N-31 and N-370. It would also be expected to divert enough daily traffic from N-31 between I-80 and Gretna to eliminate the need for the 6-lane widening project included in Strategy Package 7.

The 180th/192nd Interchange would also not impact mainline operations between N-31 and N-50. Traffic volume at the on/off-ramps at N-31 and N-370 would divert to the 180th/192nd Interchange which would improve merge/diverge and weaving mainline operations around theses interchanges. Overall, mainline operations would stay the same as the No-Build conditions.

Note that concept drawings for the 180th/192nd Interchange are not included in **Appendix D** per direction from the Management Committee. Additional studies will be necessary prior to the approval a new 180th/192nd Interchange. The inclusion of this interchange within MTIS recommendations will be considered further in Phase 3.

Corridor Alternatives Assessment

The focused corridor Alternatives and Sub Options previously described were evaluated relative to traffic operations, safety, environmental issues, constructability, ROW impacts, construction costs and benefit-cost ratios. The methodologies applied as part of this assessment are described in the following sections.

Operations

Traffic operational analyses were performed for each Alternative and Sub Option using both Highway Capacity Manual methodologies (for LOS output) and microsimulation using TransModeler v4.0 (for travel speed output). The analyses were performed for mainline segments, ramp junctions, weaving areas, freeway systems, and ramp terminal intersections. Other operational criteria such as lane balance, design uniformity, driver expectancy and ramp sequencing were also evaluated.

Safety

A crash assessment of the Alternatives and Sub Options was conducted using the Highway Safety Manual predictive methods (ISATe) that were applied in Phase 1 to predict crashes for 2040 No-Build Conditions. The ISATe model allows for analysis of changes to the geometric features of freeways, interchanges and intersections.

Environmental

In Phase 2, natural and human environment resources in the Environmental Study Area (ESA) were identified. The ESA consisted of the existing ROW, plus an additional 250 feet beyond ROW for most resources, with the exception of Hazardous Materials, which extended 1/10th mile beyond ROW, and Section 4(f), which extended ¼ mile beyond ROW. The existing conditions for each resource was assessed to determine the presence of the resource and its general quality. Resources that were identified included:

- Wetlands and Waters of the U.S.
- Threatened and Endangered Species
- Floodplains and Water Resources
- Hazardous Materials
- Historical Resources
- Section 4(f) and Section 6(f) Resources
- Farmland
- Environmental Justice
- Noise-Sensitive Receivers

The potential impacts of the Alternatives and Sub Options on the resources identified above were not identified in Phase 2. This assessment will be performed in Phase 3. Resources directly impacted by the project alternatives will be quantified where and when possible, and in other instances, qualitative assessments will be necessary. The review will identify potential fatal flaws or defensible reasons to reject specific actions. Issues warranting further environmental study during future project development phases will be identified.

Existing environmental resources in and adjacent to the freeway corridors are summarized in **Appendix C**.

Constructability

A high-level constructability review was conducted in Phase 2 for the Alternatives and Sub Options. The primary output from the review was a narrative regarding potential issues, such as the need to maintain the existing number of basic lanes, are common to all alternatives and sub options. Other features, such as changes to access or interchange configurations, vary significantly between alternatives and greatly affect their relative constructability. In general, issues and features that affect constructability include:

- Concepts that reuse and/or widen existing mainline pavements are easier to construct than concepts that require full reconstruction.
- Concepts that reuse and/or widen existing bridges are easier to construct than concepts that replaced bridges.
- Interchange type conversions greatly complicate maintenance of traffic on side-road ramp terminal intersections and require more construction on the side-roads themselves.
- Construction of ramp and mainline pavements on existing alignment is more difficult than construction of shifted roadways.
- Outward shifts of ramp tapers due to mainline pavement widening without off-alignment ramp reconstruction complicates maintenance of traffic.

A more comprehensive evaluation of constructability and maintenance of traffic will be performed during the Phase 3 evaluation based on preliminary alignment, profiles, and cross sections for critical segments that will be developed during alternative refinement.

Right-of-Way

Potential ROW impacts for the Alternatives and Sub Options were evaluated using Douglas County GIS property and parcel data. For most corridors, the new preliminary ROW need line was estimated by offsetting the existing ROW line a distance equal to the pavement widening width. Judgment was applied to identify locations where modifications to tie-in conditions would be logical to mitigate excessive ROW impacts. For corridors bounded by existing parallel roadways, such as I-480, the project footprint was constrained to avoid impacts to those roadways and adjacent properties.

NDOR completed some engineering of the two I-80 Alternatives and provided conceptual construction limits for some areas. This study verified NDOR's construction limits and appended those impacts for the remainder of the corridor. Widening construction limits will probably extend beyond the existing Union Pacific Railroad easements along the south side of I-80, but were not quantified because easement information was not available in the GIS data. Permanent ROW acquisition from the railroad is undesirable and is not anticipated.

Construction Costs

Conceptual-level construction cost estimates were prepared for each Alternative and Sub Option. Construction costs were estimated on a per-lane-mile basis using unit costs established from recent interstate reconstruction projects in the Lincoln and widening projects in Omaha. Adjustments for higher-cost special features, such as anticipated retaining and noise walls, were added to the base estimates.

The construction cost estimate for the I-480 corridor assumes full reconstruction for the portion of the corridor where a minor realignment is proposed but assumes widening only in the remainder of the corridor. The construction cost estimate for all other corridors assumes widening only and does not include overlay costs for adjacent lanes.

The construction cost estimate for each sub Options was reported as the incremental cost difference for the area covered by the Sub Option compared to Alternative 1. Other cost assumptions include:

- Full Reconstruction Cost = $1.7M per lane mile
- Widening Cost = $2.1M per lane mile
- Retaining Walls = $55/SF
- Noise Walls = $65/SF
- Barriers = $100/LF
- Ramp metering = $400,000/ramp (includes ramp widening for storage)
- Ramp removal = $100,000/ramp
- Dynamic Lane Use Sign = $350,000/location (assumed full color DMS with steel truss, cell modem, and power)

Benefit-Cost Ratios

A benefit-cost analysis was completed to determine the relative economic benefits compared to the costs of each alternative or sub option. The goal of the analysis is to put a dollar value (monetize) on the social benefits of an investment and compare that to the costs of the investment. For each alternative or sub option, the Study Team evaluated the level of changes related to:

- **Vehicle Travel Time**: typically the largest benefit associated with a transportation investment. Vehicle travel time is measured as VHT, and includes the cost of time for drivers, passengers (in personal vehicles) and freight trucks separately.
- **Vehicle Operating Cost**: measured as VMT, and reflects the fuel consumption and depreciation ("wear and tear") costs of driving personal vehicles and trucks. Many roadway investments lead to more driving / longer routes and thus induce higher vehicle operating costs.
- **Residual Capital Value**: measured as estimated value of infrastructure remaining at the end of the analysis period.

Evaluation Summaries

Evaluation summaries have been prepared for each Alternative and Sub Option. The summaries cover the criteria listed below and can be found in **Appendix D** through **Appendix H**.

- Design Features
- Safety
- Traffic Operations
- ROW Impacts
- Constructability
- Construction Costs
- Benefit-Cost Ratio

Key Takeaways

The strategies, alternatives, and sub options discussed in this chapter are the initial step in developing a freeway master plan for NDOR. Alternatives and sub options developed in this phase will be refined further in Phase 3. The primary purpose of Phase 3 will be to answer the following questions:

- What is the "vision" for the freeway system in the Omaha metropolitan area
- How are we going to get there?