Traffic Technical Report - I-270 Corridor Improvements Environmental Impact Statement

Federal Project No.: STU 2706-046

CDOT Project Code: 25611

Identification Number: FHWA-CO-EIS-24-001

July 2025

Contents

Page No.

Traffic Technical Report - I-270 Corridor Improvements Environmental Impact Statement 1

Contents i

Acronyms and Abbreviations vi

1.0 Introduction 1

1.1 Project Description 1

2.0 Context 2

2.1 Federal Context 2
2.2 State and Local Context 3

3.0 Overview of Traffic Analysis Methods and Assumptions 4

3.1 Study Area and Model Boundaries 4
3.2 Selection and Justification of Traffic Analysis Tools 5
3.2.1 TransModeler (Version 6.1) Microsimulation Modeling Software 6
3.2.2 DRCOG Travel Demand Model 6
3.3 I-270 EIS Traffic Working Group 6

4.0 Data Collection for Model Calibration and Validation 6

4.1 Data Collection – Base Model Development 7
4.2 Data Collection – Determining Travel Conditions 7

5.0 Identification of Model Calibration Targets 7

5.1 Identification of the Representative Day (Cluster Analysis) 8
5.2 Preparation of Calibration Envelopes 8
5.2.1 Travel Time Measures 8
5.2.2 Bottleneck Dynamics 9
5.3 Calibration of the Model within Acceptable Criteria 9

6.0 Base Model Development 11

6.1 Defining the Roadway Network 11
6.2 Traffic Demand Data 13
6.3 Vehicle Composition 14
6.4 Traffic Assignment and Routing 14
6.5 Error Checking 14

7.0 Model Calibration 14

7.1 Visual Inspection with Typical Day Inputs 14
7.2 Peak Period Bottleneck Formation 14
7.3 Summary of Calibration Adjustments 15

8.0 Existing (2023) Traffic Conditions ... 15

8.1 Peak Hour Traffic Volumes ... 15

9.0 Travel Demand Model Calibration ... 27

9.1 Travel Demand Model Calibration Data ... 27
9.2 Travel Demand Model Calibration Adjustments ... 28
9.2.1 Link Attributes and Centroid Connectors ... 28
9.2.2 Roadway Capacity and Free Flow Speed ... 28
9.2.3 Time Penalties and Other Refinements Considered ... 28
9.3 Travel Demand Model Calibration Results ... 28

10.0 No Action Alternative (2050) ... 29

10.1 No Action Alternative Traffic Volumes (2050) ... 28

11.0 Build Alternatives (2050) ... 40

11.1 Three General-Purpose Lanes Alternative ... 40
11.1.1 Three General-Purpose Lanes Alternative Volumes (2050) ... 44
11.2 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative ... 48
11.2.1 Two General-Purpose Lanes and One Express Lane that Accommodates Transit - Alternative Volumes (2050) ... 51

12.0 Measures of Effectiveness ... 59

12.1 Overall System Performance Measures of Effectiveness ... 59
12.1.1 Average Number of Vehicles Processed ... 59
12.1.2 Average Number of Queued Trips ... 62
12.1.3 Average Speed ... 63
12.1.4 Total Delay ... 65
12.1.4 Vehicle Miles Traveled and Vehicle Hours Traveled ... 66
12.2 Travel Time and Reliability ... 69
12.3 Queuing – Intersection Operations ... 76
12.4 Delay – Intersection Operations ... 79
12.5 Density – Freeway Operations ... 85
12.5.1 No Action Alternative Freeway Operations (2050) ... 86
12.5.2 2050 Three General-Purpose Lanes Alternative Freeway Operations ... 89
12.5.3 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Freeway Operations (2050) ... 93

13.0 Summary of Traffic Impacts ... 98

14.0 Required Permits and Coordination ... 100

15.0 References ... 100

Acronyms and Abbreviations

Acronym	Definition
a.m.	Morning
ATR	Automatic Traffic Recorder
BDAE	Bounded Dynamic Absolute Error
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
DRCOG	Denver Regional Council of Governments
EB	Eastbound
EDA	Exploratory Data Analysis
EIS	Environmental Impact Statement
EL	Express lane
FHU	Felsburg Holt & Ullevig
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
FTA	Federal Transit Administration
GPL	General purpose lane
GPS	Global positioning system
I-25	Interstate 25
I-270	Interstate 270
I-70	Interstate 70
I-76	Interstate 76
ITS	Intelligent Transportation Systems
LOS	Level of Service
MOE	Measures of Effectiveness
mph	miles per hour
MVRTP	Metro Vision Regional Transportation Plan
NB	Northbound
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NWS	National Weather Service
O-D	Origin-Destination
ODME	Origin-Destination Matrix Estimation
Old SH 2	Old State Highway 2
p.m.	Afternoon
pc/mi/ln	passenger cars per mile per lane
PD	Policy Directive
RTD	Regional Transportation District
RWIS	Road Weather Information System

Acronym	Definition
SB	Southbound
SH	State Highway
TPR	Transportation Planning Region
TRB	Transportation Research Board
TTI	Travel Time Index
U.S.	United States
U.S.C.	United States Code
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled
vph	vehicles per hour
vphpl	vehicles per hour per lane
WB	Westbound

1.0 Introduction

CDOT is dedicated to providing an accessible experience for everyone. While we are continuously improving our standards, some complex items in this document, such as certain figures and images, are difficult to create with fully accessible parameters to all users. If you need help understanding any part of this document, we are here to assist and have resources to provide additional accessibility assistance to any requests. Please email us at CDOT_Accessibility@state.co.us to request an accommodation, and a member of our I-270 Engineering Program will schedule a time to review the content with you. To learn more about accessibility at CDOT, please visit the Accessibility at CDOT webpage on the CDOT Website.

The Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) are preparing an Environmental Impact Statement (EIS) to evaluate potential improvements to the Interstate 270 (I-270) corridor. FHWA and CDOT are the lead agencies for this National Environmental Policy Act (NEPA) process, which was initiated in 2020, initially anticipating an Environmental Assessment. Moving into 2023, CDOT determined a more detailed environmental review was needed and requested that an EIS be prepared.

This technical report evaluates and documents transportation and traffic resources. It supports the analysis and conclusions in the EIS.

1.1 Project Description

I-270 (in Colorado) is a controlled-access interstate highway, with two through lanes in each direction, between I-25 and I-70 in central Denver and Commerce City (Figure 1). It has a posted speed limit of 55 miles per hour (mph). The project limits include the I-270 interchanges with I-76, York Street, Vasquez Boulevard, and Quebec Street. The project will tie into the I-25 and I-70 system interchanges, but improvements to these interchanges are part of projects on I-25 and I-70 and will be designed and approved separately.

The purpose of the I-270 Corridor Improvements Project is to implement transportation solutions that modernize the I-270 Corridor to accommodate existing and forecasted transportation demands. The project needs are:

- Traveler safety on the corridor,
- Travel time and reliability on the corridor,
- Transit on the corridor,
- Bicycle and pedestrian connectivity across I-270, and
- Freight operations on the corridor.

In addition to addressing project needs, CDOT, FHWA, and Cooperating and Participating Agencies have established a key project goal: to minimize environmental and community impacts resulting from the project.

Figure 1. I-270 Corridor Improvements Project Limits

2.0 Context

The development of transportation plans and projects is governed by federal, state, and local regulations, designed to ensure long-term, intermodal, and environmentally compliant transportation systems.

2.1 Federal Context

NEPA, enacted in 1970, requires federal agencies to assess environmental impacts of proposed transportation projects, like I-270. Conducting an EIS as part of NEPA ensures that the potential effects of traffic, road widening, and transportation changes are evaluated. NEPA also mandates the development of alternative project options and promotes public engagement.

Key regulations relevant to transportation and traffic include:

- **23 United States Code (U.S.C.) 135(f)(1)**: Requires states to develop long-range transportation plans, covering a minimum 20-year period, with a focus on intermodal transportation systems. These plans help guide statewide transportation development.
- **23 Code of Federal Regulations (CFR) Part 450 Subparts B and C**: Specifies that metropolitan transportation planning must include a 20-year forecast and be consistent with NEPA requirements. This ensures that traffic and transportation studies assess environmental impacts and follow a coordinated planning process. In nonattainment areas (where air quality standards are not met), conformity determinations from FHWA and Federal Transit Administration (FTA) are required to ensure compliance.
- **FHWA Traffic Analysis Toolbox Volume III (2019)**: Provides guidelines for applying traffic microsimulation modeling software, including cluster analysis methodologies, operational alternatives evaluations, and data requirements. This guidance is critical for microsimulation and travel demand modeling used in the project analysis.

2.2 State and Local Context

CDOT has several policy directives that influence investment in the transportation system. These directives include:

- **CDOT NEPA Manual (Chapter 3)**: Colorado's planning framework was established by the General Assembly in 1991, emphasizing a collaborative planning approach that includes both urban and non-urban regions. Colorado's transportation plans are designed with input from the state's 15 Transportation Planning Regions (TPR), which reflect local priorities, ensuring a comprehensive multimodal system for the future.
- **CDOT Traffic Analysis and Forecasting Guidelines (2023)**: This state-level guideline is central to the project's data collection, model calibration, and forecasting efforts. It sets standards for traffic data collection, ensuring alignment with state requirements for model calibration and alternatives analysis.
- **Policy Directive (PD) 14.0:** Transportation Planning Policy - This policy guides the development of the statewide transportation plan and regional transportation plans, ensuring that investment decisions align with strategic priorities, such as safety, mobility, economic vitality, and environmental sustainability. Investment in the I-270 corridor is included in CDOT's Statewide Transportation Plan.
- **PD 1602.0 and Procedural Directive 1602.1:** These directives require CDOT to accommodate the needs of bicycles and pedestrians in the planning, design, operation, and maintenance of transportation facilities. The needs of bicyclists and pedestrians are considered and included in the development and evaluation of I-270 alternatives. (CDOT 2017a, 2017b).
- **PD 1603.0:** Managed Lanes Policy - This directive establishes statewide guidelines for the evaluation of managed lanes. The PD requires managed lanes to be strongly considered during the planning and development of capacity improvements on state highway

facilities. Managed lanes (Express Lanes) are included in the development and evaluation of the I-270 alternatives.

- **Denver Regional Council of Governments (DRCOG) Focus Model**: The DRCOG Focus Model (version 2.3.2) was used to meet the federal requirements for long-range transportation planning under 23 CFR Part 450. DRCOG's 2050 Metro Vision Regional Transportation Plan (MVRTP) ensures compliance by forecasting travel demand, traffic growth, and infrastructure needs.

3.0 Overview of Traffic Analysis Methods and Assumptions

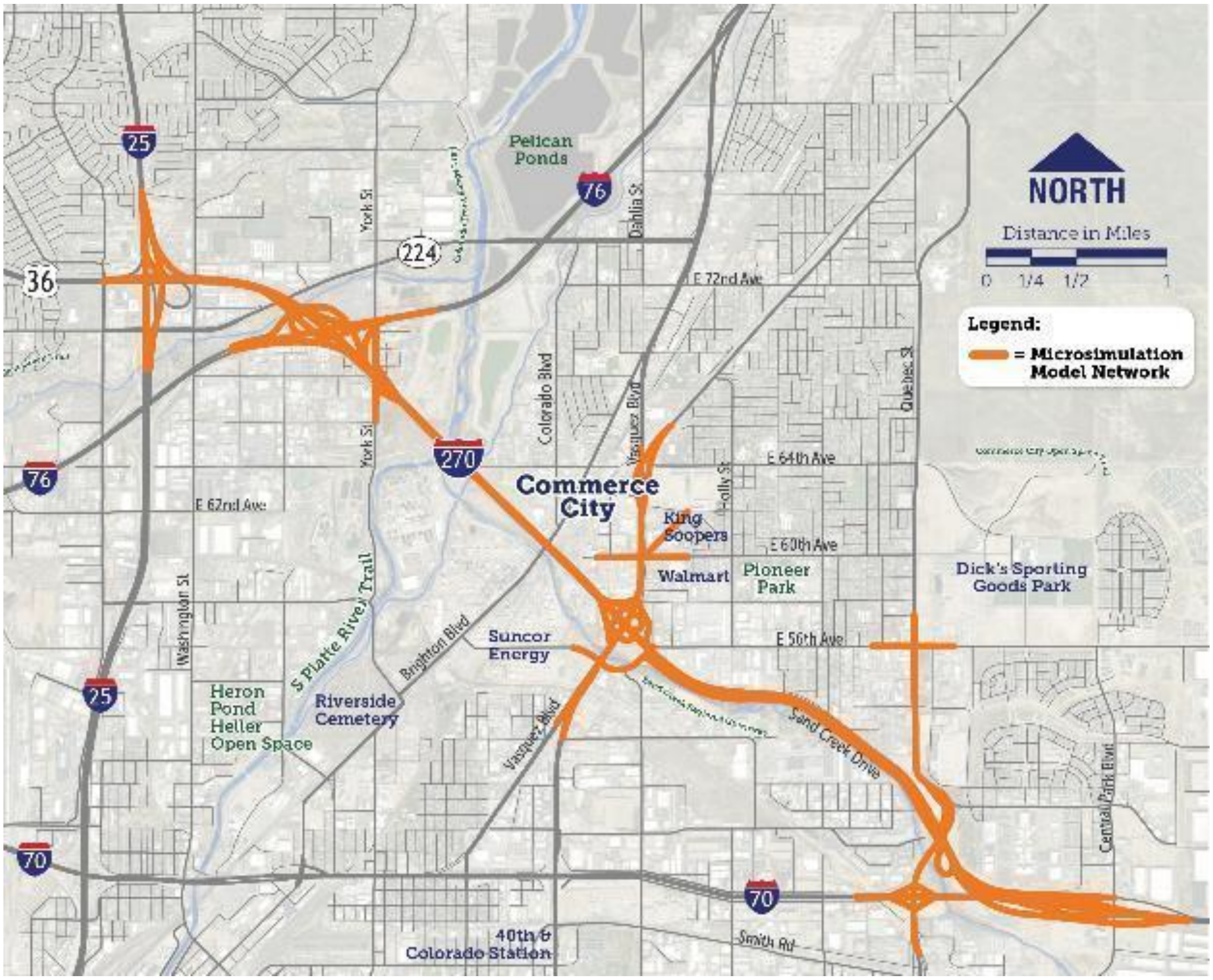
3.1 Study Area and Model Boundaries

For urban freeways, like I-270, the spatial limits of the study area should include upstream queuing, and temporal limits should capture the beginning and end of congestion to confirm that the model and traffic data capture the true demand volume and not just the volume served.

The modeling limits include the following roadways and interchanges (all interchange ramps are included, unless noted otherwise), see Figure 2:

- I-270 (Interstate 25 [I-25] to Interstate 70 [I-70])
- I-270/I-25 Interchange (including the: (1) the Westbound (WB) I-270 to Northbound (NB) I-25 and (2) Southbound (SB) I-25 to Eastbound (EB) I-270 ramps)
- I-270/Interstate 76 (I-76) Interchange (including all ramps and mainline I-76)
- I-270/York Street Interchange
- I-270/Vasquez Boulevard Interchange
- Vasquez Boulevard – Ramps to/from Old State Highway 2 (Old SH 2) to the north and extending south to the ramps to/from Colorado Boulevard
- I-270/Quebec Interchange
- I-70/Quebec Interchange
- I-270/I-70 Interchange
- I-270 ramps to/from Central Park Boulevard: (1) the eastbound I-270 off-ramp to Central Park Boulevard and (2) the westbound I-270 on-ramp from Central Park Boulevard

Figure 2. I-270 Project Modeling Limits



The analysis evaluated the morning (a.m.) and afternoon (p.m.) peak periods to capture the onset and dissipation of peak hour congestion. The a.m. (6–10 a.m.) and p.m. (4–7 p.m.) peak periods were identified based on data obtained as part of the project data collection efforts and historic congestion patterns on I-270.

3.2 Selection and Justification of Traffic Analysis Tools

This section summarizes the analytical tools selected for the I-270 EIS traffic and transportation analysis. Additional information can be found in Attachment A, Microsimulation Methods and Assumptions Technical Memorandum (updated February 2024).

The project team selected the DRCOG Focus version 2.3.2 Travel Demand Model and TransModeler 6.1 microsimulation software as the primary tools for the I-270 traffic analysis. These tools provide accurate traffic forecasts and detailed simulations, meeting the technical requirements established by CDOT and FHWA.

3.2.1 TransModeler (Version 6.1) Microsimulation Modeling Software

Microsimulation modeling has been selected as a primary tool for analyzing and predicting the operational performance of both current and proposed conditions on I-270. The project team selected TransModeler microsimulation software for the I-270 traffic analysis to maintain consistency with previous traffic studies conducted along the corridor, which also used TransModeler. TransModeler version 6.1, the most up-to-date version available at the time the analysis began, was used for all analyses.[1]

3.2.2 DRCOG Travel Demand Model

The team chose the DRCOG Focus version 2.3.2 Travel Demand Model to generate long-range travel forecasts that comply with the federal mandate under 23 CFR Part 450 for a 20-year transportation planning horizon. As the standard regional model, DRCOG's Focus model accurately reflects both passenger and commercial vehicle interactions in the Denver metro area. By aligning with the 2050 MVRTP, the model also ensures compliance with federal air quality and transportation planning requirements, making it the most suitable tool for forecasting long-term traffic impacts in the I-270 corridor.

The analysis uses the 2023 base year and 2050 horizon year travel demand models from Focus version 2.3.2 for the existing and future traffic condition analyses.

3.3 I-270 EIS Traffic Working Group

The Traffic Working Group for the I-270 EIS was formed to manage and ensure the technical integrity of travel demand modeling and traffic analysis. The group included technical experts from CDOT, FHWA, DRCOG, and consultants from the Felsburg Holt & Ullevig (FHU) modeling team.

A key function of the group was its ability to foster collaboration between CDOT, FHWA, and DRCOG, which ensured that all stakeholders were aligned on the modeling assumptions and approaches used for the I-270 EIS. The Traffic Working Group played a crucial role in reviewing and refining the assumptions used in both travel demand and microsimulation model development and calibration processes. The collective expertise of the group guided calibration decisions, such as capacity adjustments, speed modifications, and parameters adjustments, to ensure that the model outputs reflected the observed real-world conditions. In doing so, the group not only improved the accuracy of the models but also ensured that the analytical process was methodologically sound, consistent with industry best practices, and compliant with regulatory standards.

4.0 Data Collection for Model Calibration and Validation

Microsimulation studies require extensive data collection efforts for base model development, determining travel conditions and calibration. The data collection and preparation process were critical to developing an accurate microsimulation model for the I-270 corridor.

[1] TransModeler 7.0 was officially released in April 2023. The decision to continue using TransModeler 6.1 for the I-270 analysis was made to maintain project momentum, and because it was the latest available version when the study began. TransModeler 6.1 provided the necessary capabilities for complex traffic simulation, including modeling interactions between general-purpose and express lanes.

This section outlines the data requirements, sources, and processing steps essential for establishing a calibrated and validated model (See Attachment B, Traffic Analysis Data Collection Plan, April 2023).

4.1 Data Collection – Base Model Development

The data collection for the base model development included traffic demand, vehicle characteristics, driver behavior, roadway geometry, and traffic control data. Traffic counts were aggregated into 15-minute intervals and recorded alongside vehicle classification, spot speeds, and field observations to capture demand patterns and vehicle types. Field observations documented driver behaviors, such as lane usage and gap acceptance, and assessed bottleneck throughput using travel times and queuing patterns.

Roadway geometry data, confirmed through both desktop and field reviews, included lane configurations, signage, and pavement markings. Traffic control elements, including signal timings and ramp meter settings, were also integrated as provided by CDOT, Denver, and Commerce City. For more detailed information, please refer to Attachment B, Traffic Analysis Data Collection Plan.

4.2 Data Collection – Determining Travel Conditions

Data to support the cluster analysis and identify typical conditions for model calibration included historic volume, travel times, weather, and incident data. Historic demand data was obtained from CDOT's automatic traffic recorder (ATR) on I-270 near York Street. INRIX provided eastbound and westbound travel time data for segments of I-270. Initially, weather data was sourced from CDOT's Road Weather Information System (RWIS), but concerns about its accuracy led to the selection of the National Weather Service (NWS) dataset, which offered more comprehensive weather information. CDOT provided incident data with details on crash types, lane closures, incident locations, and clearance times. For further details, please refer to Attachment B, Traffic Analysis Data Collection Plan and Attachment C, Cluster Analysis Technical Memorandum.

5.0 Identification of Model Calibration Targets

A key step in the microsimulation process is the development of a calibrated and validated TransModeler model to reflect existing travel conditions.

Consistent with the FHWA Toolbox, the I-270 model calibration process included the following three steps:

1. **Identify Representative Day** – Data collected as part of the data collection program were assembled and evaluated in a cluster analysis to identify key travel condition variables for calibration.
2. **Preparation of the Variation Envelopes** – Time-dynamic envelopes to reflect the variation in observed field data were selected calibration performance measures based on the variability, identified in the dominant clusters. Variation envelopes served as the calibration targets for the microsimulation calibration.

3. **Calibration of the Model within Acceptable Criteria** – The model parameters were iteratively adjusted until calibration performance measures were acceptably close to the target variation envelope.

This section provides a high-level summary of the first two steps in the calibration process. Step three is addressed in Section 7.0, Model Calibration. Detailed information on the cluster analysis used to identify the representative day can be found in Attachment C, Cluster Analysis Technical Memorandum. Similarly, Attachment D, Microsimulation Calibration Technical Memorandum provides detailed information about the preparation of the variation envelopes.

5.1 Identification of the Representative Day (Cluster Analysis)

The purpose of the cluster analysis was to identify distinct travel conditions on the I-270 corridor, to ensure the model accurately reflected typical traffic demand and patterns. This analysis segmented data by direction and peak periods, creating models for eastbound and westbound travel during both a.m. and p.m. peak times.

Due to limited available data, the EIS team chose to calibrate the model to the "dominant cluster," which best represented the most common traffic conditions on I-270.

The cluster analysis used data from INRIX travel times, ATR demand, and weather/incident records collected between January 2022 and May 2023.

Exploratory Data Analysis (EDA) identified key parameters, such as travel times, peak volumes, incident duration, severity, and visibility, to highlight relationships and improve the accuracy of the cluster analysis. The Elbow Method and silhouette scores helped determine the optimal number of clusters and the best clustering algorithm. After testing K-means, Bayesian Gaussian, and hierarchical clustering algorithms, K-means were chosen due to its consistently high silhouette scores, indicating well-defined clusters.

Comprehensive data collected on May 2–4, 2023, revealed that these days consistently fell within the dominant cluster. Among them, May 4 was selected as the most representative day due to the detailed data available, which formed the basis for the existing conditions model calibration.

5.2 Preparation of Calibration Envelopes

Per guidance in the FHWA Toolbox, effective calibration of a microsimulation model requires at least two key performance measures: one related to travel time or speed along I-270 and one related to bottleneck dynamics on the corridor. Following this guidance, the I-270 calibration used the cluster analysis results to create variation envelopes for travel times and bottleneck dynamics. These envelopes became the targets for calibrating the model to existing conditions.

5.2.1 Travel Time Measures

Travel time envelopes were based on INRIX data from the cluster analysis. For westbound traffic, the envelope covered the segment from just west of the I-70 and Central Park Boulevard on-ramps to where I-270 transitions into US 36. For eastbound traffic, the envelope represents the segment from where US 36 becomes I-270 to just west of the I-70 and Central

Park divergence. Travel times from the dominant cluster were evaluated in 15-minute intervals to plot the ±1 and ±2 standard deviation bands.

The calibration also identified two critical time periods: the time interval with the highest observed travel time and the second highest in a non-adjacent interval to evaluate how well the model reflected congestion. This approach ensured the model accurately captured peak congestion periods and variations in traffic flow.

Additional information and plots of the travel time calibration envelopes are included in Attachment D, Microsimulation Calibration Technical Memorandum.

5.2.2 Bottleneck Dynamics

Bottleneck locations are defined by where demand exceeds facility capacity, and speeds drop below the bottleneck congestion speed threshold. The bottleneck analysis used data from a continuous counter between the York Street and Vasquez Boulevard interchanges, capturing traffic flow from both the eastbound bottleneck near York Street and the westbound bottleneck near Vasquez Boulevard.

It is important to note that this data was limited to one-hour intervals, giving fewer points for calibration. To improve accuracy, additional speed data was collected every 15 minutes upstream of bottlenecks to better capture the start and duration of congestion. While hourly data still provided the main throughput information, two critical time periods were selected within each peak, with the p.m. peak intervals set at 4–5 p.m. and 6–7 p.m. and the a.m. peak at 6–7 a.m. and 8–9 a.m. This approach ensured the model accurately reflected peak congestion patterns.

Additional information and plots of the bottleneck throughput calibration envelopes are included in Attachment D, Microsimulation Calibration Technical Memorandum.

5.3 Calibration of the Model within Acceptable Criteria

Consistent with the FHWA Toolbox, the travel time and bottleneck throughput calibration criteria include:

- CRITERION I: 95 percent of simulated outputs fall within the ~2 Sigma Band. Note: If fewer than 20 time intervals are used to characterize time-dynamics, Criterion I is relaxed to allow for one simulated result outside the ~2 Sigma Band.
- CRITERION II: Two-thirds of the simulated results (and both critical time intervals) fall within the 1 Sigma Band for this travel condition.
    - Critical time intervals are defined by the time of congestion onset (speed falls below the congestion threshold) and dissipation (when speed rises above the congestion threshold).
- CRITERION III: The Bounded Dynamic Absolute Error (BDAE) criterion is used to ensure that the simulation results are close to the representative day, by ensuring that the average simulated absolute error from the representative day over all time intervals is less than or equal to differences from the representative day seen across all days in the relevant cluster. The BDAE threshold is calculated as follows:

$$BDAE\ Threshold = \frac{\sum_{i \neq r} \sum_{t} \frac{\left(\left|c_r(t) - c_i(t)\right|\right)}{N_T}}{N_{cluster} - 1}$$

Where:

$c_r(t)$	Observed value of representative day during time interval t
$c_i(t)$	Observed value of non-representative day within the cluster during time interval t
N_T	Number of time intervals
$N_{cluster}$	Number of days in the cluster representing the travel condition

- CRITERION III is met when:

$$\frac{\sum_t \left|c_r(t) - \tilde{c}_i(t)\right|}{N_T} \leq BDAE\ Threshold$$

Where:

$\tilde{c}_r(t)$	Simulated performance measure during time interval t

- CRITERION IV: The Bounded Dynamic Systematic Error criterion ensures that the simulated data are not excessive over- or under-estimators and uses a test similar to Criterion II, but with respect to average simulated error (not absolute).
    - CRITERION IV is met when:

$$\left|\frac{\sum_t c_r(t) - \tilde{c}_i(t)}{N_T}\right| \leq \frac{1}{3} \times BDAE\ Threshold$$

As previously noted in the Attachment A, Microsimulation Methods and Assumptions Technical Memorandum, the calibration employs a hybrid approach that uses the previous individual link flows, modeled vs. observed, calibration criteria.

According to these criteria, individual link flows (modeled versus observed), should have a calibration acceptance target of more than 85 percent of network links or additional critical links or movements.

Select I-270 mainline links and ramps were identified as critical links for calibration to meet the following criteria:

- Within 100 vehicles per hour (vph) for volumes less than 700 vph
- Within 15 percent for volumes between 700 and 2700 vph
- Within 400 vph for volumes greater than 2700 vph

6.0 Base Model Development

The existing conditions model also serves as a baseline for evaluating the potential impacts of proposed transportation improvements, allowing for a direct comparison between existing conditions and future alternatives.

By calibrating the model with observed traffic data and field measurements, the model ensures that future analyses accurately reflect how drivers operate on the corridor and the ability of alternatives to address current operational challenges, such as peak period delays and travel time reliability.

Base model development involves constructing the initial microsimulation network and defining inputs, including vehicle volumes, traffic signal control, vehicle types, and roadway alignment details. For further details on model development, please refer to Attachment A, Microsimulation Methods and Assumptions Technical Memorandum and Attachment, Microsimulation Calibration Technical Memorandum.

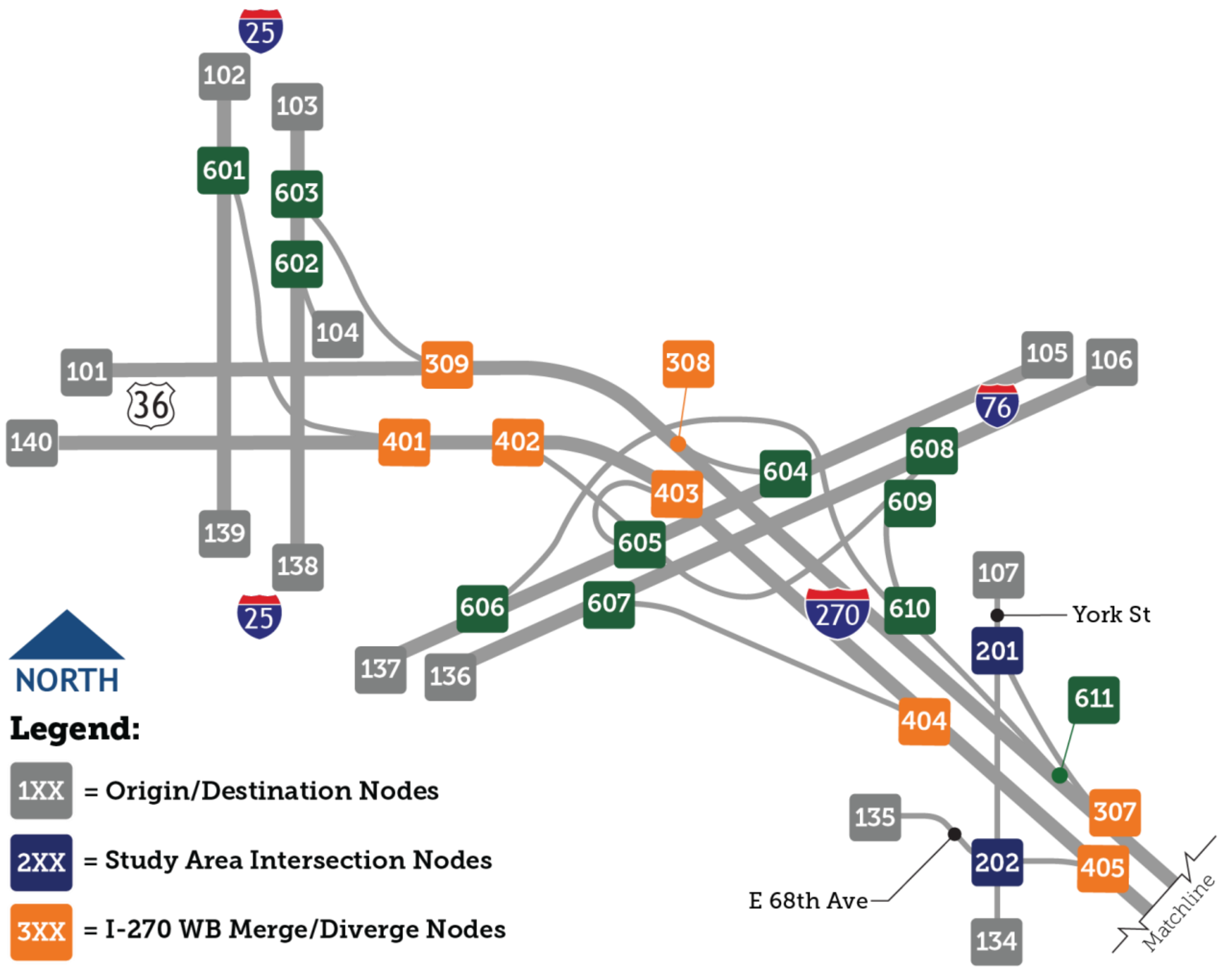
6.1 Defining the Roadway Network

The link-node diagram serves as the blueprint for constructing the base microsimulation model, detailing all highways, roadways, and intersections included in the model. The TransModeler network was built, as shown in the node diagram depicted in Figures 3 and 4 and represents the existing I-270 roadway network as of May 2023. Figure 3 illustrates the network for I-270 from the I-25/US 36 interchange to the York Street interchange and Figure 4 illustrates the network for I-270 from the Vasquez Interchange to I-70.

The model was designed to replicate travel dynamics, roadway geometry, traffic control features, and vehicle demand along the I-270 corridor. Key elements incorporated into the base model include:

- **Geometric data:** Roadway features, such as lane configurations, turn lanes, and pavement markings, were included based on field observations and desktop reviews of aerial imagery
- **Control data:** Signal timings and ramp meter settings were incorporated for intersections and ramps within the corridor using data provided by CDOT, Denver, and Commerce City
- **Grade and elevation:** Elevation data for roadways, ramps, and bridges was incorporated into the model using survey data, provided by the design team; survey data was collected in April 2020

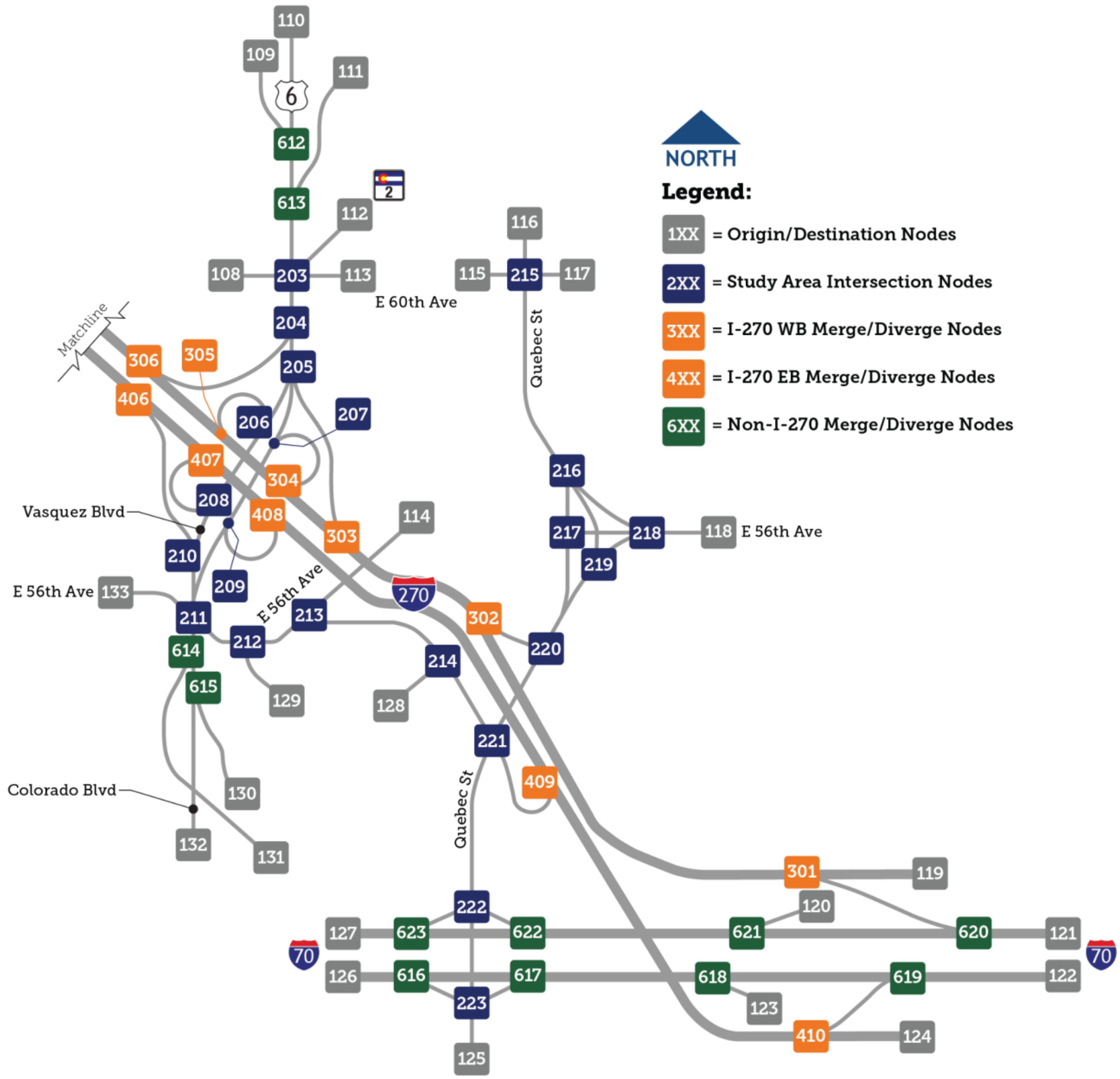
Figure 3. Existing (2023) Network Node Diagram - I-270 from the I-25/US 36 Interchange to York Street Interchange



Legend:

- 1XX = Origin/Destination Nodes
- 2XX = Study Area Intersection Nodes
- 3XX = I-270 WB Merge/Diverge Nodes
- 4XX = I-270 EB Merge/Diverge Nodes
- 6XX = Non-I-270 Merge/Diverge Nodes

Figure 4. Existing (2023) Network Node Diagram - I-270 from the Vasquez Boulevard Interchange to I-70



6.2 Traffic Demand Data

Development of the traffic demand data model inputs began with post-processing of the May 3, 2023, traffic count data, as it represented the most comprehensive dataset available. All mainline and intersection counts were aggregated and adjusted to produce an internally consistent set of volumes for every link and node in the microsimulation model.

While the May 3, 2023, data collection program was comprehensive, the balancing exercise identified the need for a sink and source node along Sandcreek Drive, to account for locations where traffic counts were not recorded for all the unsignalized intersections and accesses. A source and sink node (node 214) was added to Sandcreek Drive to achieve an internally balanced network for all vehicles. These adjustments were used to create inputs for the representative day model.

6.3 Vehicle Composition

Vehicle composition refers to the mix of different types of vehicles on the road, represented as a percentage of total traffic. For this project, data was collected to classify vehicles into three categories: light-duty (passenger cars), medium-duty (smaller trucks and delivery vehicles), and heavy-duty (large trucks). Classification counts were recorded at all signalized intersections, ramps, and at key locations along mainline I-270. The classification count data informed traffic demand and origin-destination (O-D) inputs for each of the three vehicle categories to more accurately reflect real-world conditions in the simulation.

6.4 Traffic Assignment and Routing

In the I-270 microsimulation model, traffic assignment and routing were developed using TransModeler's Origin-Destination Matrix Estimation (ODME) tool. This tool generated an O-D matrix that matched the observed traffic counts by aligning link volumes and turning movement volumes.

Adjustments were made to the O-D matrices and routing data for light-, medium-, and heavy-duty vehicles to reflect May 4, 2023, traffic conditions.

6.5 Error Checking

Before starting the calibration process, the microsimulation network and link connectivity error checks were run, and all identified errors were addressed. The error check process was repeated iteratively, until no errors were identified.

7.0 Model Calibration

The model calibration process involved reviewing and adjusting model parameters to match observed traffic conditions on the representative day.

7.1 Visual Inspection with Typical Day Inputs

The calibration began with a visual inspection of the simulated model to ensure proper operation. This included checking traffic signals, general vehicle operations, and system performance measures, like throughput and travel times, to confirm that demand data had been accurately input into the model.

Global parameters were adjusted first to reflect the observed conditions. Localized parameters were then modified, as needed, to replicate bottleneck dynamics, particularly at key congestion points. This iterative approach led to further refinements, as detailed below.

7.2 Peak Period Bottleneck Formation

Field observations and traffic counts revealed distinct driver behaviors, contributing to eastbound and westbound bottlenecks. For eastbound traffic, bottlenecks during peak periods were observed forming near the York Street and I-76 interchanges and influenced by merging activity from the I-76 ramps. During the p.m. peak, the bottleneck extended westward and was also impacted by merging traffic from southbound I-25.

The westbound bottleneck, near the Vasquez Interchange, was influenced by tightly spaced ramps, loop ramp constraints, and poor pavement quality, which reduced vehicle speed and increased braking. Default model parameters were insufficient to fully capture these bottleneck effects, and targeted calibration adjustments were required to replicate these conditions.

7.3 Summary of Calibration Adjustments

The following adjustments were made to the base model to achieve model calibration:

- Developed separate time demand provides for eastbound and westbound traffic on the I-270 corridor to better reflect observed overall volume throughput and travel time curves.
- Adjusted driver behavior headway car following parameters to mimic observed throughput capacity.
- Adjusted p.m. peak period O-D matrix loading times to more accurately reflect bottleneck throughput and timing of vehicles, reaching key bottleneck locations at observed times.

The a.m. and p.m. peak period base models were deemed to have been adequately calibrated and meet all calibration acceptance targets. Detailed information about the model calibration process and adjustments are summarized in Attachment D, Microsimulation Calibration Technical Memorandum.

8.0 Existing (2023) Traffic Conditions

The calibrated existing conditions model quantifies the existing operational conditions observed on the I-270 corridor. This section provides an overview of the existing traffic volumes, patterns, and the results of the operational analysis.

8.1 Peak Hour Traffic Volumes

The microsimulation model accurately reflects these peak periods, capturing both the morning peak from 6 to 10 a.m. and the evening peak from 4 to 7 p.m. By modeling these specific time frames, the analysis provides a realistic view of the current traffic conditions and congestion patterns, allowing for a detailed understanding of how the corridor operates during the peak hours (the times of highest demand).

This section summarizes the existing peak hour traffic volumes on I-270, highlighting the busiest times when demand on the corridor is highest. The a.m. peak hour was identified to occur between 7:30 and 8:30 a.m., while the p.m. peak hour occurs between 4:30 and 5:30 p.m.

Figure 5 illustrates a.m. and p.m. peak hour volumes on mainline I-270 and the surrounding study area interstate network. The a.m. and p.m. peak hour study area intersection turning movement volumes are shown on Figures 6 through 11.

The traffic analysis used specific performance measures identified and defined in Attachment A, Microsimulation Methods and Assumptions Technical Memorandum to evaluate the ability of the No Action and Build Alternatives to address the project Purpose and Need. These measures of effectiveness (MOE) are selected to provide a comprehensive understanding of corridor performance and are consistent with FHWA guidelines.

Figure 5. Existing (2023) Mainline I-270 Peak Hour Traffic Volumes

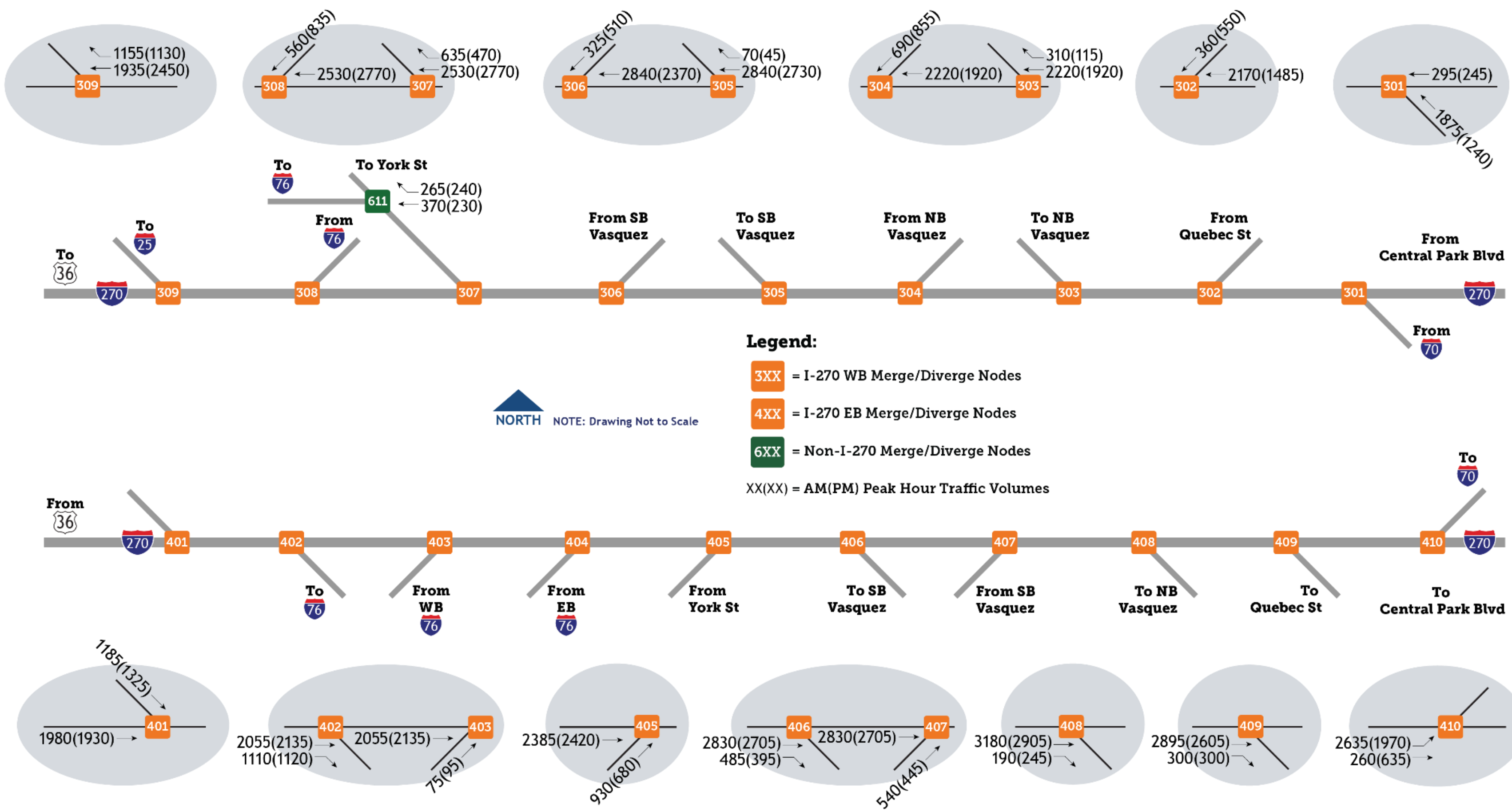


Figure 6. Existing (2023) I-25 Peak Hour Traffic Volumes

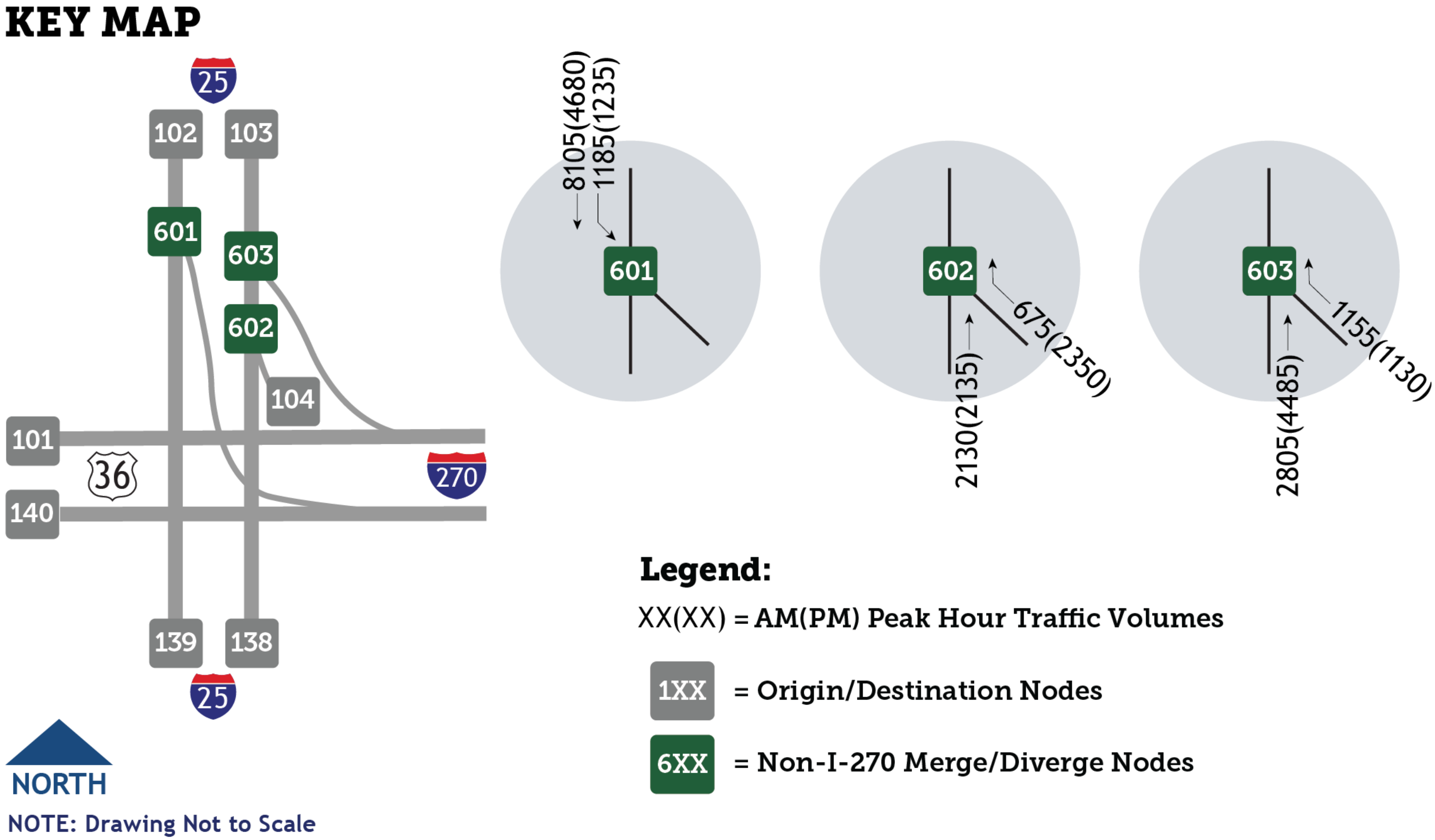


Figure 7. Existing (2023) I-76 and York Street Peak Hour Traffic Volumes

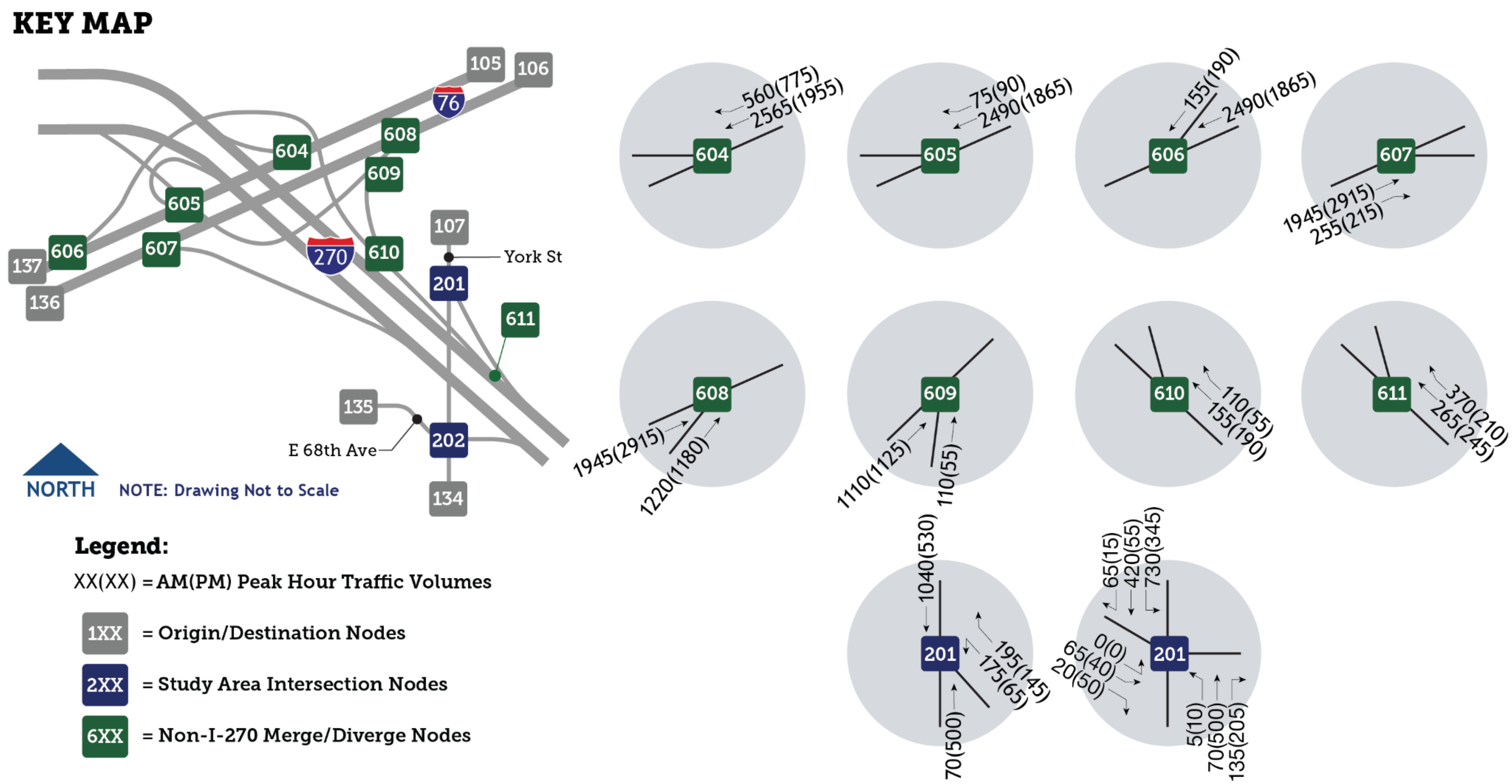


Figure 8. Existing (2023) Vasquez Boulevard Interchange Peak Hour Traffic Volumes

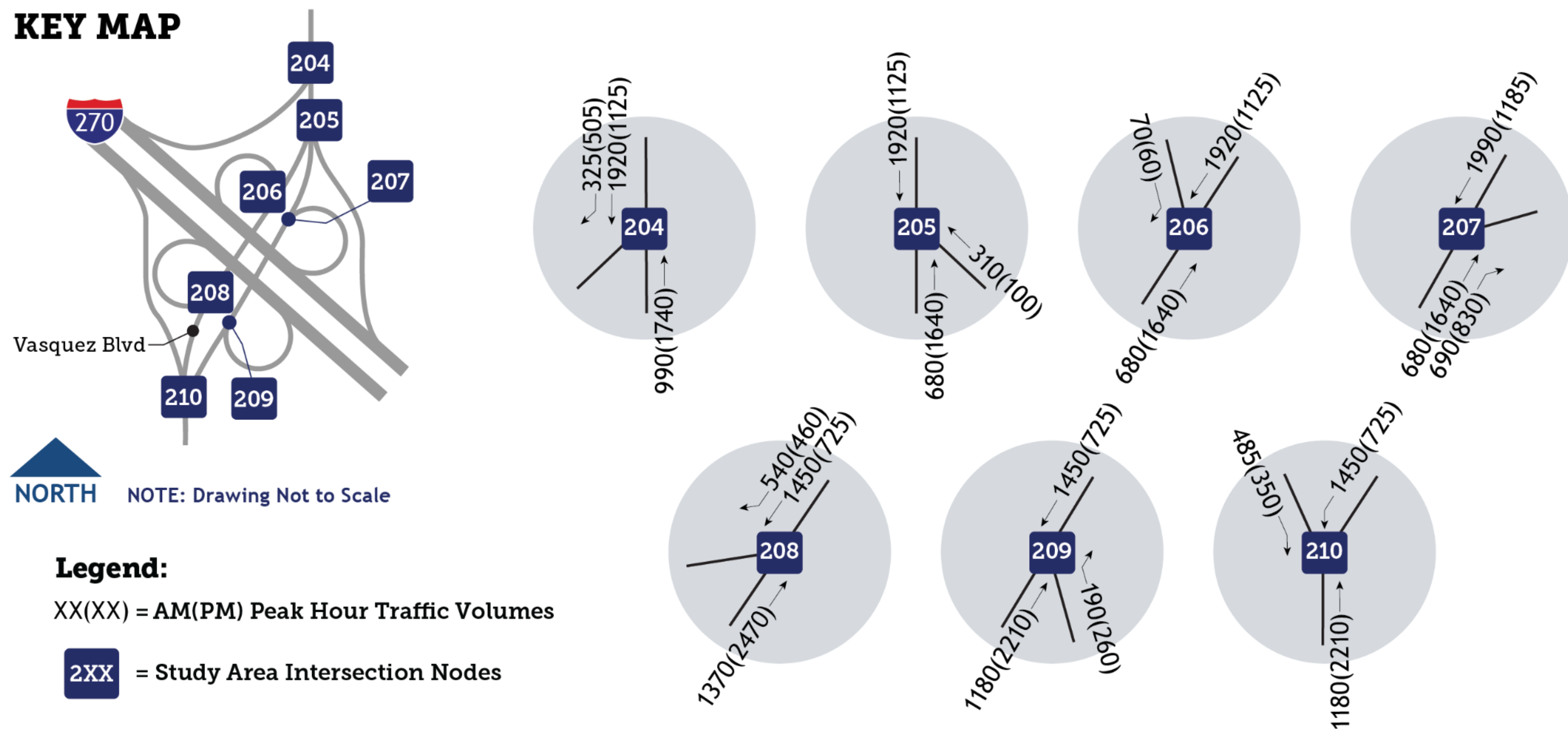


Figure 9. Existing (2023) Vasquez Boulevard Peak Hour Traffic Volumes

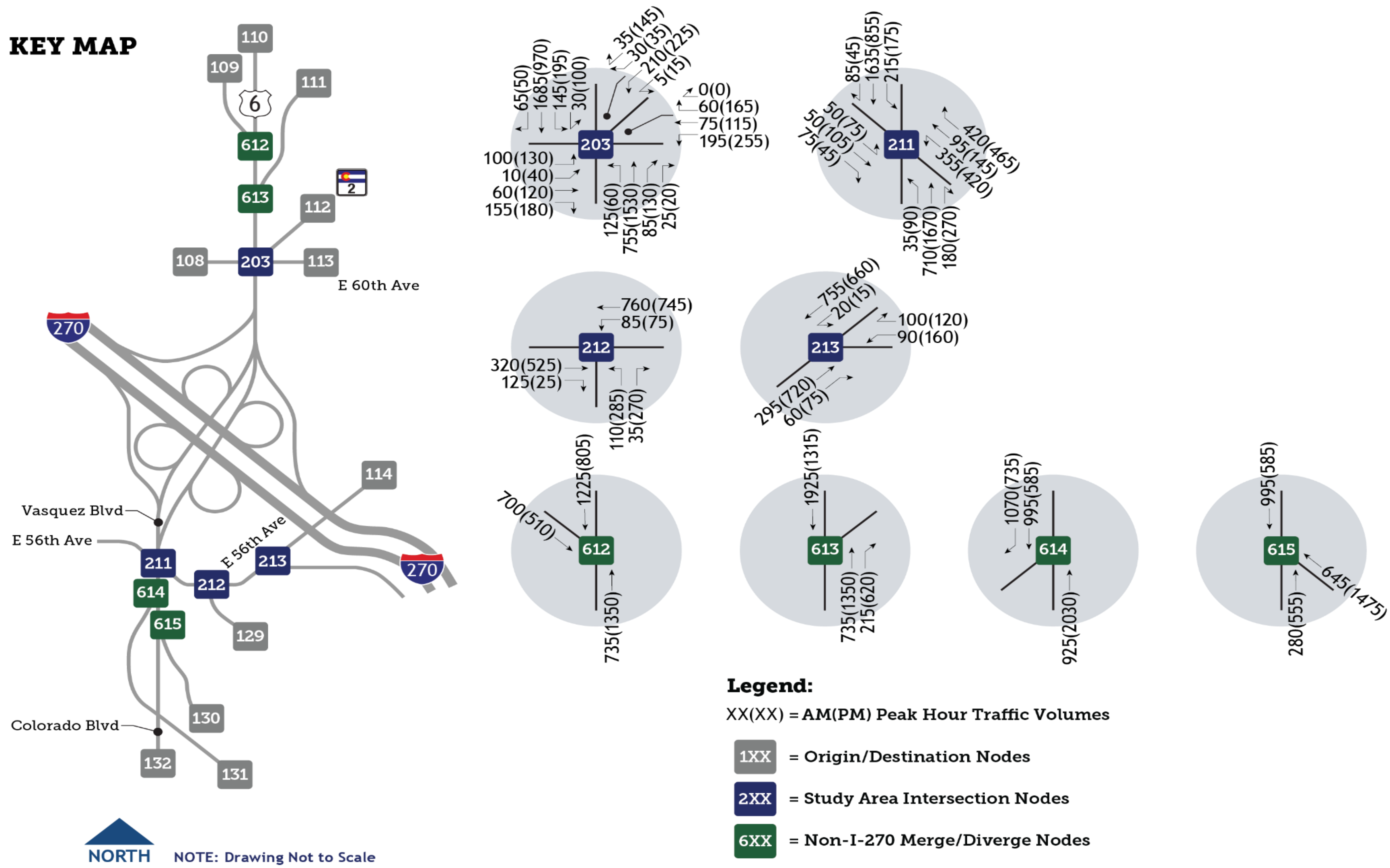
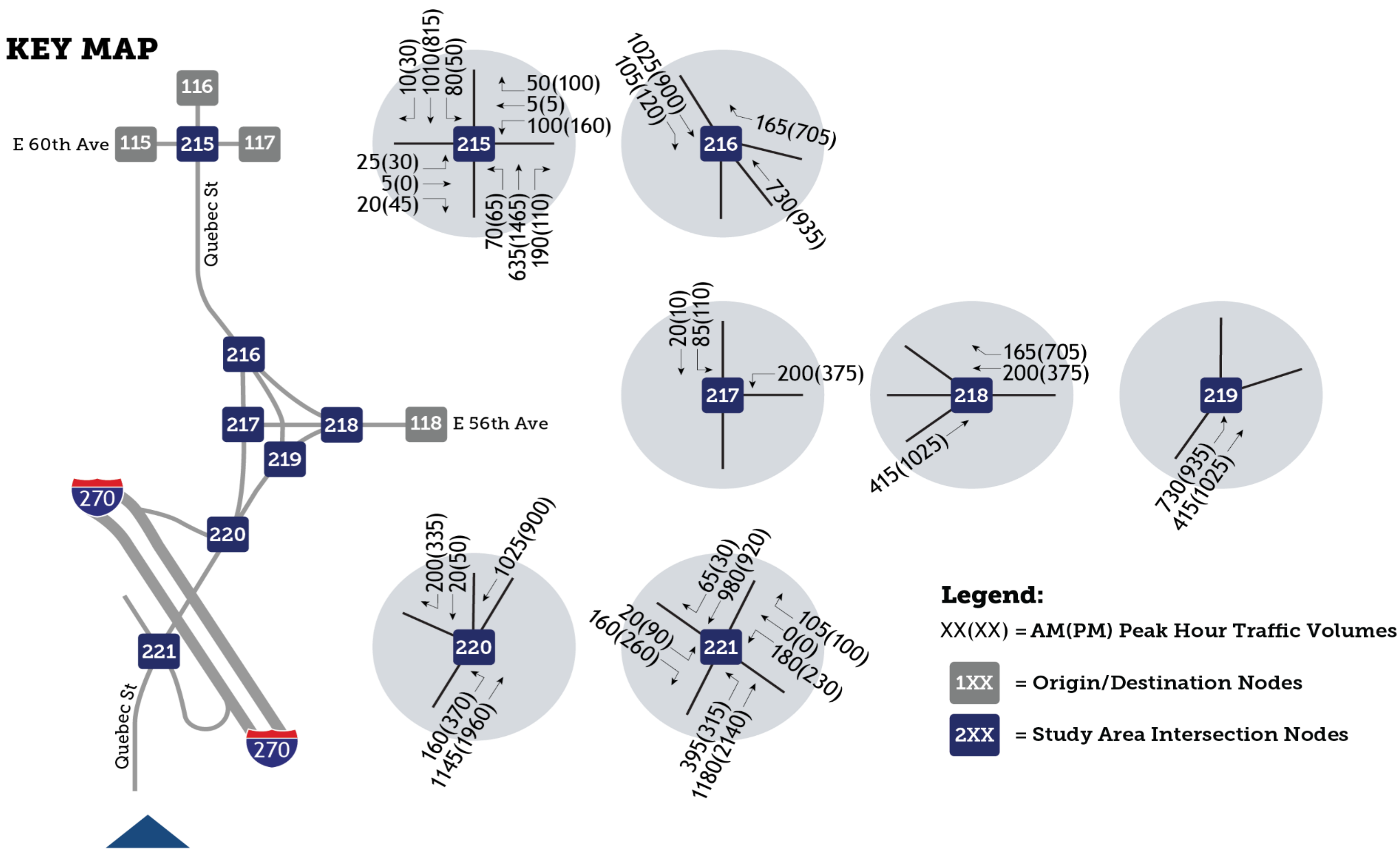
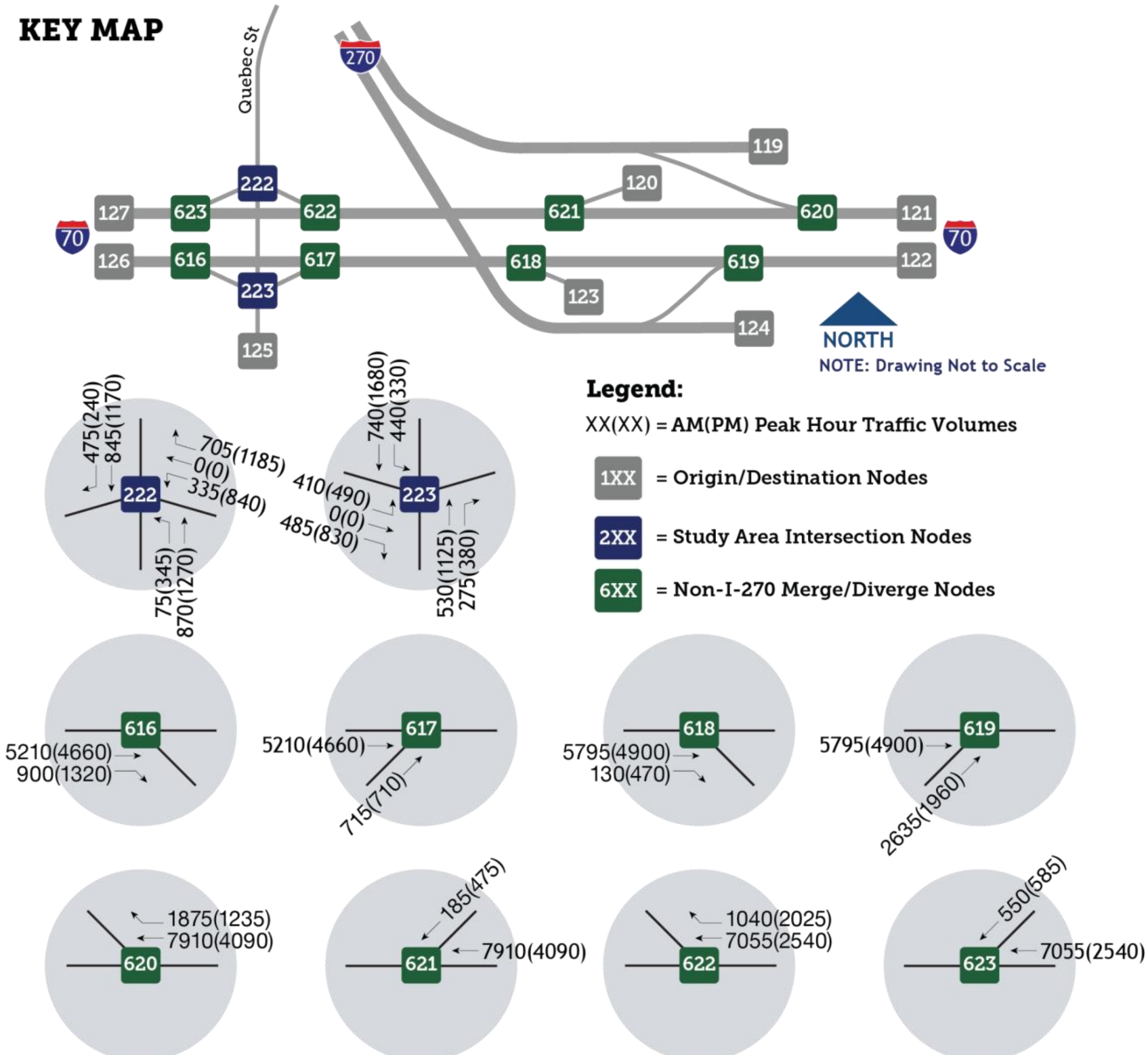


Figure 10. Existing (2023) Quebec Street Peak Hour Traffic Volumes



NOTE: Drawing Not to Scale

Figure 11. Existing (2023) I-70 Peak Hour Traffic Volumes



9.0 Travel Demand Model Calibration

The DRCOG travel demand model (Focus 2.3.2) was calibrated to reflect the observed real world travel patterns within the I-270 project study area. The purpose of the base model calibration process is to improve the ability of the 2023 base year travel demand model to reflect the observed conditions on the I-270 corridor. The calibration process is not intended to produce modeled volumes that precisely match existing volumes. Additional information on the calibration methodology can be found in Attachment E, Travel Demand Model Calibration Methodology Technical Memorandum, September 2023.

The travel demand model was calibrated to the FHWA recommended maximum allowable average percent error for links categorized by functional classification, as defined in the CDOT Traffic Analysis and Forecasting Guidelines. See Table 1.

Table 1. FHWA Maximum Deviations for Day Volumes

Functional Classification	Allowable Percent Error (FHWA)
Freeways	± 7 percent
Principal Arterials	± 10 percent
Minor Arterials	± 15 percent
Collectors	± 25 percent
Frontage Roads/Local Road	± 25 percent

An initial comparison of the 2023 base year model traffic volumes and actual traffic counts revealed that the model was overestimating traffic on I-270; model volumes were approximately 40 percent higher than the observed counts.

9.1 Travel Demand Model Calibration Data

The data collection phase for the I-270 EIS traffic analysis was essential for providing accurate inputs to both the travel demand forecasting and microsimulation model calibration. The project team followed the CDOT Traffic Analysis and Forecasting Guidelines to ensure the data collected was consistent with the requirements for both travel demand model and microsimulation model calibration and validation. This process was crucial for creating a reliable baseline that would reflect current traffic conditions and support accurate forecasting of future travel scenarios.

Detailed information about the data collection program developed for the I-270 Improvements Project can be found in Attachment B, Traffic Analysis Data Collection Plan, April 2023.

The travel demand model calibration and validation process relied on commonly used data, including historical traffic counts and vehicle speed information. The data collection involved multiple sources to ensure accuracy. Traffic counts were gathered from 32 locations within the I-270 corridor and surrounding roads over 24-hour periods in May 2023. These counts were critical for calibrating the travel demand model.

Additionally, data was sourced from the CDOT MS2 Traffic database, which contains multi-day traffic counts and continuous counter data, categorized by direction and lane. This data helped maintain consistency with the regional travel demand model. Historical traffic data from 2019, 2021, and 2022 was adjusted by a 2 percent annual growth rate to estimate 2023 values. Data from 2020 was excluded due to the impact of COVID-19 on traffic patterns.

Free flow speed data was obtained from INRIX, a platform that aggregates real-time traffic information from various sources, such as global positioning system (GPS)-equipped vehicles and public agencies. The INRIX data was used to estimate free flow speeds across different segments of the road network, supporting the calibration of the model.

9.2 Travel Demand Model Calibration Adjustments

The travel demand model calibration process for the I-270 corridor explored and implemented a range of refinements to ensure the model accurately represented real-world conditions. This section highlights the travel demand model calibration process.

9.2.1 Link Attributes and Centroid Connectors

The initial step in calibration focused on verifying the accuracy of link attributes and centroid connectors in the study area. This process identified discrepancies in centroid connector connectivity near the Vasquez Boulevard interchange, where some connectors suggested access not currently accommodated on the roadway. The network was updated to better reflect the permitted movements and allowed access in the interchange area, and the model was re-run. However, no substantial changes in traffic volumes were observed.

9.2.2 Roadway Capacity and Free Flow Speed

Next, the calibration process evaluated adjustments to roadway capacity and free flow speed based on recorded traffic conditions. Capacity (the maximum number of vehicles a road can accommodate) was adjusted from the default 2,000 vehicles per hour per lane (vphpl) to reflect the observed throughput volumes. The traffic working group also discussed the specific challenges, including substandard lanes, high truck volumes, and poor pavement conditions that may contribute to the reduced-per-lane capacity observed on the I-270 corridor.

Free flow speed (the speed vehicles travel under uncongested conditions) was also adjusted to better reflect the observed conditions. The Focus model initially set free flow speed on I-270 at 65 mph southeast of the Vasquez Boulevard Interchange and 70 mph northwest, but real-time data from INRIX suggested that these speeds were overestimated. The model was revised to better match actual speeds observed in the corridor.

9.2.3 Time Penalties and Other Refinements Considered

The Traffic Working Group discussed a range of potential model adjustments. Time penalty refinements, which add generalized delays to links, were considered but not implemented due to their complexity and potential unintended consequences. Instead, reducing roadway capacity proved to be a more effective method for reflecting the observed corridor congestion, particularly around the Vasquez Boulevard interchange.

9.3 Travel Demand Model Calibration Results

The final 2023 calibrated base model outputs hit the calibration targets for the I-270 mainline and ramp segments and arterial roadways in the project study area.

Detailed information is documented in Attachment F, Travel Demand Model Calibration Results Technical Memorandum, October 2023.

10.0 No Action Alternative (2050)

The calibrated travel demand model was used to develop future daily traffic forecasts for study area roadways. The calibration adjustments were applied to the DRCOG travel demand model for the 2050 long-term regional planning horizon. The DRCOG 2050 base fiscally constrained plan travel demand model includes Express Lanes on I-270 as a programmed improvement. Because Express Lanes are one of the alternatives being evaluated as part of this effort, the Express Lanes were removed from I-270 for the No Action Alternative. All other fiscally constrained plan elements in the regional roadway network were retained under the No Action Alternative.

The No Action Alternative would maintain the existing highway configuration of two general-purpose travel lanes in each direction. Bridges and pavement would continue to be repaired, but underlying infrastructure deficiencies will remain. The typical section west of Vasquez Boulevard is shown on Figure 12 and east of Vasquez Boulevard is shown on Figure 13. The TransModeler network was built, as shown in the node diagrams depicted in Figure 14 and Figure 15.

Figure 12. No Action Alternative (west of Vasquez Boulevard)

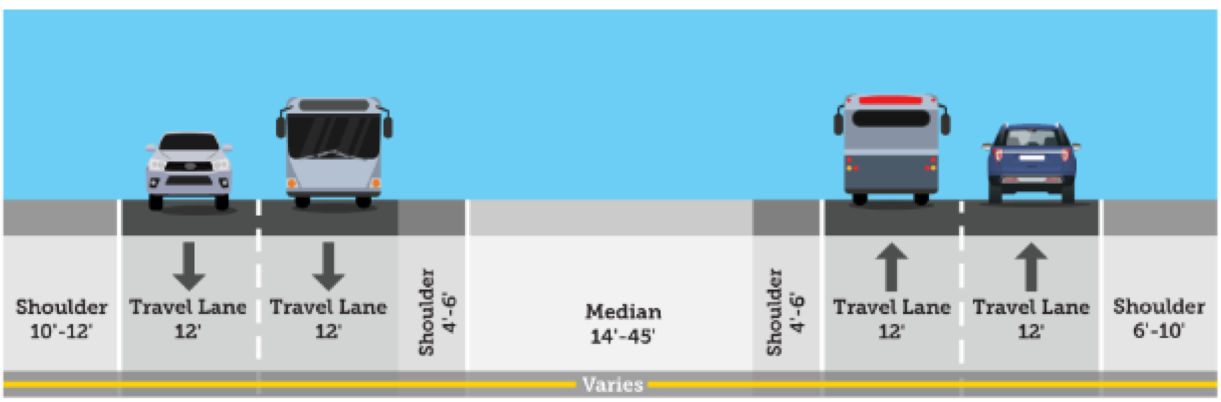


Figure 13. No Action Alternative (east of Vasquez Boulevard)

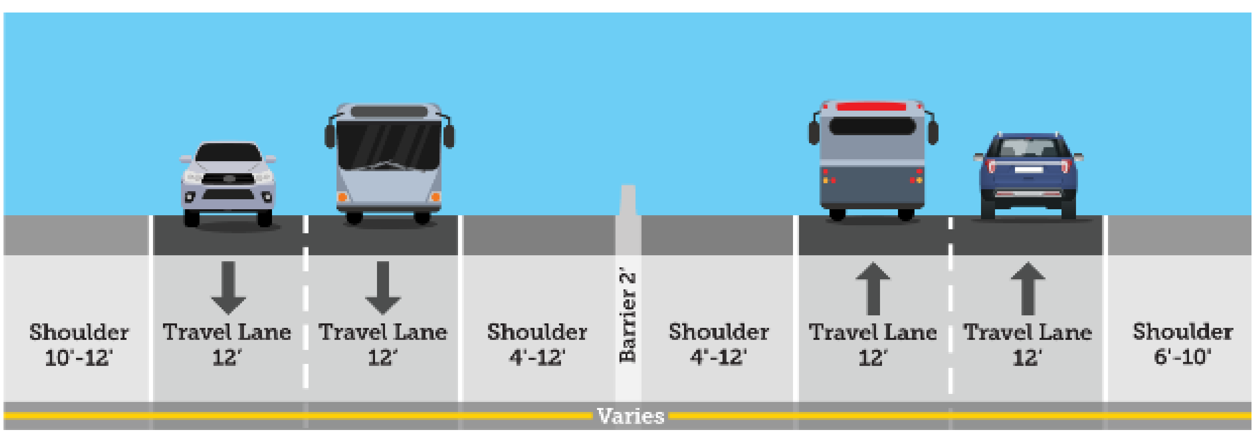


Figure 14. No Action Alternative Network Node Diagram (2050) - I-270 from the I-25/US 36 Interchange to York Street Interchange

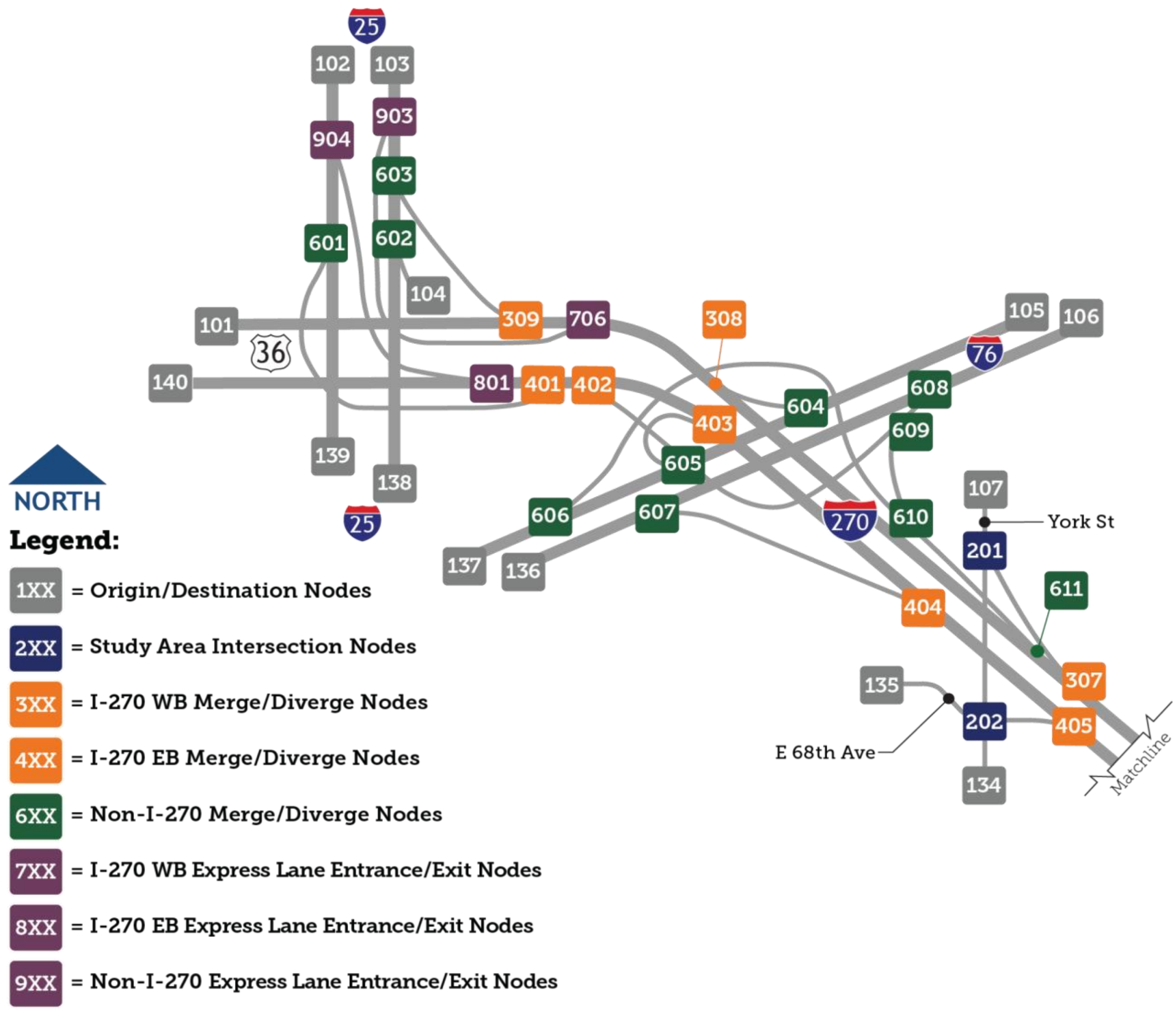
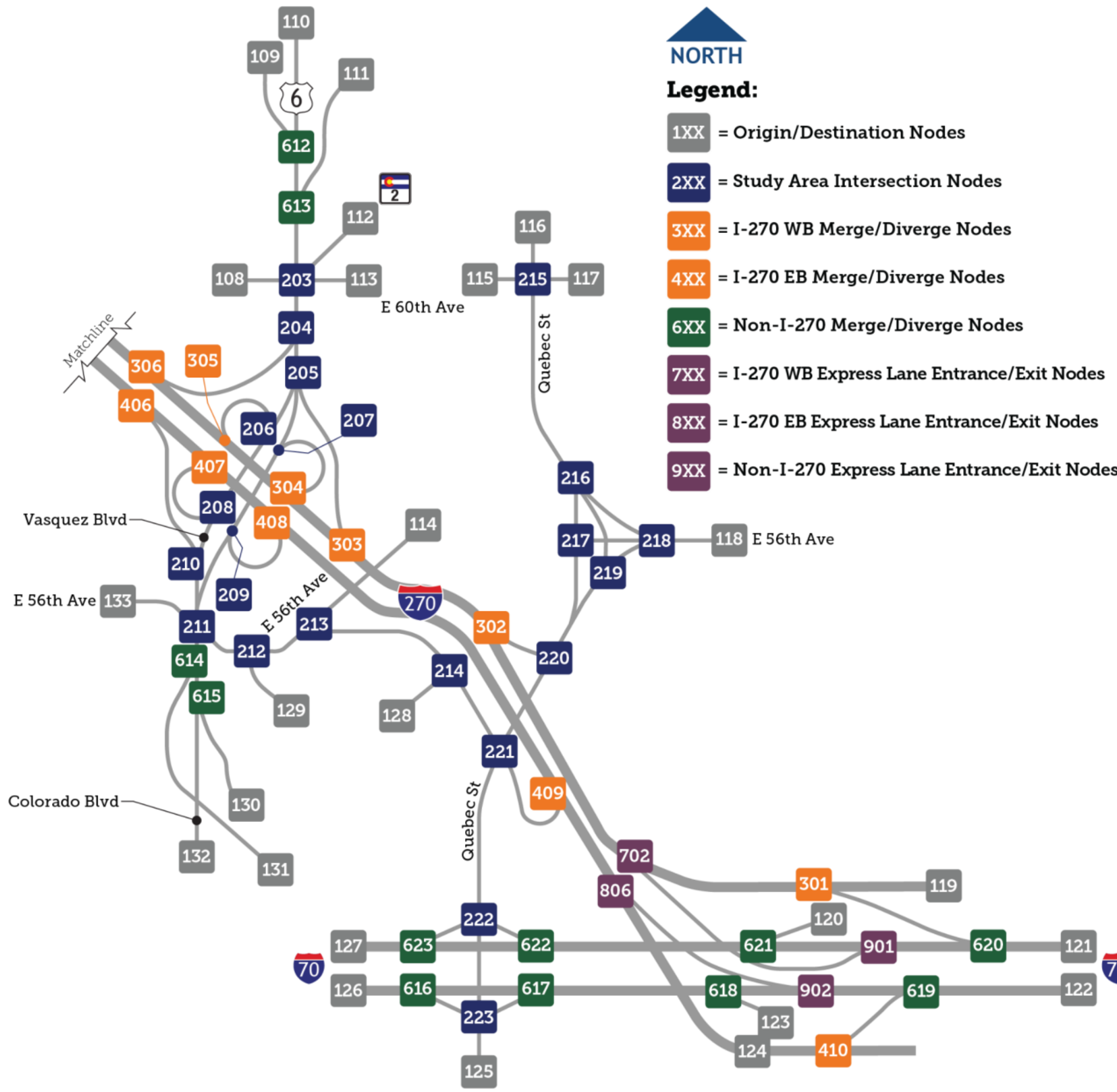


Figure 15. No Action Alternative Network Node Diagram (2050) - I-270 from the Vasquez Boulevard Interchange to I-70



10.1 No Action Alternative Traffic Volumes (2050)

The model outputs from the calibrated 2023 and 2050 regional models were used to prepare daily traffic forecasts for the study area. The forecasting process relied on methodologies described in the Transportation Research Board's (TRB) National Cooperative Highway Research Program (NCHRP) Report 765. This process recognizes that travel demand models cannot precisely match existing traffic volumes due to the complexity of real-world travel behavior. As a result, future daily forecasts are prepared by comparing existing traffic counts to the base year model, and the difference is transferred to the output from the future travel demand model. This process has been applied to all study area forecasts to develop the 2050 No Action Alternative daily traffic volumes.

Figure 16 illustrates forecasted 2050 No Action Alternative a.m. and p.m. peak hour volumes on mainline I-270 and the surrounding study area interstate network.

The a.m. and p.m. peak hour study area intersection turning movement volumes are shown on Figures 17 through 22.

Figure 16. No Action Alternative - Mainline I-270 Peak Hour Traffic Volumes (2050)

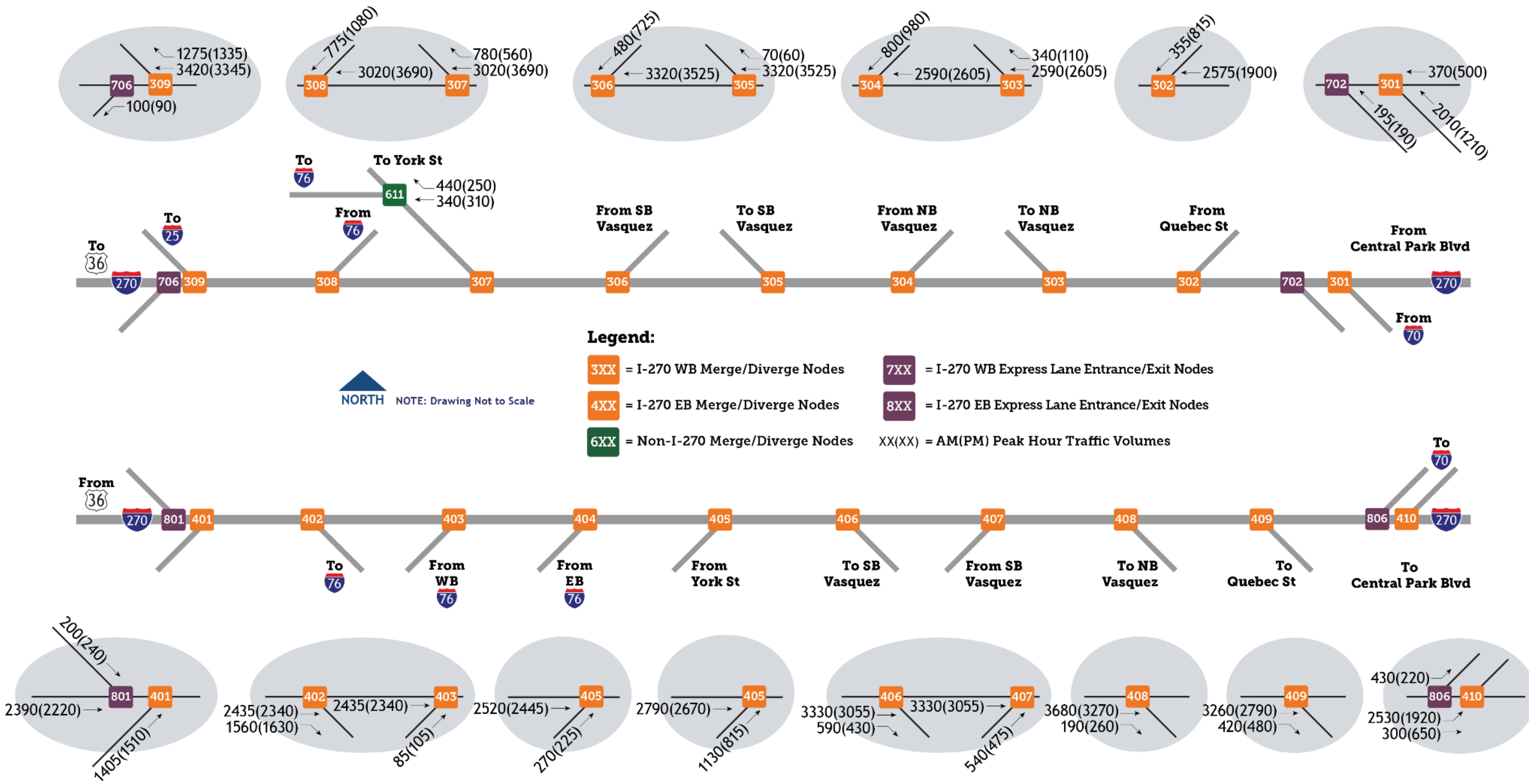


Figure 17. No Action Alternative - I-25 Peak Hour Traffic Volumes (2050)

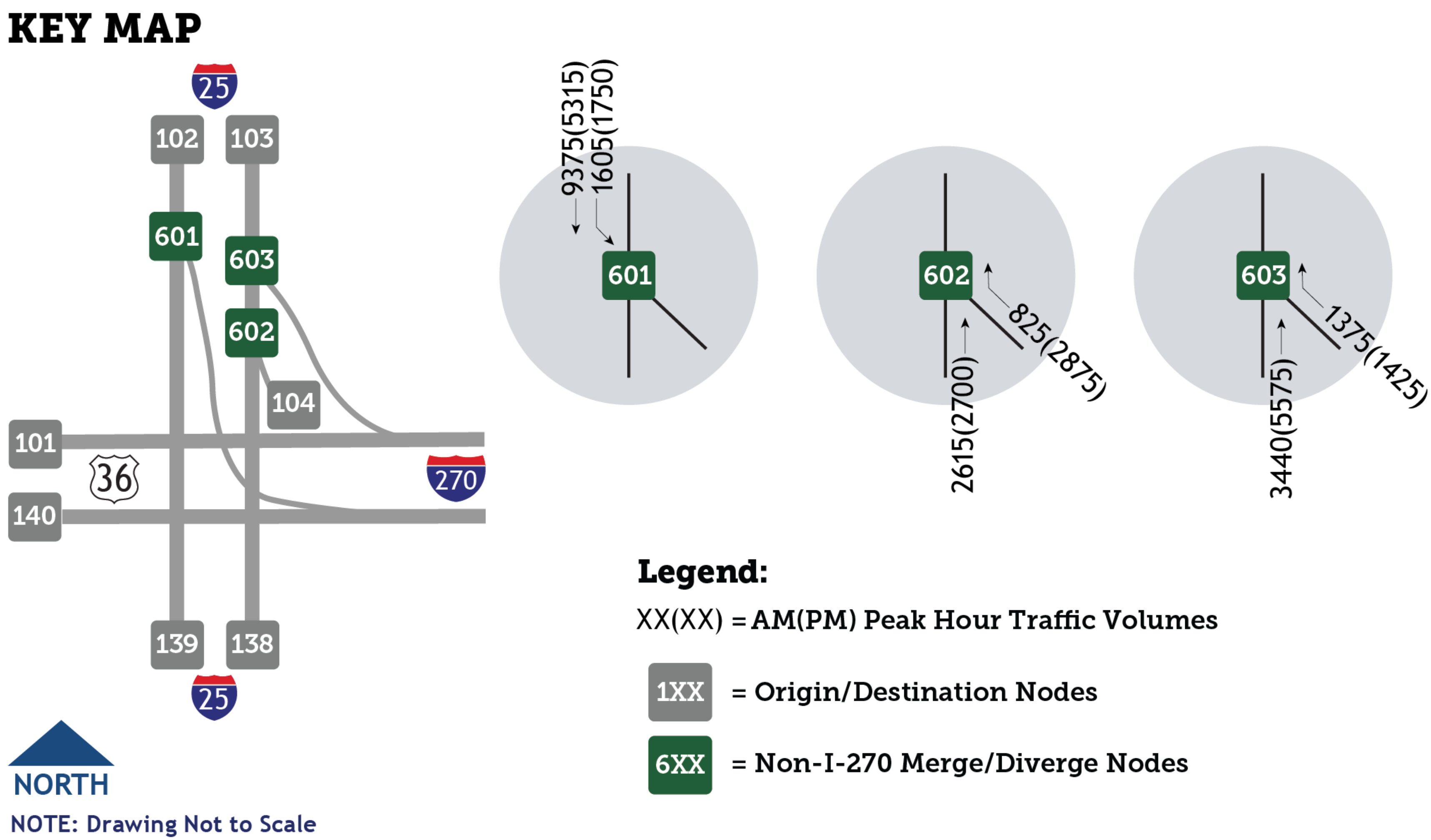


Figure 18. No Action Alternative - I-76 and York Street Peak Hour Traffic Volumes (2050)

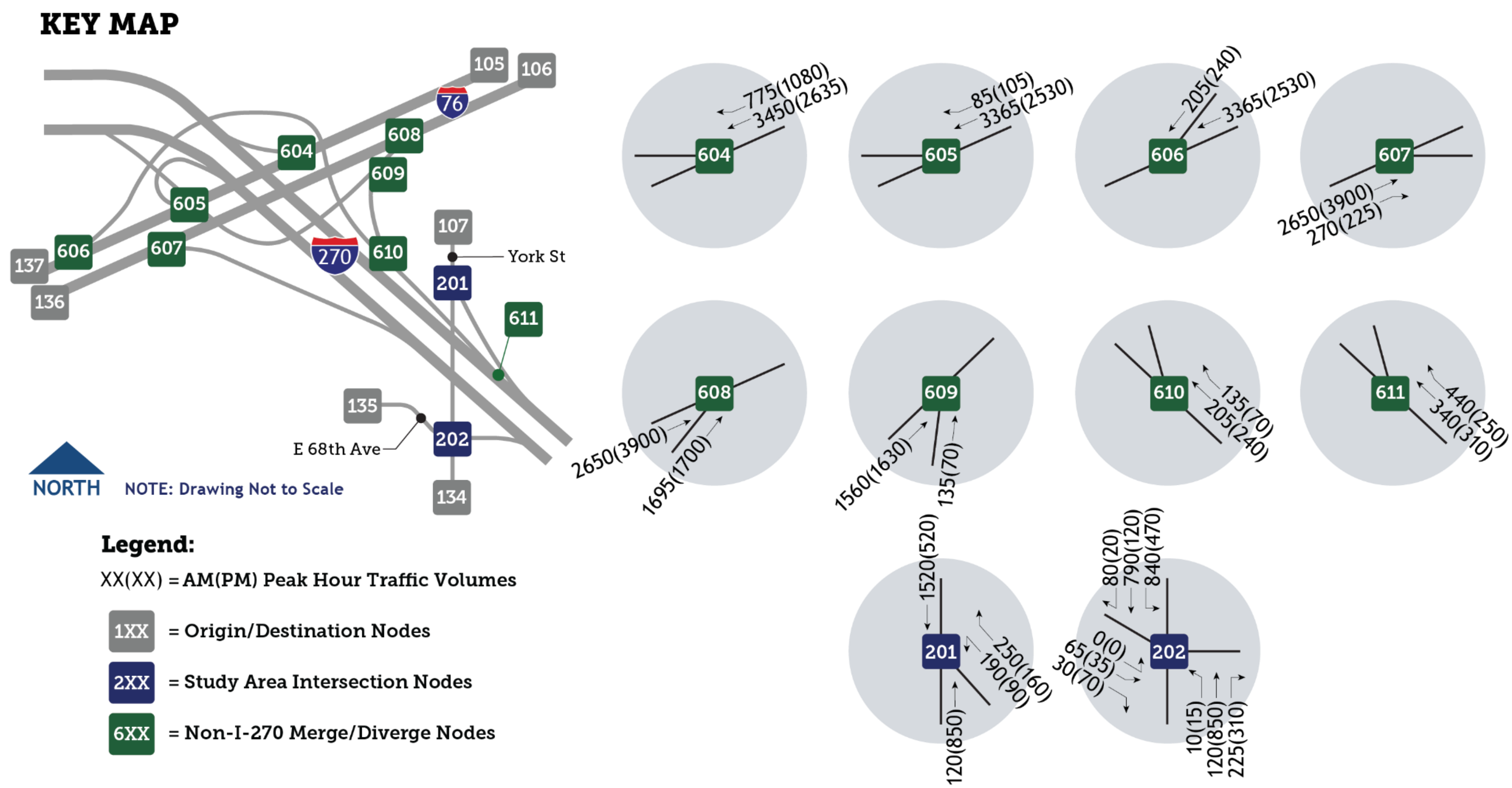


Figure 19. No Action Alternative - Vasquez Boulevard Interchange Peak Hour Traffic Volumes (2050)

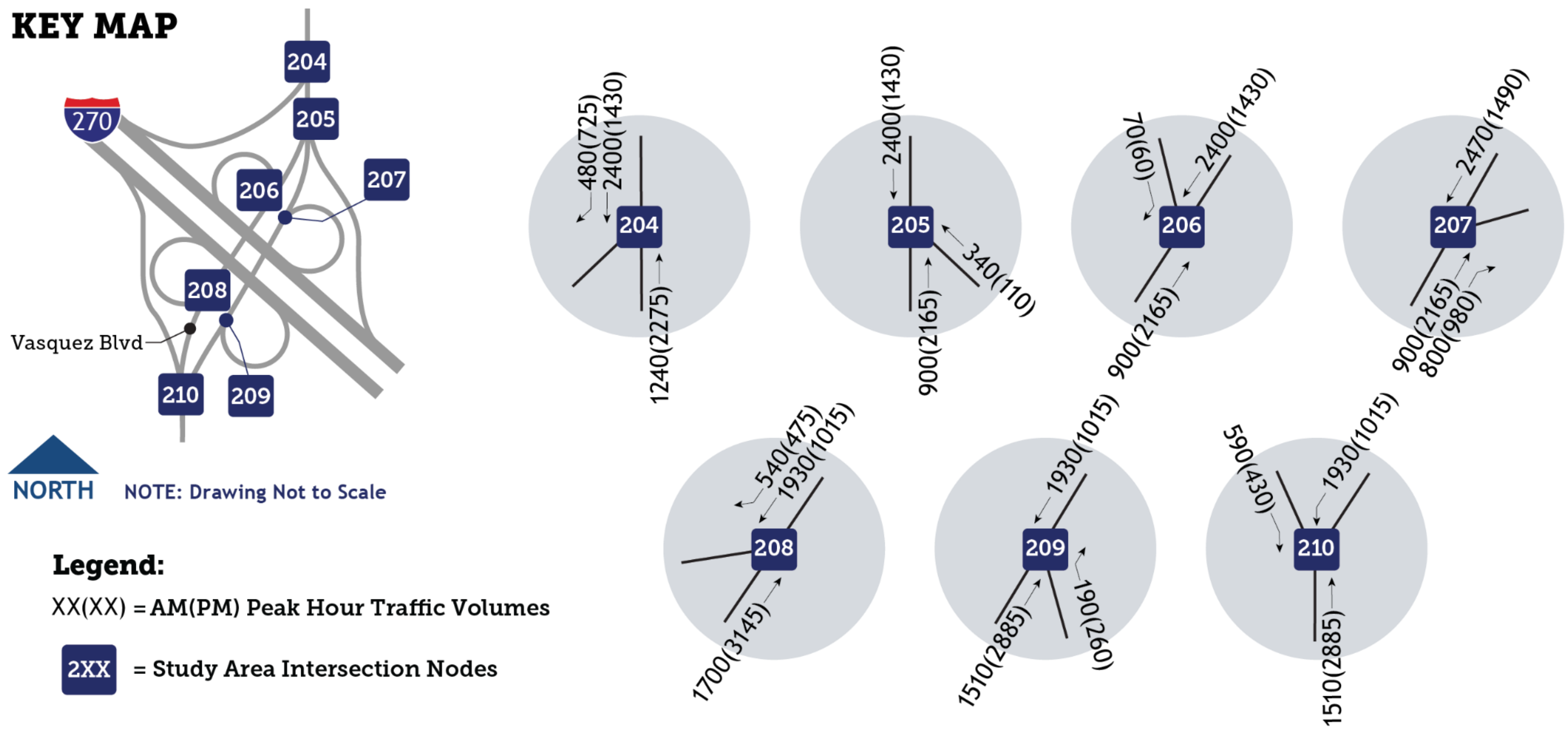


Figure 20. No Action Alternative - Vasquez Boulevard Peak Hour Traffic Volumes (2050)

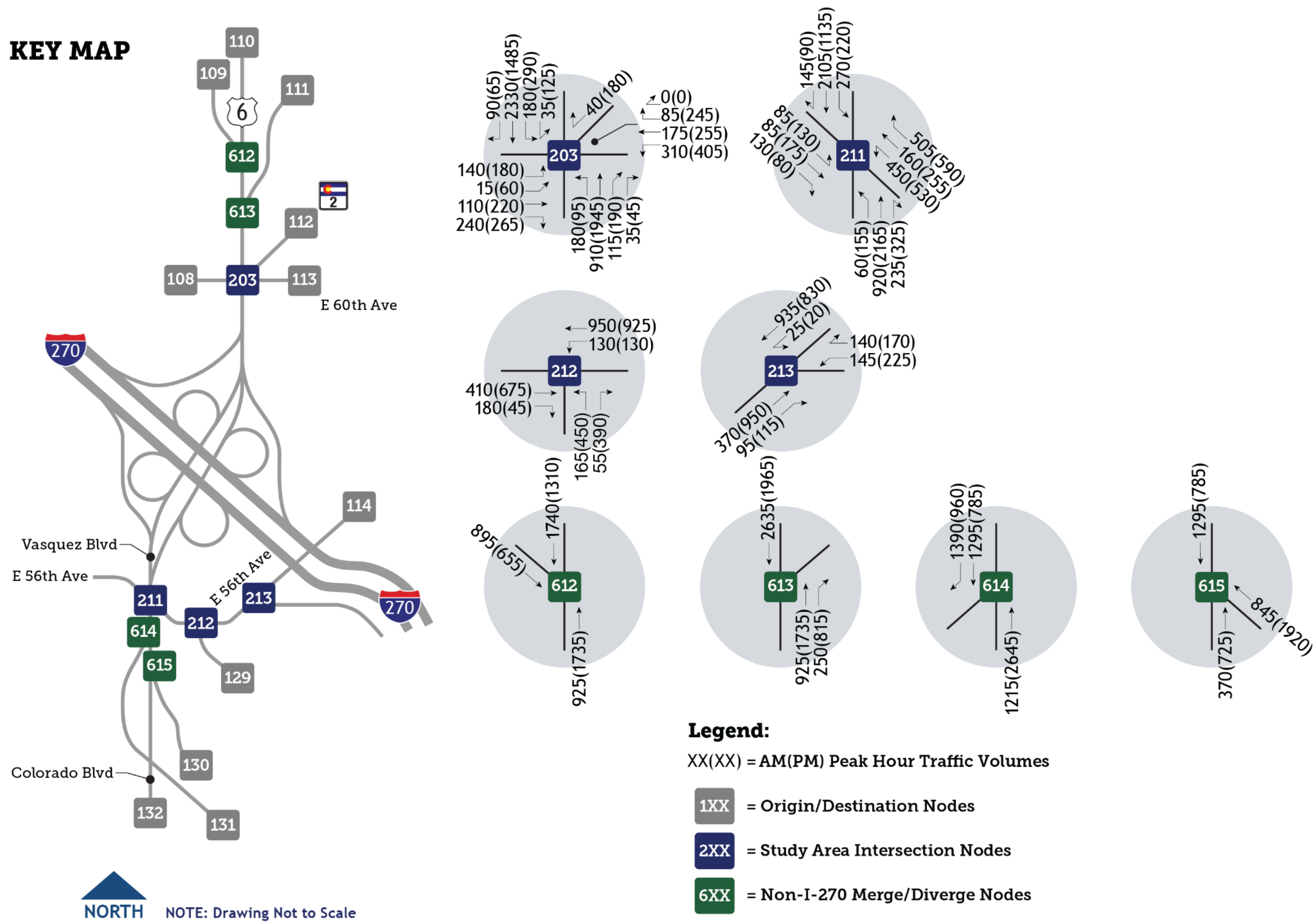


Figure 21. No Action Alternative - Quebec Street Peak Hour Traffic Volumes (2050)

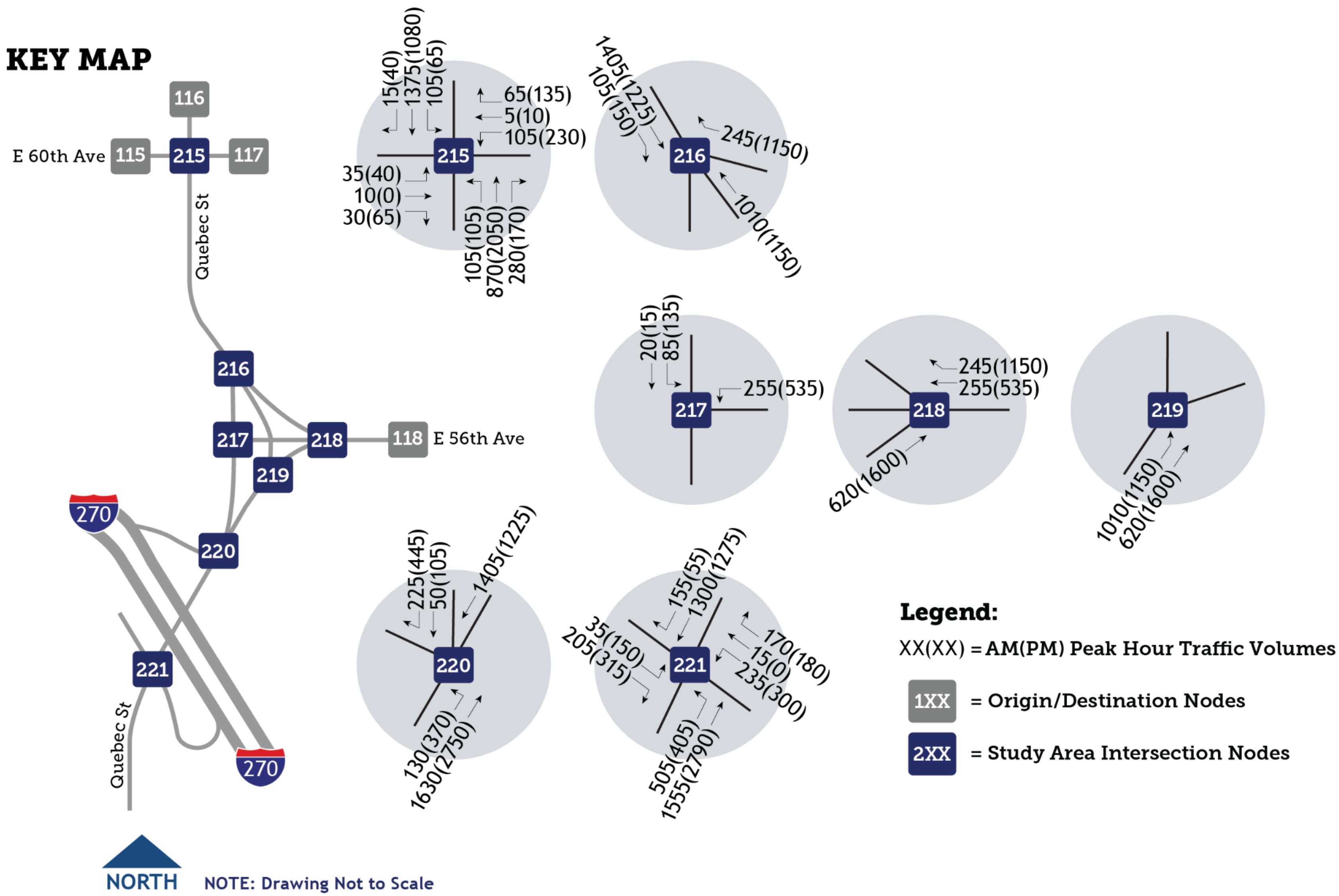
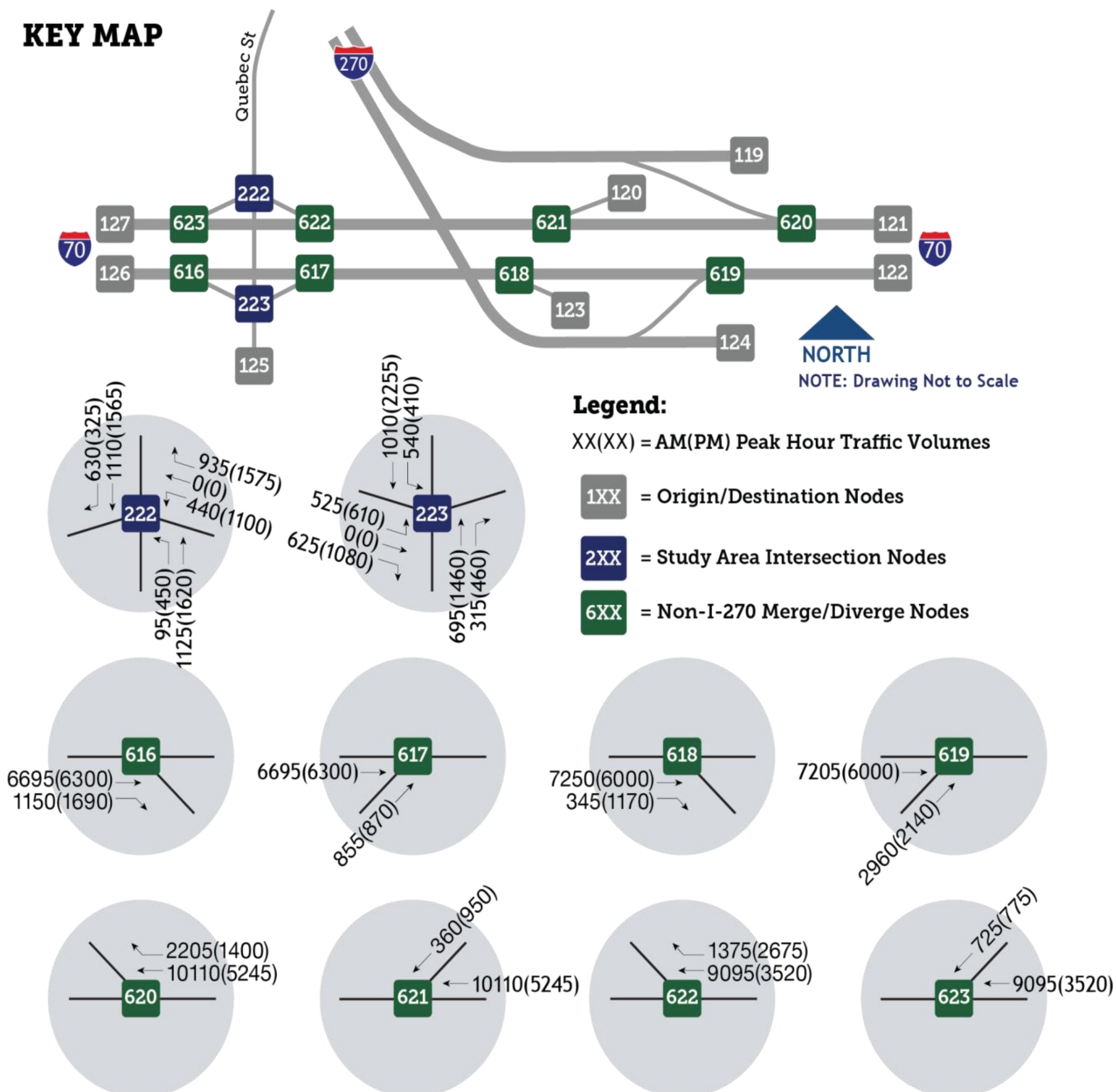


Figure 22. No Action Alternative - I-70 Peak Hour Traffic Volumes (2050)



11.0 Build Alternatives (2050)

CDOT developed a range of potential alternatives for I-270 improvements. The alternatives ranged from no improvements to minimal infrastructure improvements without added highway capacity to alternatives that added one or two travel lanes in each direction, which could be operated as transit, general-purpose, or Express Lanes.

A two-level alternatives evaluation process was used to screen the alternatives based on the project's purpose and need and goal, and two build alternatives were carried forward for detailed analysis in the EIS:

- Three General-Purpose Lanes Alternative
- Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

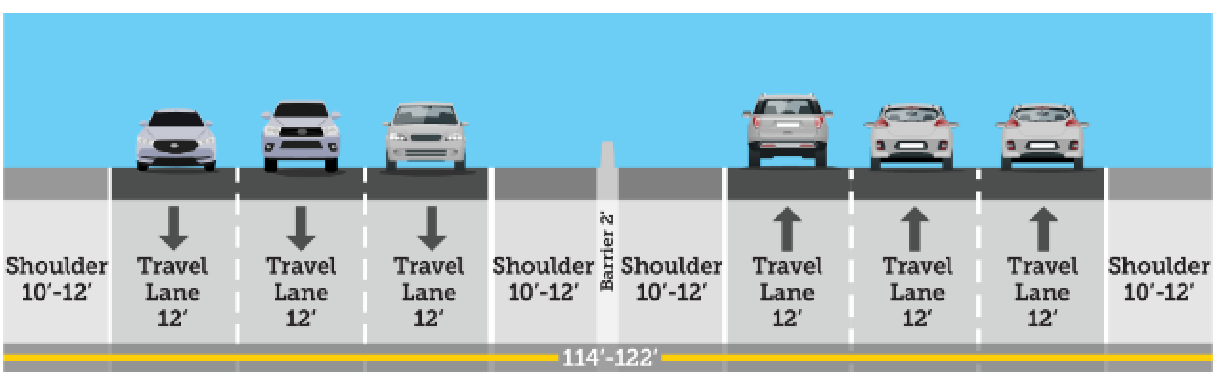
Additional information on the alternatives development and evaluation process is included in the Alternatives Development Technical Report.

The Build Alternatives include improving the operational and physical conditions of the I-270 highway; reconfiguring interchanges and ramps; enhancing transit on the corridor; improving bicycle and pedestrian access across I-270; replacing deficient bridges and other infrastructure; and providing modern drainage, water quality, intelligent transportation systems (ITS), and other supporting infrastructure. Both add one new travel lane in each direction and have similar footprints, varying primarily by how the additional travel operates.

11.1 Three General-Purpose Lanes Alternative

This alternative would reconstruct I-270 to provide three general-purpose lanes in each direction as shown in Figure 23.

Figure 23. Three General-Purpose Lanes Alternative



This alternative includes:

Mainline Improvements

- Providing three general-purpose lanes in each direction
- Widening shoulders to meet current standards
- Restriping of the westbound I-270 to northbound I-25 off-ramp to provide dual-exit lane capacity
- Adding emergency turnouts and turnaround.
- Adding one continuous auxiliary lane in each direction between the I-76 and Vasquez Boulevard on-ramps and off-ramps

Interchange Improvements

- Adding an eastbound collector ramp to consolidate incoming movements from the I-76 on-ramps
- Separating the westbound I-270 York Street and I-76 off-ramps
- Improving the Vasquez Boulevard interchange design with improved westbound on-ramp acceleration lanes and the eastbound off-ramp deceleration lanes
- Improving the Quebec Street interchange ramp acceleration and deceleration lengths

Bridge Improvements

- Reconstructing bridges that are at, or will be reaching, the end of their useful life. Bridges carrying travel lanes on I-270 include widening to accommodate additional lanes
    - Replacing the existing York Street bridge over I-270 to meet current bridge standards, accommodate an additional travel lane in each direction on York Street, include a 10-foot multi-use path and a 5-foot sidewalk, and enhance lighting
    - Replacing the existing I-270 bridges over the South Platte River Trail to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements on the South Platte River Trail, and enhance lighting
    - Replacing the existing I-270 bridges over the Burlington Ditch to meet current bridge standards, accommodate future bicycle and pedestrian improvements, and enhance lighting
    - Replacing the existing I-270 bridges over Brighton Boulevard to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements on Brighton Boulevard and future bicycle and pedestrian improvements by others, and enhance lighting
    - Replacing the existing I-270 bridges over East 60th Avenue and the BNSF crossing to meet current bridge standards, accommodate future bicycle and pedestrian improvements, and enhance lighting
    - Replacing the existing I-270 bridges over East 56th Avenue to meet current bridge standards, accommodate this project's bicycle and pedestrian improvements, and enhance lighting
    - Replacing the existing Vasquez Boulevard bridge over Sand Creek to meet current bridge standards and accommodate this project's bicycle and pedestrian improvements

Bicycle and Pedestrian Improvements

- Improving the York Street I-270 ramp terminal intersections with crosswalks, curb ramps, and pedestrian indicators at the ramp terminal traffic signals
- Adding a new 5-foot sidewalk on the west side and reconstructing a 6-foot sidewalk on the east side of Brighton Boulevard under I-270
- Reconstructing East 56th Avenue under I-270 and adding an on-street bicycle lane, a 10-foot multi-use path, and 6-foot sidewalk connecting to existing sidewalks
- Improving the intersection at East 56th Avenue and South Sandcreek Drive to include curb ramps, crosswalks, and lighting that meet current standards
- Improving the intersection at East 56th Avenue and Eudora Street to include curb ramps, crosswalks, and lighting that meet current standards
- Adding attached sidewalks on the west side of South Sandcreek Drive. The new sidewalks would be 8 feet wide from Quebec Street to East 47th Avenue Drive and 6 feet wide from East 47th Avenue Drive to East 49th Avenue, with a pedestrian crosswalk across East 47th Avenue Drive connecting the two segments
- Improving wayfinding at key locations, guiding bicyclists and pedestrians to the nearest RTD bus stops, major road connections, or distances to the next trailhead to avoid out-of-direction travel

Trail Improvements

- Reconfiguring the South Platte River Trail crossing under I-270 to improve bicycle and pedestrian visibility around tight curves and increase vertical clearance from the I-270 overpass
- Improving bicycle and pedestrian visibility on the Sand Creek Trail by straightening out tight curves, adding a center stripe, and enhancing lighting at the Vasquez Boulevard bridge over the Sand Creek Trail
- Adding a multi-use path with bicycle and pedestrian underpasses crossing under two free-flow interchange ramps on the east side of Vasquez Boulevard through the interchange with enhanced lighting
- Adding a multi-use path on the east and west sides of the Vasquez Boulevard bridge over Sand Creek, connecting users from the East 56th Avenue and Vasquez Boulevard intersection to a new connection to the Sand Creek Trail
- Adding a multi-use trail spur, connecting the proposed north-south Vasquez Boulevard multi-use trail to the East 56th Avenue and South Sandcreek Drive intersection
- Adding a multi-use path in the southeast corner of East 56th Avenue and South Sandcreek Drive
- Adding a 10-foot-wide bicycle and pedestrian overpass over I-270 and South Sandcreek Drive approximately halfway between East 56th Avenue and Quebec Street

Transit Improvements

- Adding four new bus stops with connecting sidewalks and curb ramps on Quebec Street and South Sandcreek Drive near the I-270/Quebec Street interchange to improve access to RTD routes 88 and 37

The TransModeler network was built, as shown in the node diagrams depicted in Figure 24 and Figure 25.

Figure 24. 2050 Three General-Purpose Lanes Alternative Network Node Diagram - I-270 from the I-25/US 36 Interchange to York Street Interchange

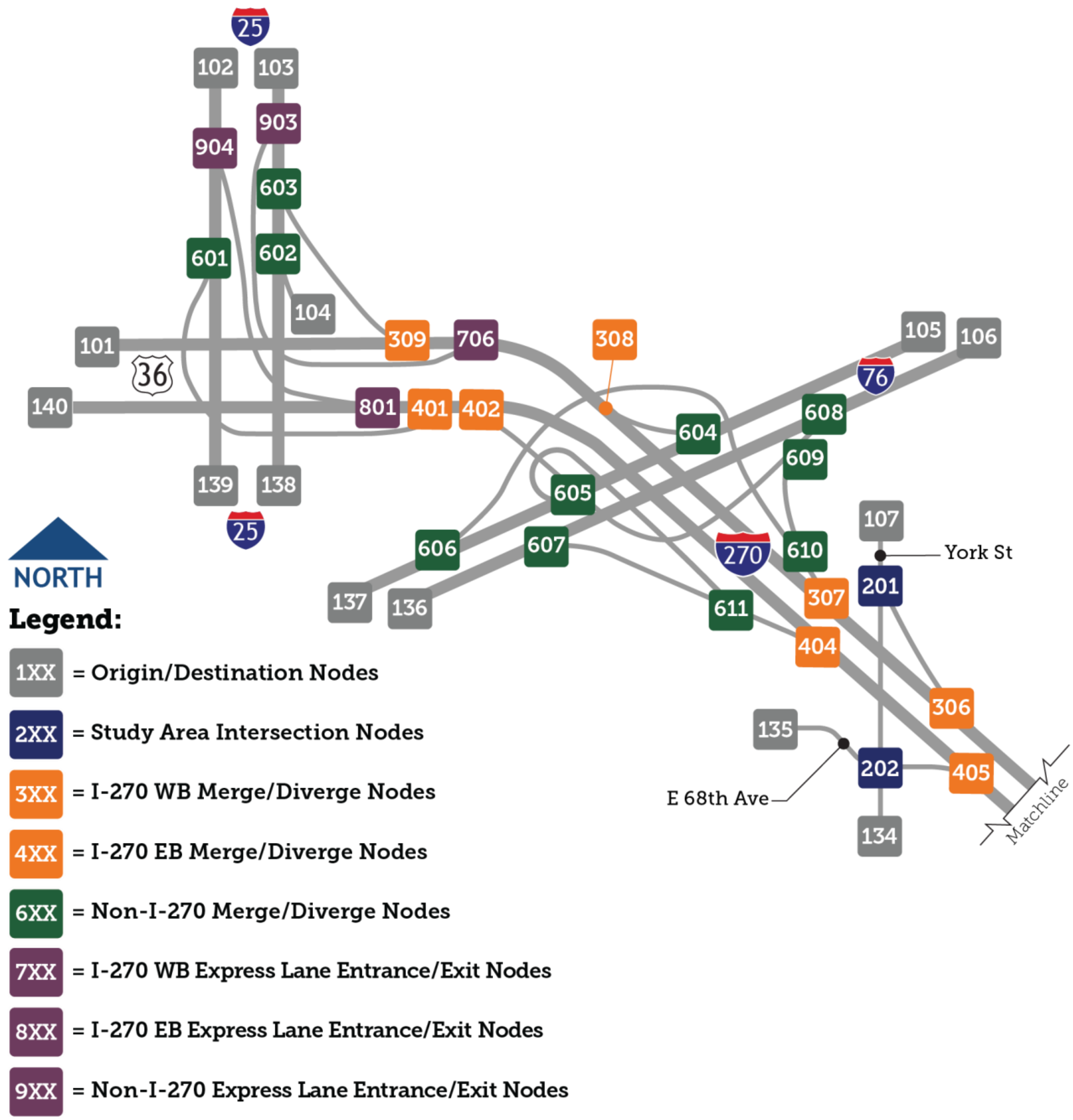
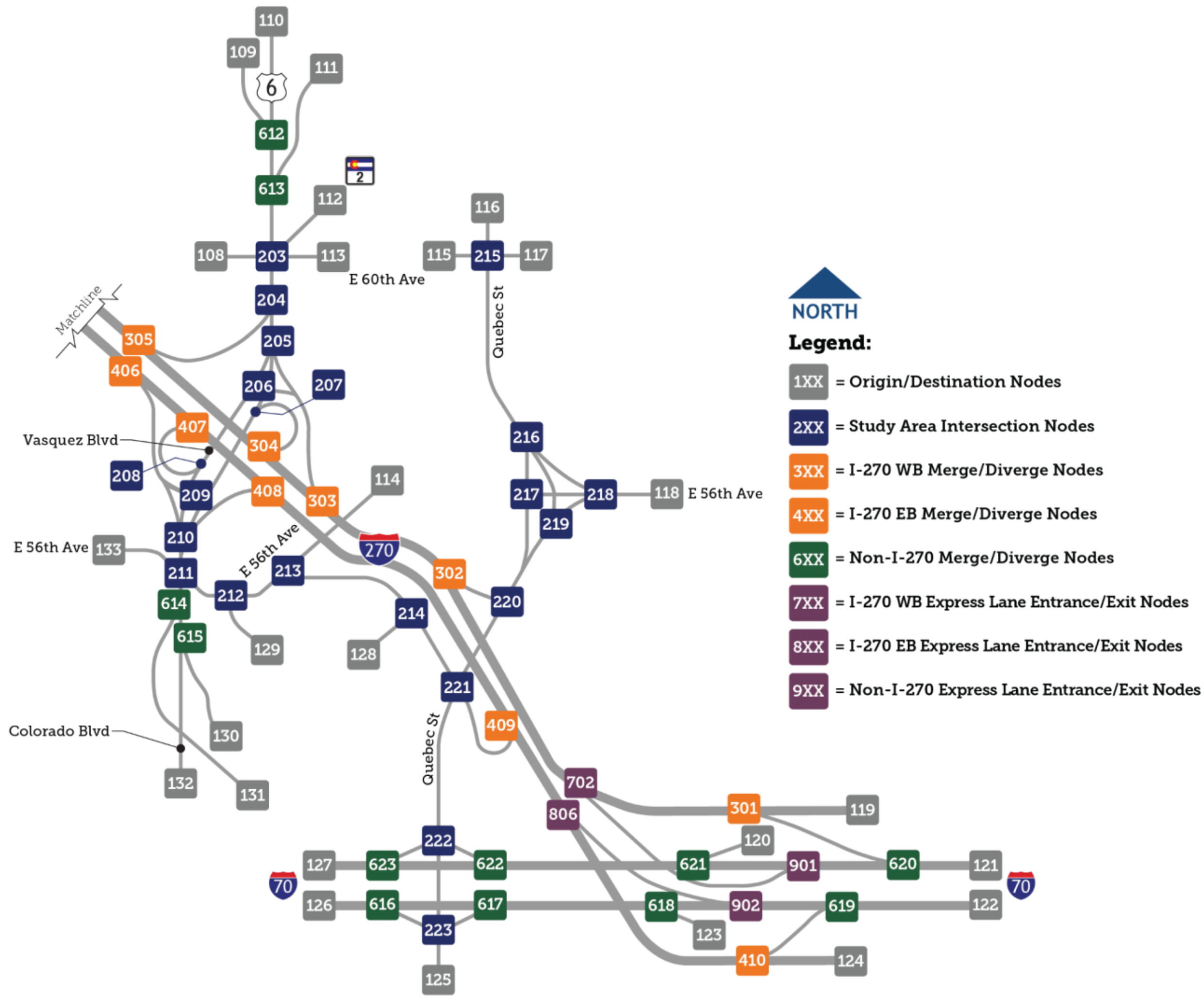


Figure 25. 2050 Three General-Purpose Lanes Alternative Network Node Diagram - I-270 from the Vasquez Boulevard Interchange to I-70



11.1.1 Three General-Purpose Lanes Alternative Volumes (2050)

As with the 2050 No Action Alternative traffic volumes, NCHRP 765 was used to forecast future intersection peak hour turning movements. There were no changes to the land use assumptions between the 2050 No Action Alternative and Three General-Purpose Lanes Alternative.

Figures 26 through 32 show the projected 2050 traffic volumes for the Three General-Purpose Lanes Alternative.

Figure 26. Three General-Purpose Lanes Alternative - Mainline I-270 Peak Hour Traffic Volumes (2050)

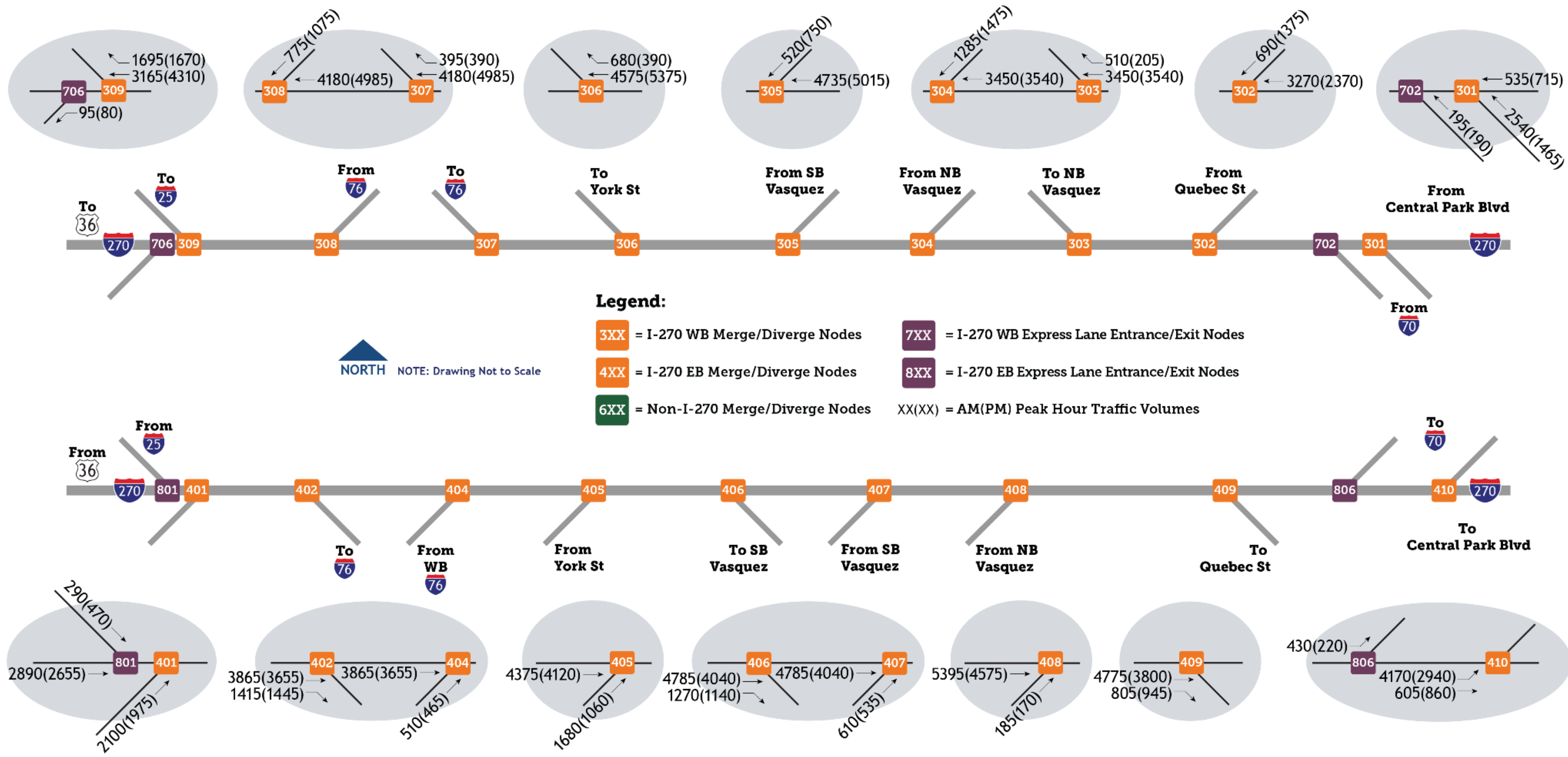


Figure 27. Three General-Purpose Lanes Alternative - I-25 Peak Hour Traffic Volumes (2050)

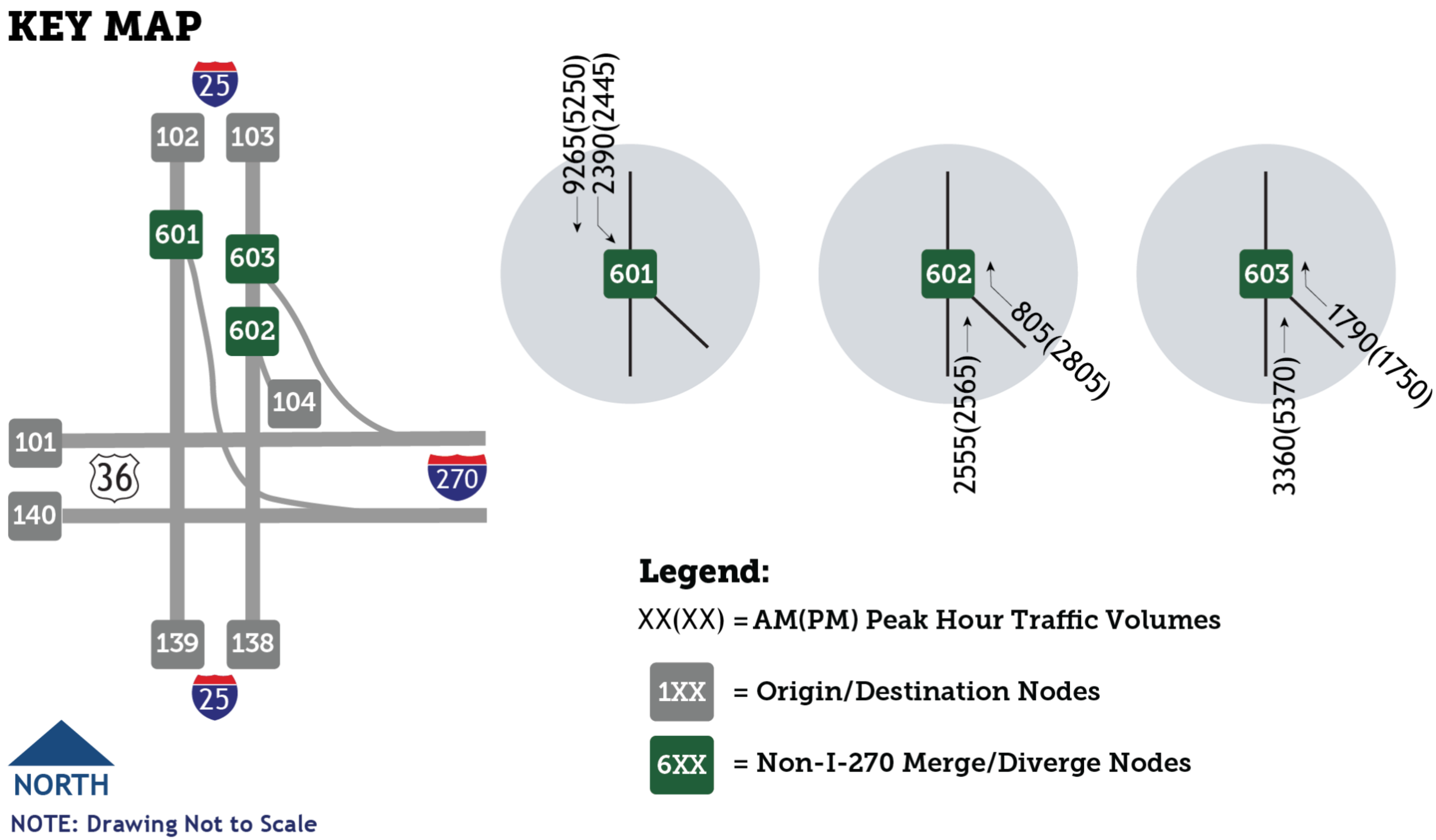


Figure 28. Three General-Purpose Lanes Alternative - I-76 and York Street Peak Hour Traffic Volumes (2050)

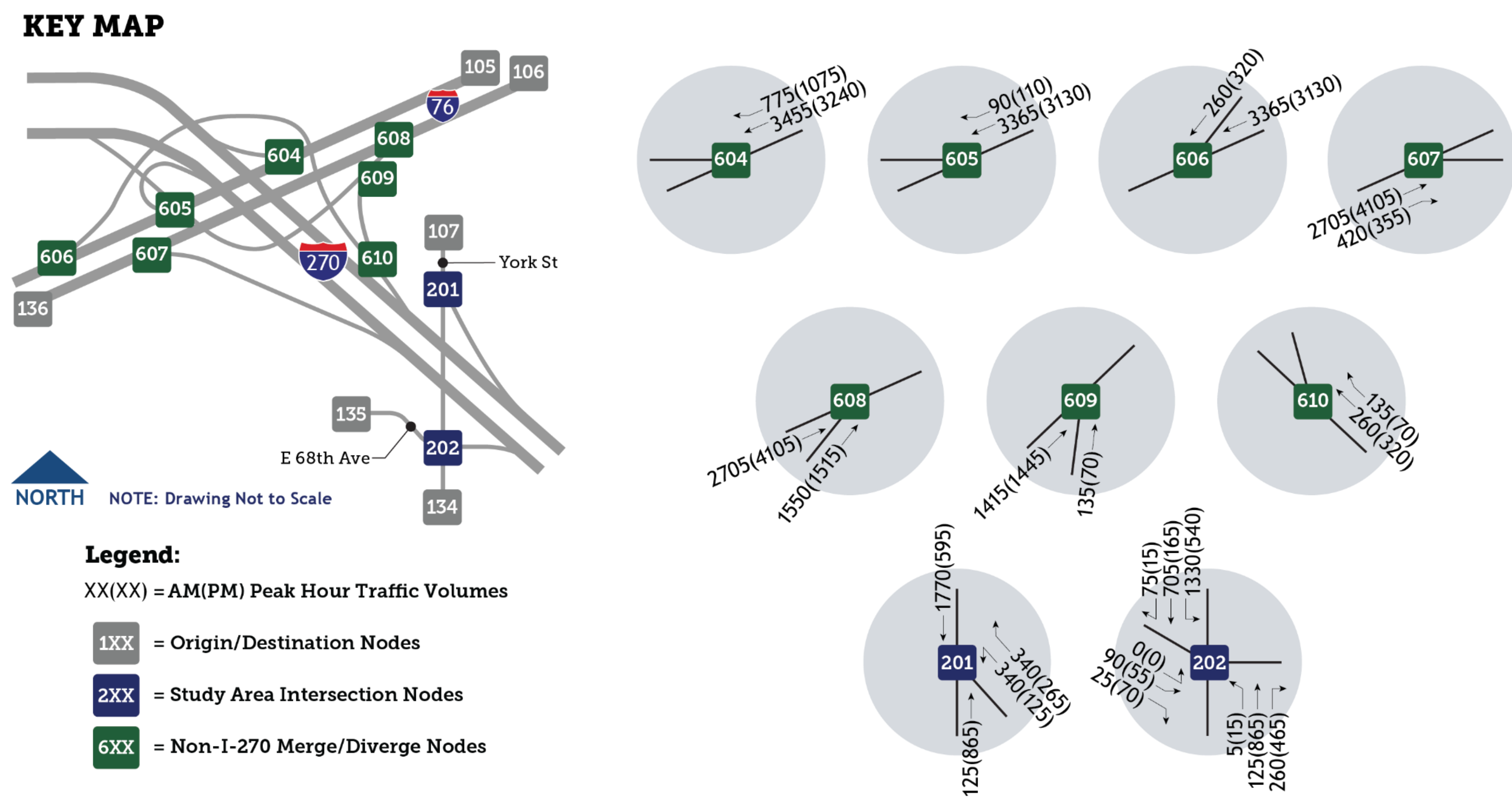


Figure 29. Three General-Purpose Lanes Alternative - Vasquez Boulevard Interchange Peak Hour Traffic Volumes (2050)

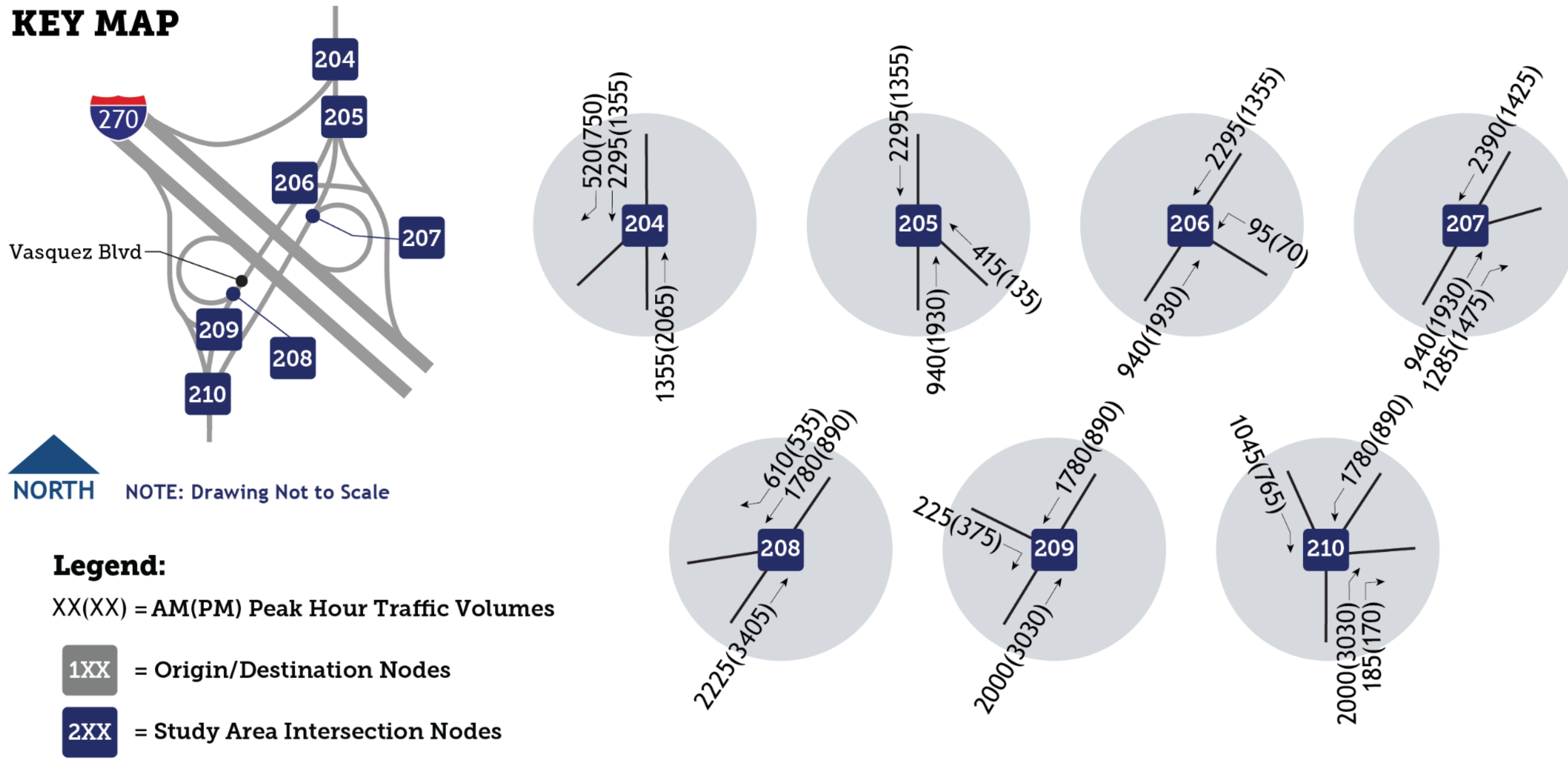


Figure 30. Three General-Purpose Lanes Alternative - Vasquez Boulevard Peak Hour Traffic Volumes (2050)

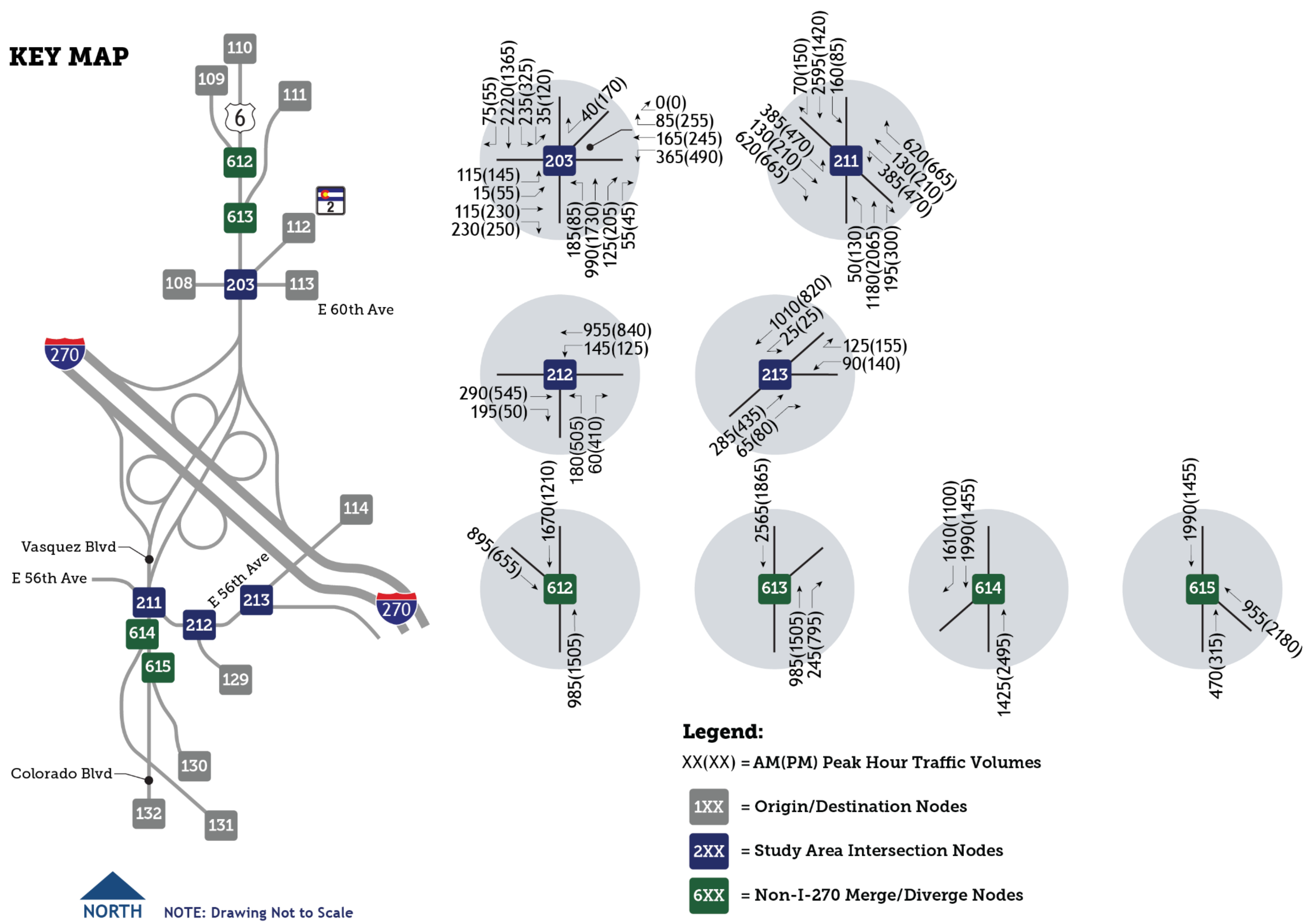


Figure 31. Three General-Purpose Lanes Alternative - Quebec Street Peak Hour Traffic Volumes (2050)

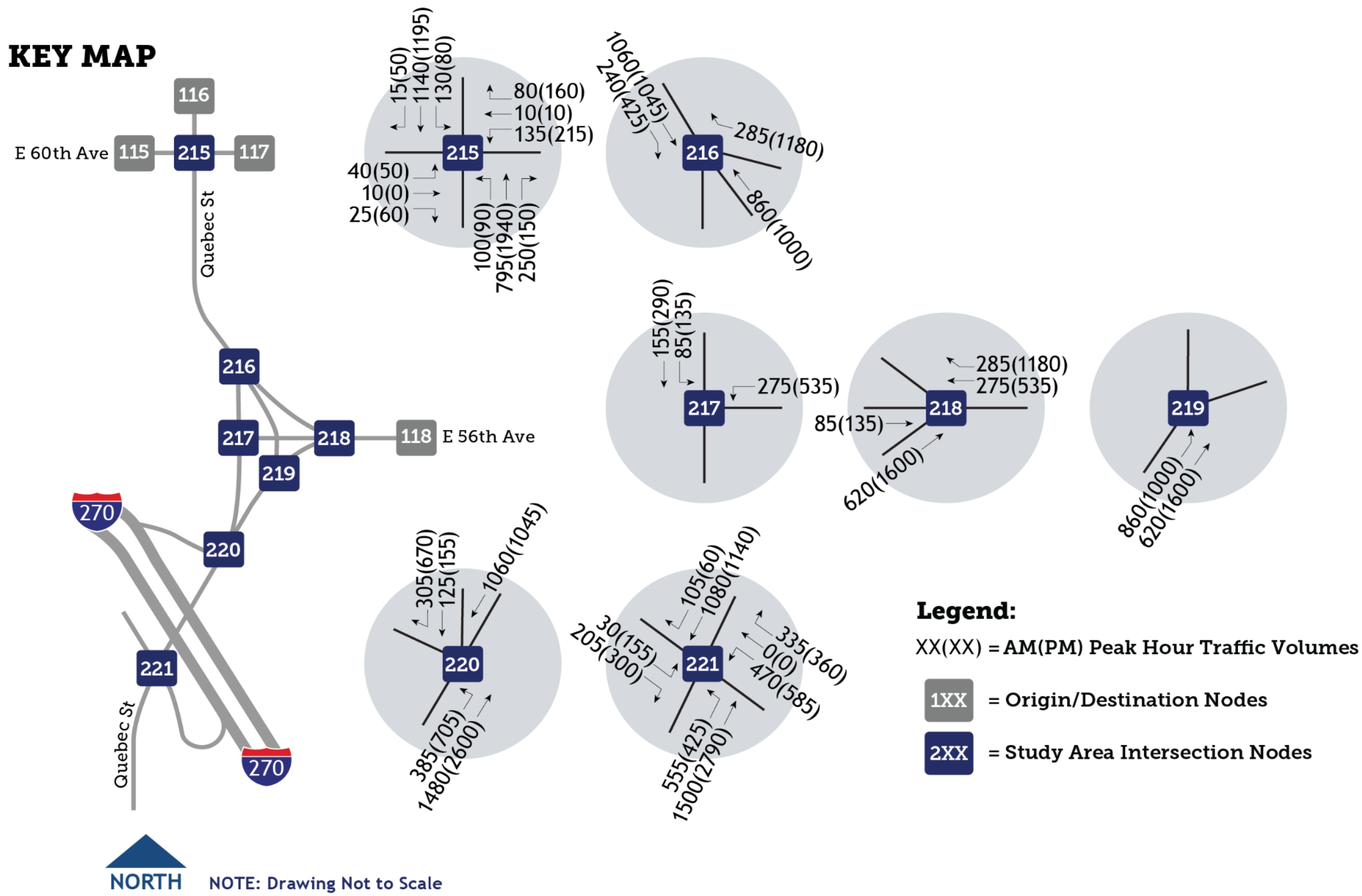
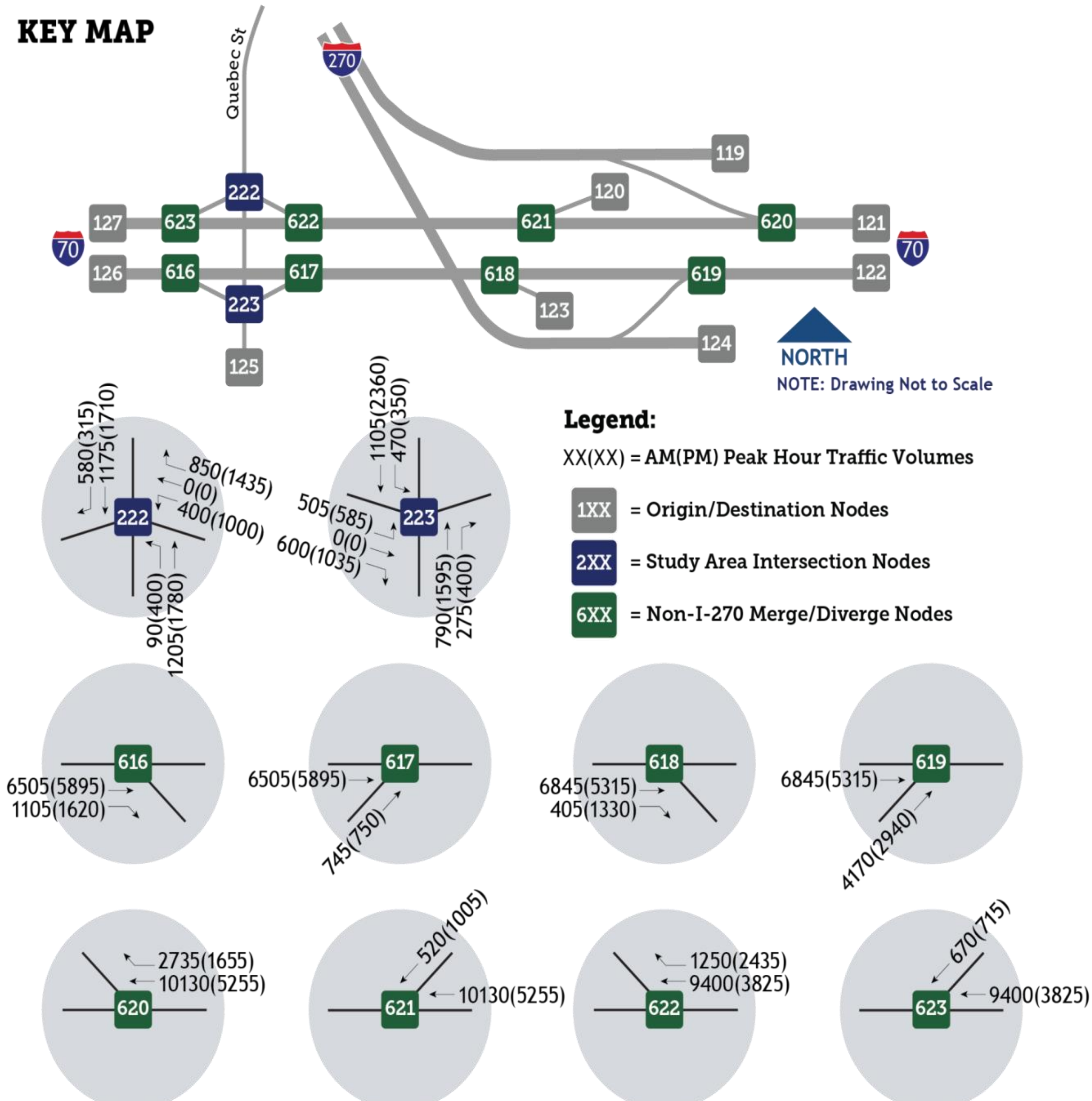


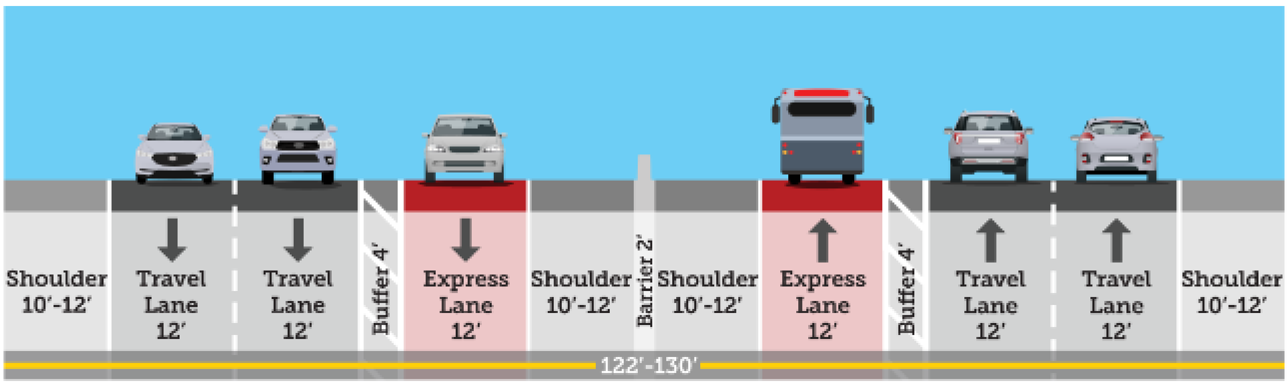
Figure 32. Three General-Purpose Lanes Alternative - I-70 Peak Hour Traffic Volumes (2050)



11.2 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

This alternative would reconstruct I-270 with two general-purpose lanes and one Express Lane in each direction, as shown in Figure 33. Transit vehicles and high-occupancy vehicles (three or more people) could travel in the Express Lane, free of charge. Other travelers, including freight trucks, who choose to pay a fee could also use the new Express Lane.

Figure 33. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative



This alternative includes:

Mainline Improvements

- Providing two general-purpose lanes and one Express Lane in each direction.
- Remainder of mainline improvements identified in the Three General-Purpose Lanes Alternative.

Interchange Improvements

This alternative includes the same interchange improvements identified in the Three General-Purpose Lanes Alternative.

Bridge Improvements

This alternative includes the same bridge improvements identified in the Three General-Purpose Lanes Alternative.

Bicycle, Pedestrian, Trail, and Transit Improvements

This alternative includes the same bicycle, pedestrian, trail, and transit enhancements identified in the Three General-Purpose Lanes Alternative.

The TransModeler network was built as shown in the node diagrams depicted in Figure 34 and Figure 35.

Figure 34. 2050 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative Network Node Diagram - I-270 from the I-25/US 36 Interchange to York Street Interchange

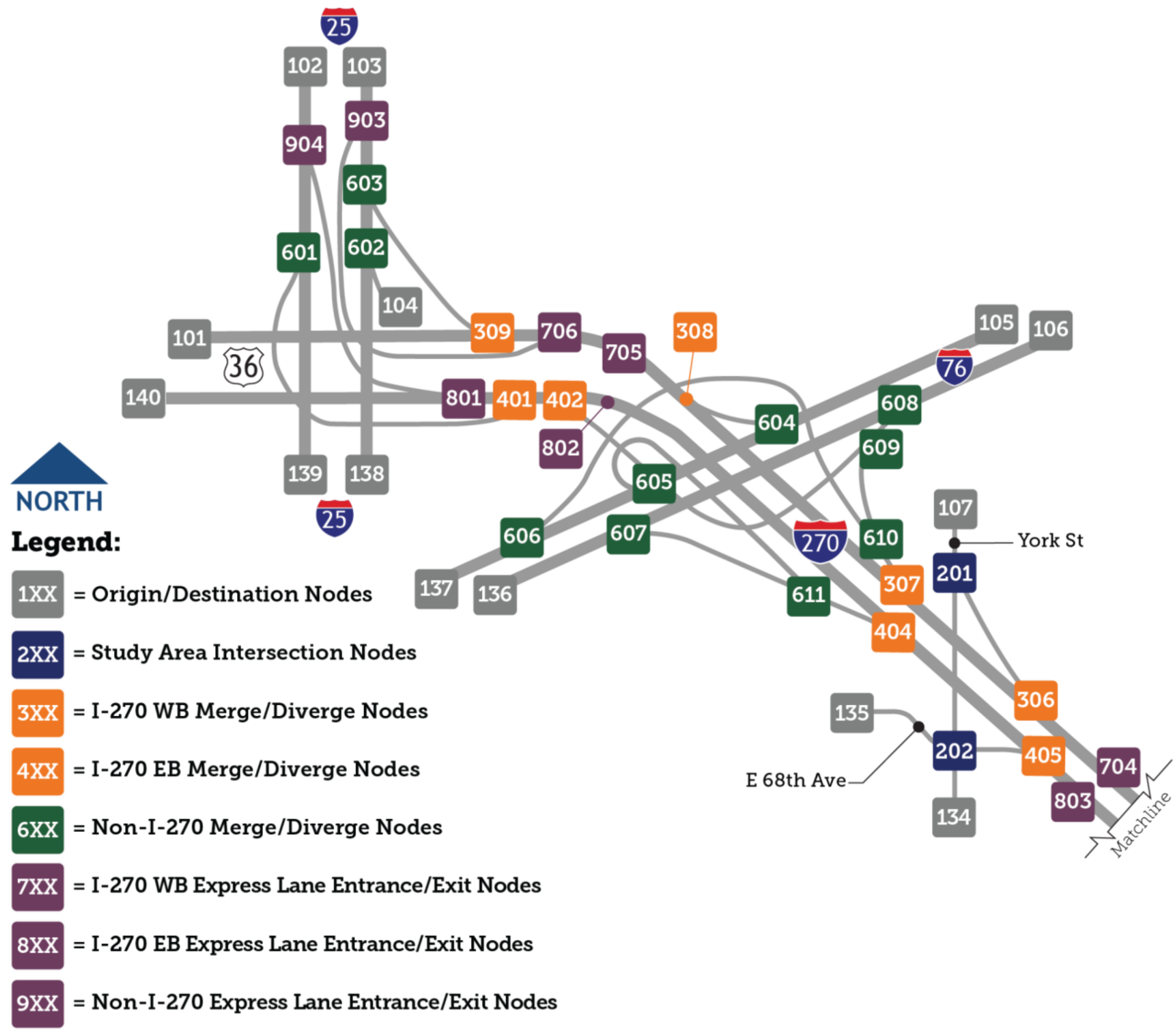
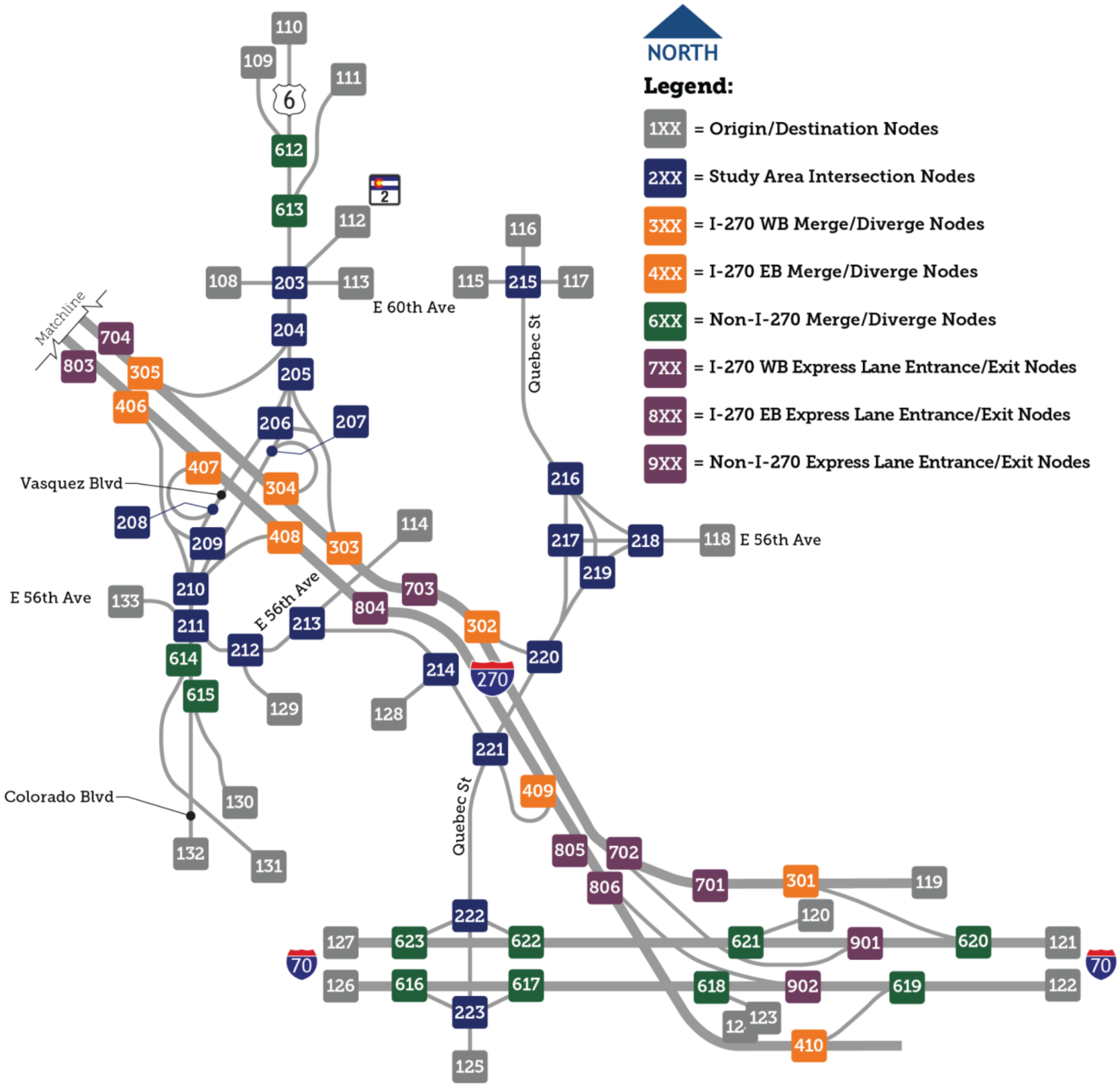


Figure 35. 2050 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative Network Node Diagram - I-270 from the Vasquez Boulevard Interchange to I-70



11.2.1 Two General-Purpose Lanes and One Express Lane that Accommodates Transit - Alternative Volumes (2050)

As with the 2050 No Action Alternative traffic volumes, NCHRP 765 was used to forecast future intersection peak hour turning movements for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative. There were no changes to the land use assumptions between the 2050 No Action Alternative and the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative.

Figures 36 through 42 show the projected 2050 traffic volumes for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative.

Figure 36. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Mainline I-270 Peak Hour Traffic Volumes (2050)

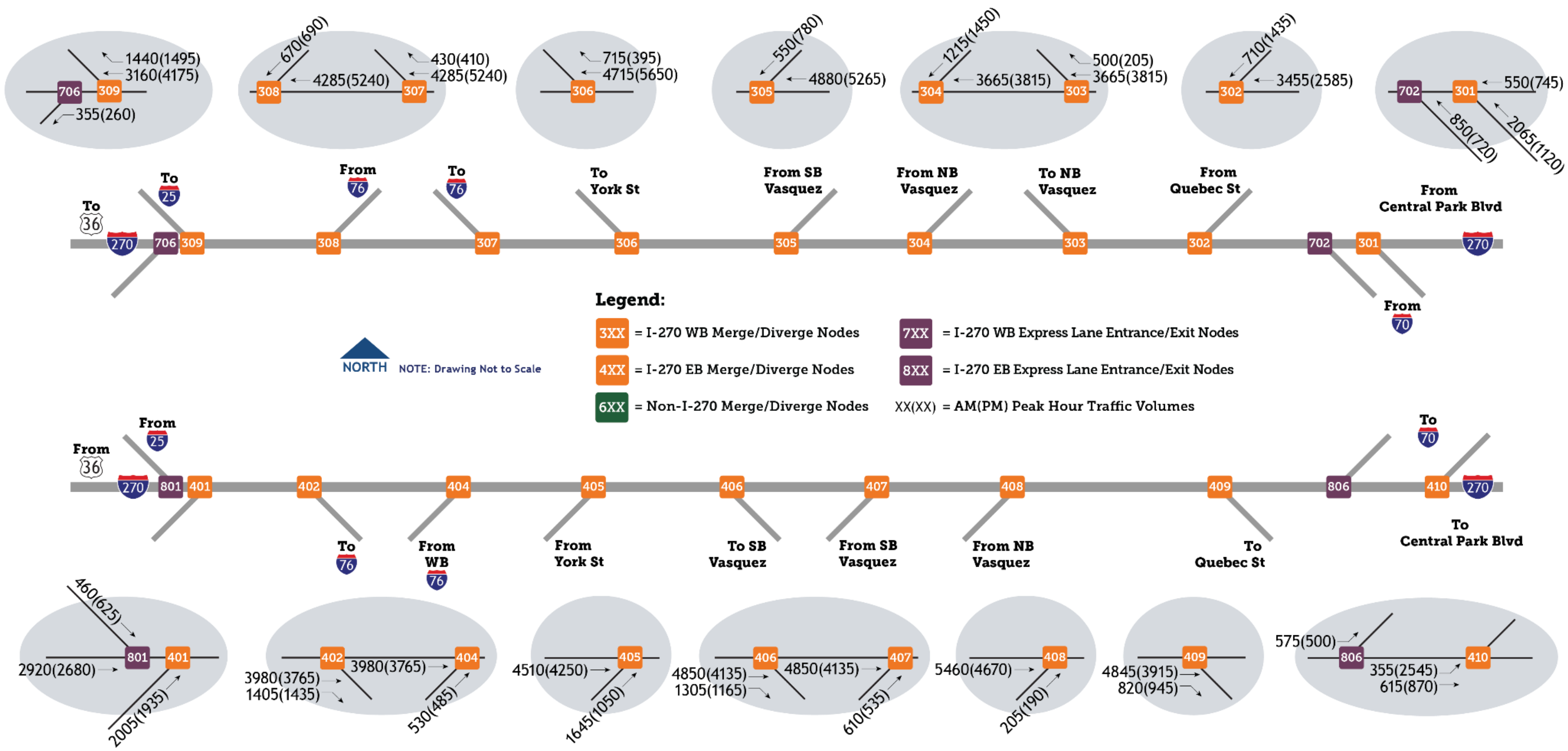


Figure 37. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - I-25 Peak Hour Traffic Volumes (2050)

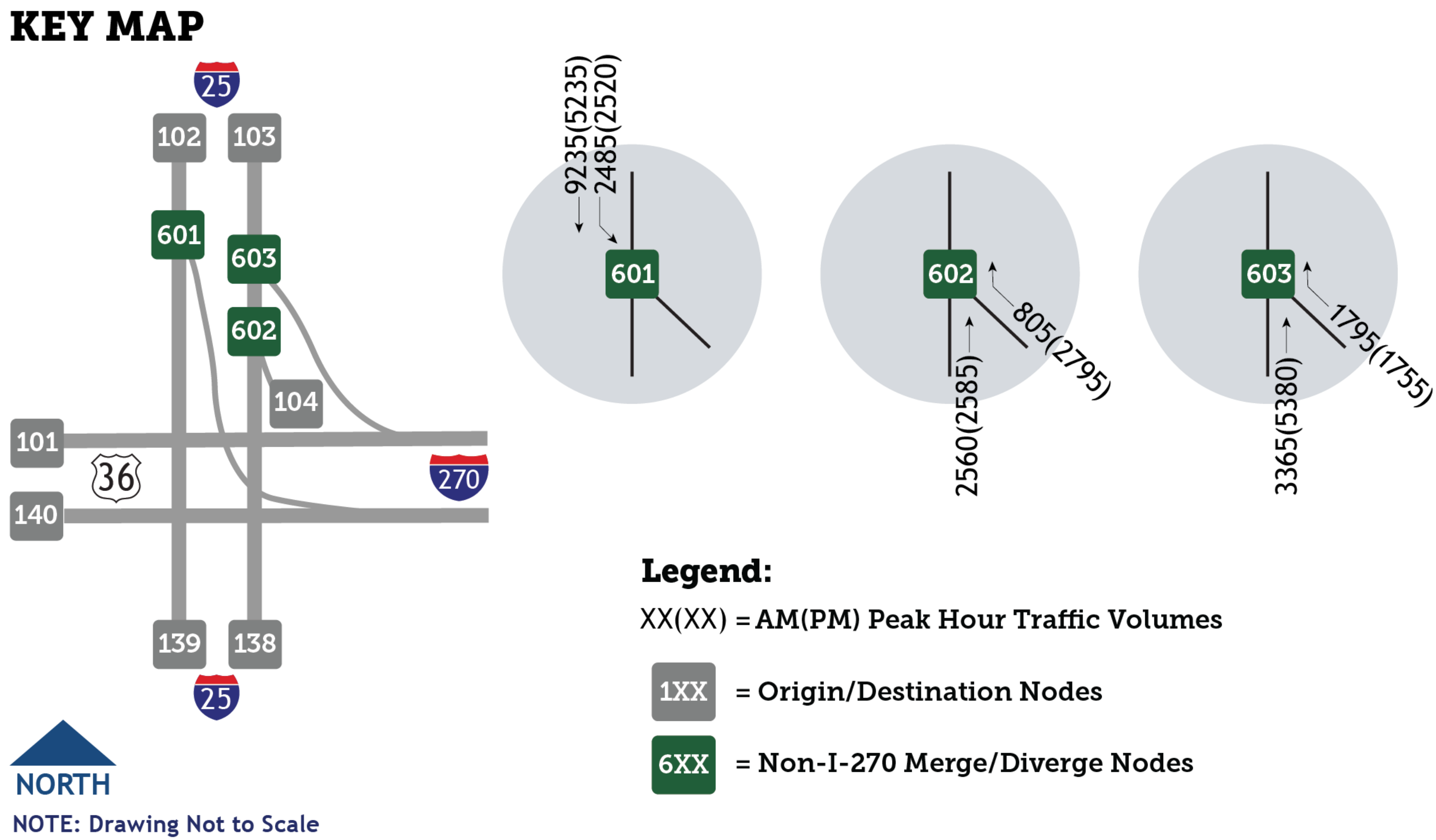


Figure 38. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - I-76 and York Street Peak Hour Traffic Volumes (2050)

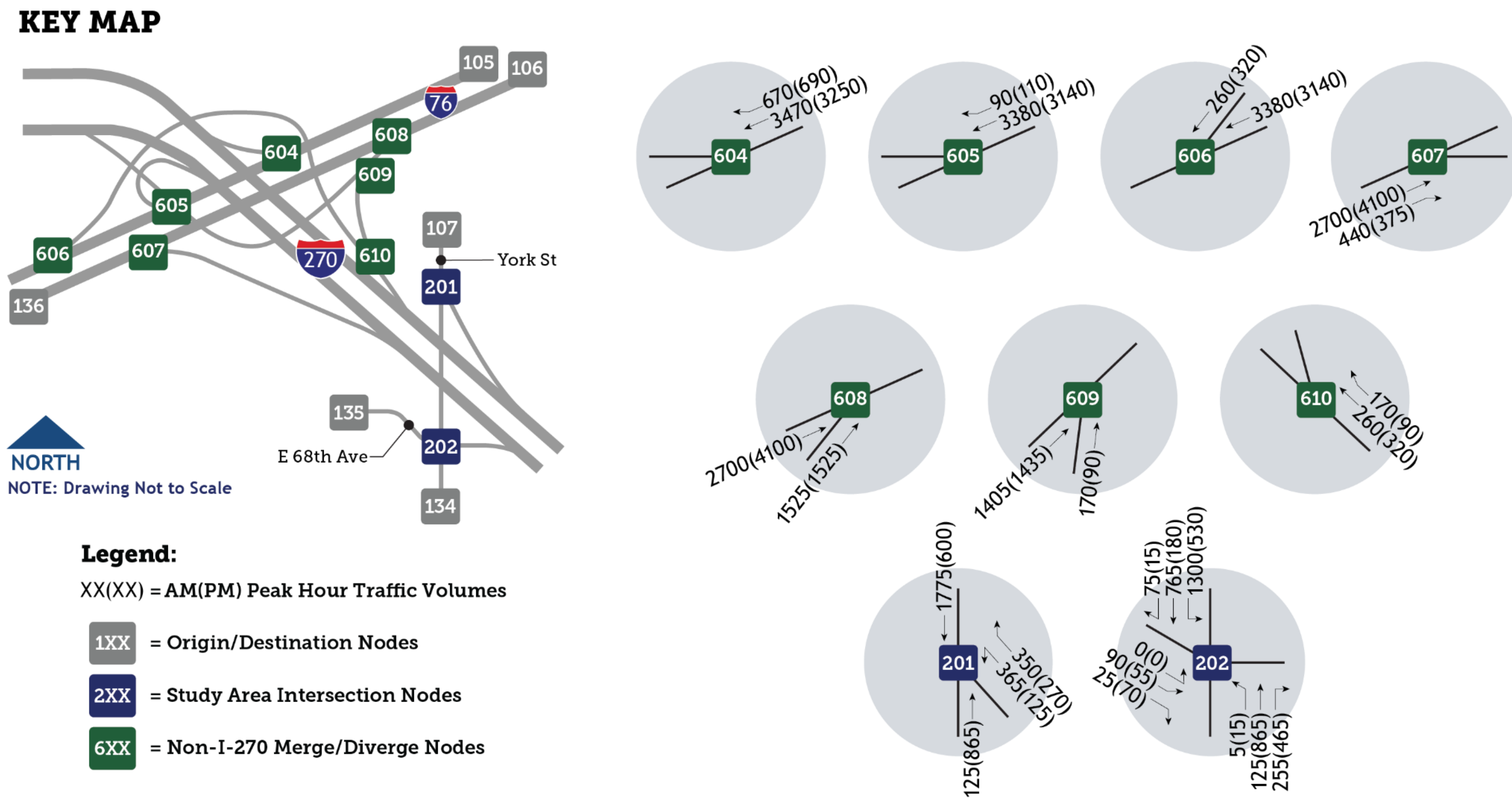


Figure 39. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Vasquez Boulevard Interchange Peak Hour Traffic Volumes (2050)

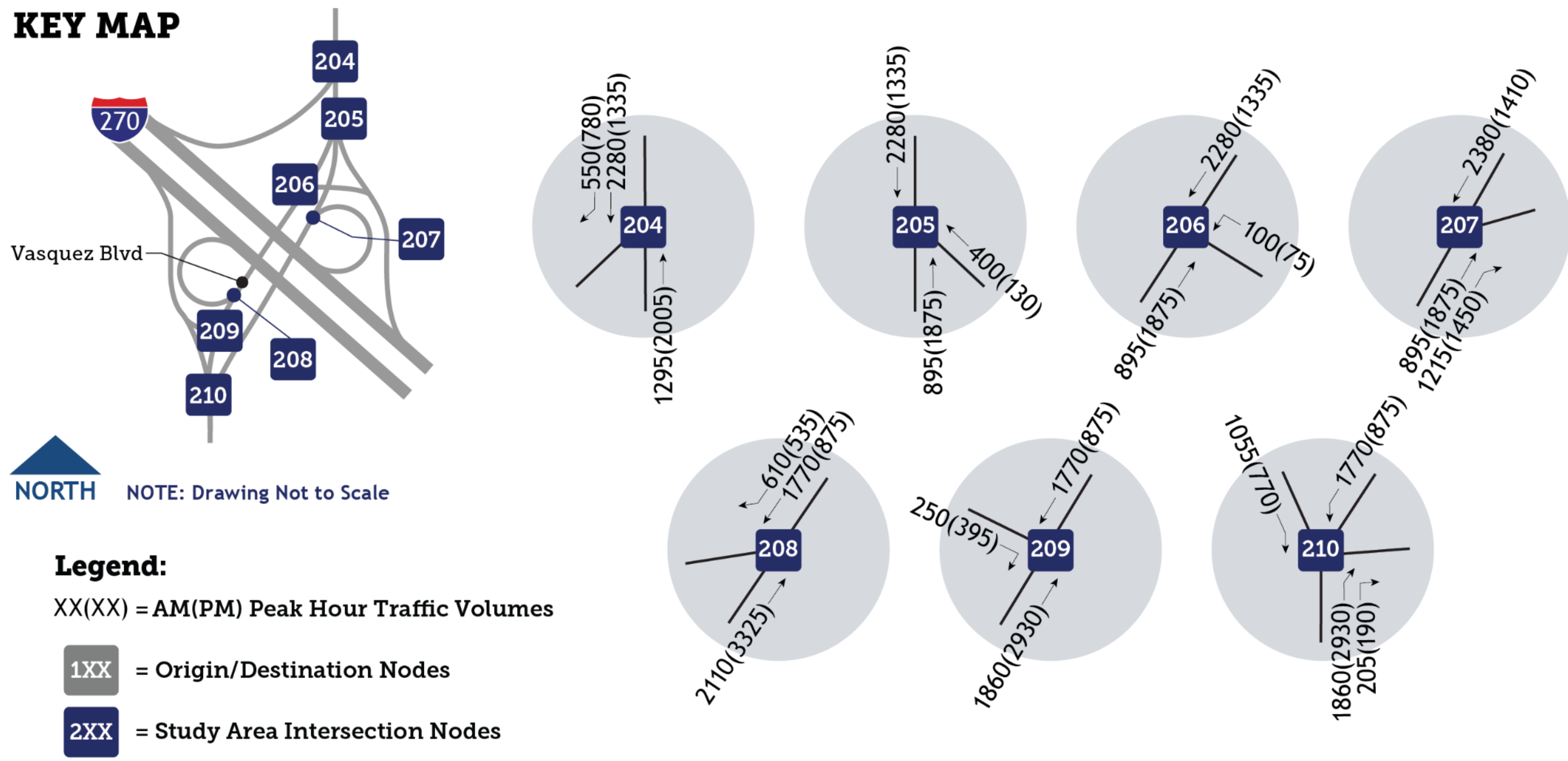


Figure 40. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Vasquez Boulevard Peak Hour Traffic Volumes (2050)

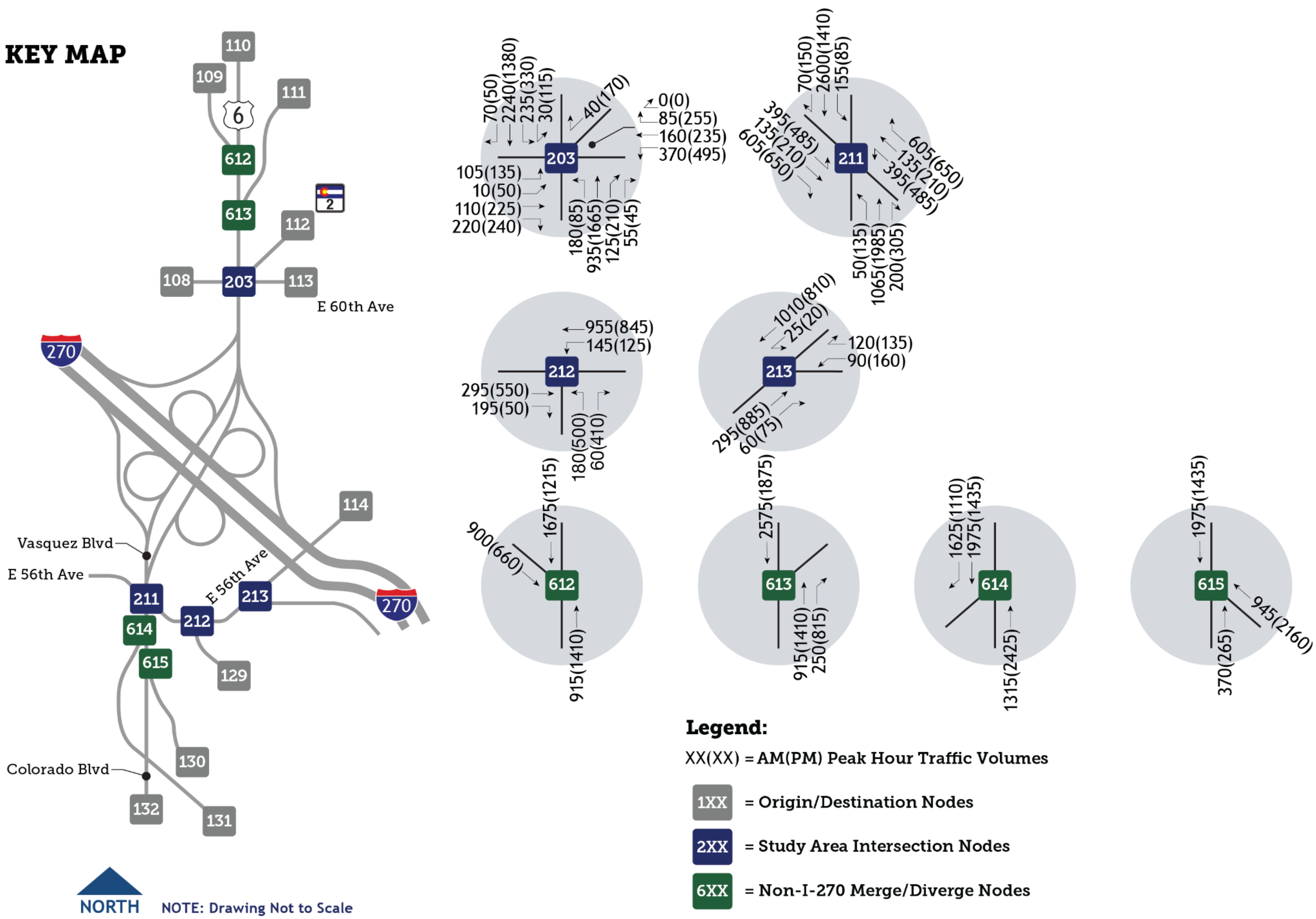


Figure 41. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Quebec Street Peak Hour Traffic Volumes (2050)

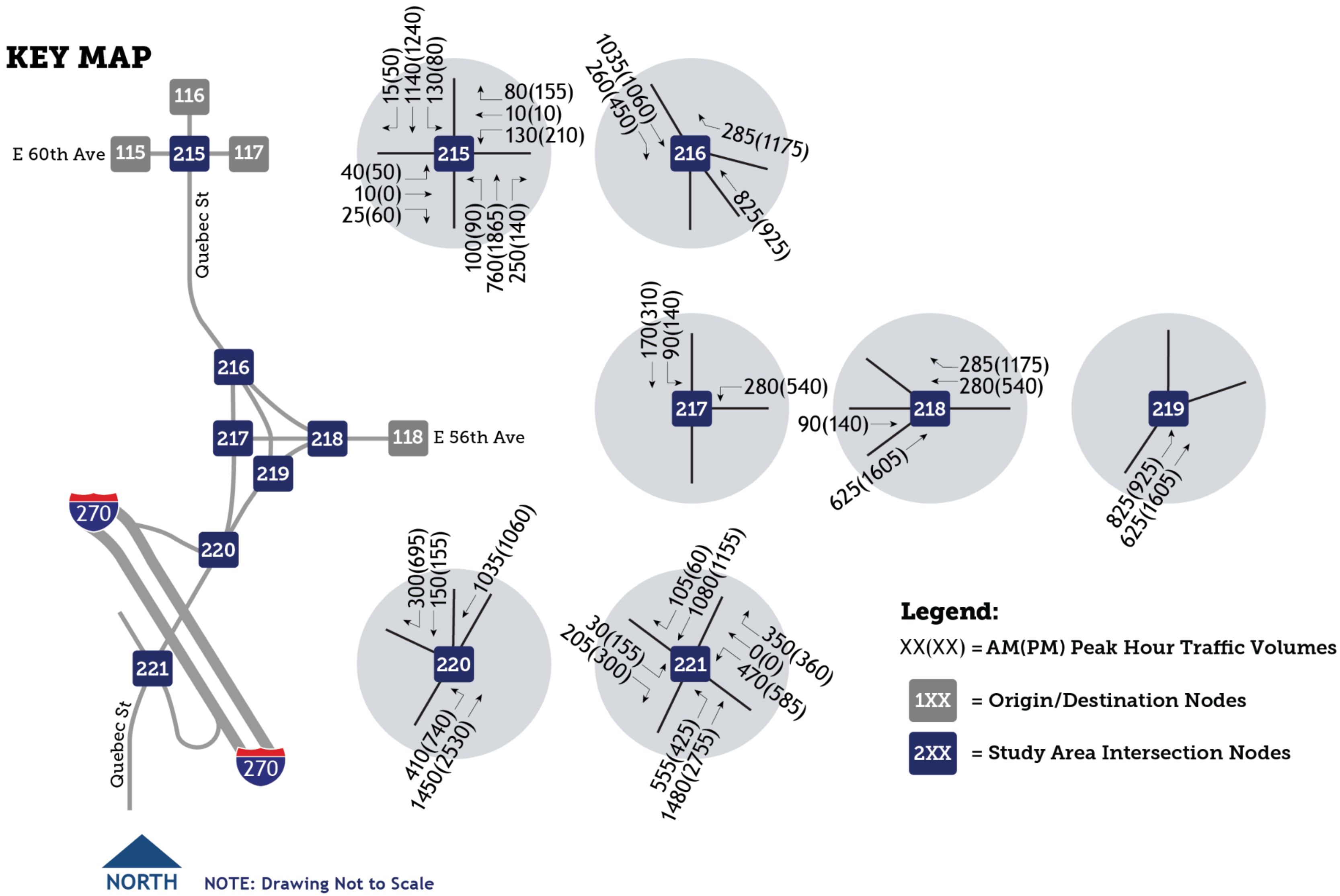
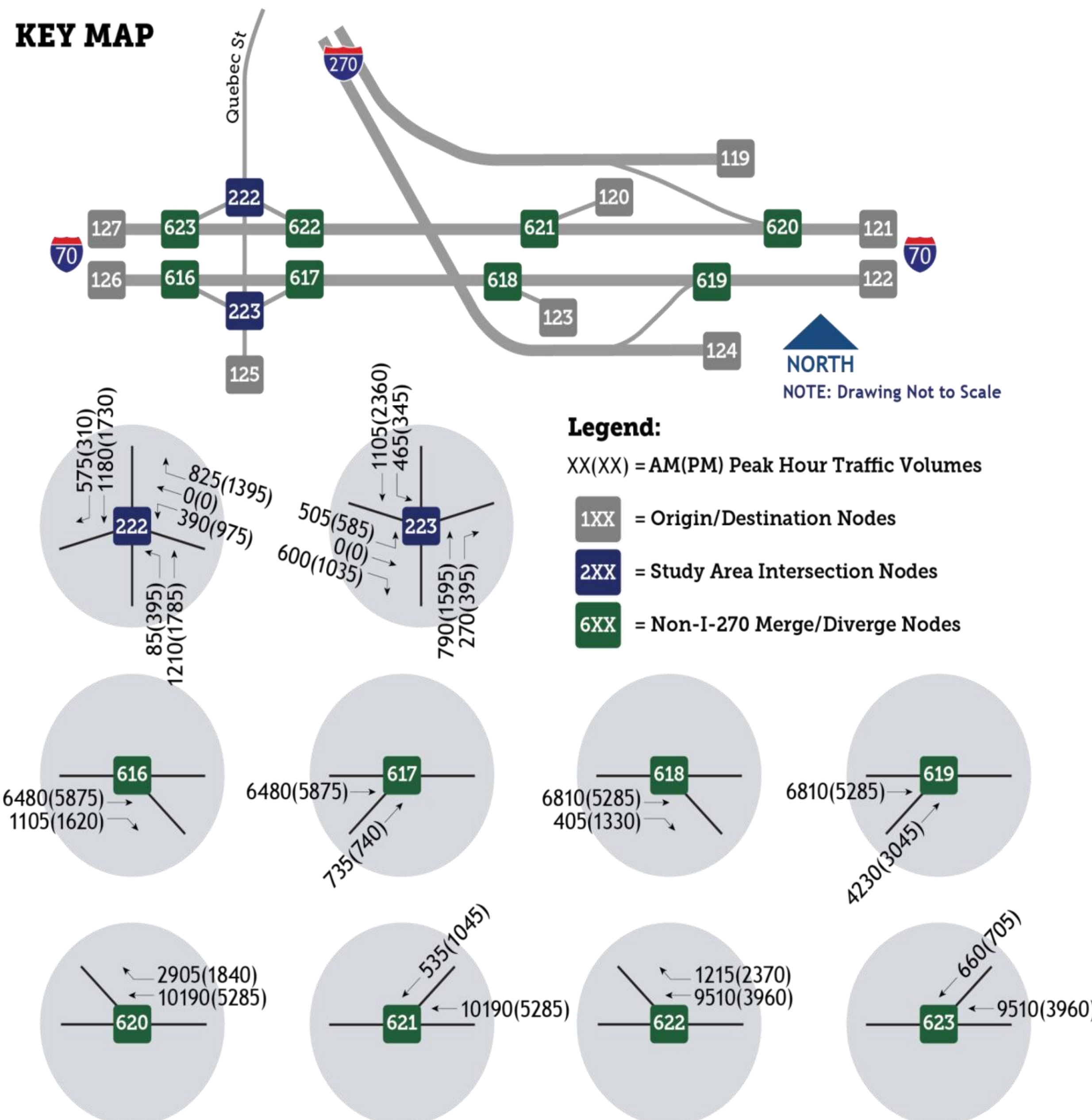


Figure 42. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - I-70 Peak Hour Traffic Volumes (2050)



12.0 Measures of Effectiveness

The traffic analysis used specific performance measures (identified and defined in Attachment A, Microsimulation Methods and Assumptions Technical Memorandum) to evaluate the ability of the No Action Alternative and Build Alternatives to address the project Purpose and Need. These MOEs are selected to provide a comprehensive understanding of corridor performance and are consistent with FHWA guidelines.

12.1 Overall System Performance Measures of Effectiveness

Each TransModeler model has been evaluated with the following network-wide performance metrics:

- Average Number of Vehicles Processed
- Average Number of Queued Trips
- Average Speed
- Vehicle Miles Traveled (VMT)
- Average Delay
- Vehicle Hours Traveled (VHT)

The following discusses what each of these metrics includes and how it helps evaluate the overall system performance of the modeled alternatives. These metrics can be queried for specific time periods covered in each microsimulation model. For this analysis, the overall system performance metrics have been reported for the a.m. and p.m. peak hours. The a.m. and p.m. peak hours reflect a single hour in the a.m. and p.m. peak period models, respectively.

12.1.1 Average Number of Vehicles Processed

The average number of vehicles processed performance metrics for the a.m. and p.m. peak hour are performance metrics that evaluate how well each alternative can process peak hour demand. TransModeler reports the average number of vehicles processed for the peak hour as the total number of trips completed that both started and ended in the peak hour plus the enroute start trips.

The total number of trips completed that both started and ended in the peak hour are trips that are included in the corresponding O-D matrices that reflect the peak hour demand that is being served in the peak hour (see Table 2).

Table 2. Comparison of Network Performance Metrics – Average Number of Vehicles Processed (Trips Starting and Ending in the Peak Hour)

Alternative	Time Period	Average Number of Vehicles Processed
No Action Alternative	a.m. Peak Hour	35,286
No Action Alternative	p.m. Peak Hour	21,325
Three General-Purpose Lanes Alternative	a.m. Peak Hour	35,868
Three General-Purpose Lanes Alternative	p.m. Peak Hour	31,733
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	36,429
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	34,268

As shown in Table 2, during the a.m. peak hour, the three alternatives all process approximately 35,000 peak hour demand trips. The p.m. peak hour shows a higher peak hour completed trips under the two Build Alternatives as compared to the No Action Alternative. In the p.m. peak hour, the Build Alternatives are able to process a higher percentage of the peak hour demand within the peak hour. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to process 8 percent more peak hour trips than the Three General-Purpose Lanes Alternative.

Included in the completed trips, en route trips are the completed trips that were already in the network at the start of the peak hour. A high number of "En Route Start" trips can indicate that many vehicles are carrying over from previous periods, potentially due to extended travel times or network congestion (see Table 3).

Table 3. Comparison of Network Performance Metrics - Average Number of Vehicles Processed (En Route Start Trips)

Alternative	Time Period	Average Number of Vehicles Processed
No Action Alternative	a.m. Peak Hour	12,547
No Action Alternative	p.m. Peak Hour	33,263
Three General-Purpose Lanes Alternative	a.m. Peak Hour	14,876
Three General-Purpose Lanes Alternative	p.m. Peak Hour	26,976
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	14,507
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	24,188

For en route trips (Table 3), the two Build Alternatives are projected to process demand that is projected to build up in the system prior to start of the a.m. peak hour. Table 3 also indicates that there are fewer en route start trips in the network at the start of the p.m. peak hour, reflecting a better ability of the build alternative networks to address demand leading up to the p.m. peak hour. Nevertheless, there is still substantial demand built up in the network, as reflected in the more than 24,000 to 26,000 en route start trips reported in the p.m. peak hour for the Three General-Purpose Lanes and Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternatives, respectively.

Together, the peak hour completed trips and the enroute trips reflect the average number of vehicles processed for the a.m. and p.m. peak hours. Table 4 below summarizes the average number of vehicles processed for the a.m. and p.m. peak hours for each alternative.

Table 4. Comparison of Network Performance Metrics - Average Number of Vehicles Processed

Alternative	Time Period	Average Number of Vehicles Processed
No Action Alternative	a.m. Peak Hour	47,833
No Action Alternative	p.m. Peak Hour	54,855
Three General-Purpose Lanes Alternative	a.m. Peak Hour	50,743
Three General-Purpose Lanes Alternative	p.m. Peak Hour	58,700
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	50,935
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	58,456

As shown in Table 4, the build alternatives are projected to process approximately 3,000 more trips in the a.m. peak hour and 3,500 more vehicles in the p.m. peak hour than would be expected to be processed under the No Action Alternative. An increase in the average number of completed trips indicates improved network performance, as it reflects a greater ability to accommodate demand and move vehicles efficiently through the corridor; this, in turn, enhances travel time reliability by reducing congestion-related delays and ensuring more consistent and predictable trip durations that would be expected with either the Three General-Purpose Lanes Alternative or the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative.

12.1.2 Average Number of Queued Trips

The average number of queued trips metric reports the number of vehicles included in the peak hour demand O-D metrics that were unable to enter the network during the peak hour. This situation typically occurs when the network is congested, causing entry delays that prevent vehicles from starting their trips as planned. This metric can be influenced by delays on the local network that restrict the flow of vehicles into the network and onto I-270. Table 5 below compares the en route end trips reported for the a.m. and p.m. peak hours for each alternative.

Table 5. Comparison of Network Performance Metrics - Average Queued Trips

Alternative	Time Period	Average Queued Trips
No Action Alternative	a.m. Peak Hour	12,632
No Action Alternative	p.m. Peak Hour	30,303
No Action Alternative	Total Peak Hour Trips	42,935
Three General-Purpose Lanes Alternative	a.m. Peak Hour	15,679
Three General-Purpose Lanes Alternative	p.m. Peak Hour	18,649
Three General-Purpose Lanes Alternative	Total Peak Hour Trips	34,353
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	15,145
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	18,208
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Peak Hour Trips	33,353

As shown in Table 5, the Three General-Purpose Lanes Alternative is projected to have 19 percent more queued trips waiting to enter the network at the end of the a.m. peak hour than the No Action Alternative. Similarly, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to have 17 percent more queued trips waiting to enter the network at the end of the a.m. peak hour than the No Action Alternative. For the p.m. peak hour, the Three General-Purpose Lanes Alternative is projected to have 38 percent fewer queued trips and the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to have 40 percent fewer queued trips waiting to enter the network at the end of the p.m. peak hour than the No Action Alternative.

While there were increases in the a.m. peak hour average queued trips, there were decreases in the p.m. peak hour average queue trips for both build alternatives when compared to the No Action Alternative.

As shown in the “Total Peak Hour Trips” rows in Table 5, summing the a.m. and p.m. peak hour queued trips shows that the No Action Alternative is projected have 8,600 more peak hour queued trips than the Three General-Purpose Lanes Alternative and 9,500 more peak hour queued trips than the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative.

The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative demonstrates the best overall performance for this metric, reducing total peak hour queued trips by approximately 9,500 compared to the No Action Alternative. This reduction is slightly greater than that of the Three General-Purpose Lanes Alternative, indicating that incorporating an express lane has the potential to improve travel time reliability by minimizing congestion and reducing vehicle queues.

12.1.3 Average Speed

Average speed is reported in mph as the travel speed averaged over all who completed their trips in the peak hour, weighted by trip distance. It is important to note that this includes all vehicles in the network. Including those travelling on lower speed roadways. Table 6 includes additional information about the travel time and speeds specifically on I-270.

Table 6. Comparison of Network Performance Metrics – Average Speed (mph)

Alternative	Time Period	Average Speed (mph)
No Action Alternative	a.m. Peak Hour	28.0
No Action Alternative	p.m. Peak Hour	15.4
No Action Alternative	Total Modeled Peak Periods	22.3
Three General-Purpose Lanes Alternative	a.m. Peak Hour	31.1
Three General-Purpose Lanes Alternative	p.m. Peak Hour	17.6
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	26.9
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	29.2
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	23.8
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	28.1

The comparison of the average recorded modeled speeds across the No Action Alternative and Build Alternatives demonstrates improved traffic efficiency with the proposed Build Alternatives. Over the total modeled period (both the a.m. and p.m. peak periods), the Build Alternatives modeled results reflect more than a 20 percent increase in network-wide, travel speeds when compared to the No Action Alternative.

In the a.m. peak hour, the Three General-Purpose Lanes Alternative achieves the highest average speed of 31.1 mph, approximately a 10 percent increase over the No Action Alternative. In the p.m. peak hour, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to result in more than a 50 percent increase in p.m. peak hour average speed as compared to the No Action Alternative.

In the a.m. peak hour, the average speed for the Three General-Purpose Lanes Alternative is projected to be 7 percent higher than for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative. For the p.m. peak hour, the average speed for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to be 21 percent higher than for the Three General-Purpose Lanes Alternative. For the total modeled peak periods, the average speed for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to be 4 percent higher than for the Three General-Purpose Lanes Alternative.

12.1.4 Total Delay

Total delay quantifies the amount of time for vehicles that completed their trip during the peak hour spent traveling below the ideal (or free-flow) speed due to factors, like traffic congestion, traffic signals, or other impediments. Table 7 below provides a comparison of total delay.

Table 7. Comparison of Network Performance Metrics – Total Delay (Hours)

Alternative	Time Period	Total Delay (Hours)
No Action Alternative	a.m. Peak Hour	9,857
No Action Alternative	p.m. Peak Hour	43,489
No Action Alternative	Total Modeled Peak Periods	141,827
Three General-Purpose Lanes Alternative	a.m. Peak Hour	10,915
Three General-Purpose Lanes Alternative	p.m. Peak Hour	33,123
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	117,928
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	10,952
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	28,697
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	113,903

During the a.m. peak hour, both Build Alternatives are projected to experience an 11 percent increase in the total delay. For the p.m. peak hour, when compared to the No Action Alternative, the Three General-Purpose Lanes Alternative and the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative are projected to result in a 24 percent and 34 percent reduction in total delay, respectively. The total delay under the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is 4 percent lower than the Three General-Purpose Lanes Alternative.

Because the total delay summed over all completed trips increases in the Build Alternatives as compared to the No Action Alternative in the a.m. peak hour, another way to look at delay is the average delay per completed trip (see Table 8 below).

Table 8. Comparison of Network Performance Metrics – Average Delay per Completed Trip (Min)

Alternative	Time Period	Average Delay per Completed Trip (min)
No Action Alternative	a.m. Peak Hour	12.36
No Action Alternative	p.m. Peak Hour	47.80
No Action Alternative	Total Modeled Peak Periods	21.21
Three General-Purpose Lanes Alternative	a.m. Peak Hour	12.91
Three General-Purpose Lanes Alternative	p.m. Peak Hour	33.86
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	15.85
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	12.90
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	29.45
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	15.12

When calculated as an average delay per completed trip, the a.m. peak hour delay per vehicle increase is approximately 4 percent. For the p.m. peak hour, both alternatives are projected to result in a reduction in total peak hour delay and delay per completed trip. In the p.m. peak hour, the Three General-Purpose Lanes Alternative is projected to experience nearly a 25 percent reduction in total delay and nearly a 30 percent reduction in average delay per completed trip. For the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative, it is projected that the p.m. peak hour total delay is projected to result in a nearly 35 percent decrease, with a 38 percent decrease in average delay per completed trip. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative.

12.1.4 Vehicle Miles Traveled and Vehicle Hours Traveled

The VMT and VHT metrics collectively highlight the increased network utilization and improved travel efficiency, achieved under the Build Alternatives.

VMT measures the total distance covered by all vehicles that completed their trip during the peak hour, while VHT represents the cumulative time that all completed trips spend traveling within the network during that same period. Table 9 and Table 10 compare peak hour VMT and VHT reported for the a.m. and p.m. peak hours for each alternative.

Table 9. Comparison of Network Performance Metrics – Vehicle Miles Traveled

Alternative	Time Period	Vehicles Miles Traveled
No Action Alternative	a.m. Peak Hour	155,791
No Action Alternative	p.m. Peak Hour	175,390
No Action Alternative	Total Modeled Peak Periods	1,268,485
Three General-Purpose Lanes Alternative	a.m. Peak Hour	188.277
Three General-Purpose Lanes Alternative	p.m. Peak Hour	201,277
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	1,637,606
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	184,288
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	197,650
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	1,617,385

Both Build Alternatives show higher VMT across all evaluated time periods compared to the No Action Alternative, indicating that more vehicle miles are being traveled. Looking at VMT alone, this growth could indicate that the alternatives may better accommodate overall travel demand or could result in longer trips. Because VMT is reported for all vehicles completing their trips, looking at the average VMT per completed trip can help provide additional insight into the growth in VMT projected under the Build Alternatives (see Table 10).

Table 10. Comparison of Network Performance Metrics - Average Vehicle Miles Traveled per Completed Trip

Alternative	Time Period	Average Vehicles Miles Traveled per Completed Trip
No Action Alternative	a.m. Peak Hour	3.3
No Action Alternative	p.m. Peak Hour	3.2
No Action Alternative	Total Modeled Peak Periods	3.2
Three General-Purpose Lanes Alternative	a.m. Peak Hour	3.7
Three General-Purpose Lanes Alternative	p.m. Peak Hour	3.4
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	3.7
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	3.6
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	3.4
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	3.6

As shown in Table 11, during the a.m. peak hour, the Three General-Purpose Lanes Alternative and Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative are projected to result in 21 and 18 percent increases in VMT, respectively. However, this corresponds with only a 14 to 11 percent increase in trip length, respectively. Similarly, in the p.m. peak hour, the Three General-Purpose Lanes Alternative and Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative are projected to result in 15 and 13 percent increases in VMT, respectively, equating to a 7 to 5 percent increase in trip length, respectively.

The a.m. peak hour experiences moderate increases in total VHT, 12 percent, for both Build Alternatives as compared to the No Action Alternative. However, this equates to only a 5 percent increase in the average VHT per completed trip (less than a minute more per completed trip). Furthermore, as shown below in Table 11 (despite the increase in VMT), both alternatives are projected to experience substantial reductions in VHT during the p.m. peak hour. This reduction implies that, on average, vehicles are spending less time traveling through the model area network. This reduction equates to an average reduction of over 20 minutes per completed trip in the p.m. peak hour.

Table 11. Comparison of Network Performance Metrics - Vehicle Hours Traveled

Alternative	Time Period	Vehicle Hours Traveled
No Action Alternative	a.m. Peak Hour	13,131
No Action Alternative	p.m. Peak Hour	60,069
No Action Alternative	Total Modeled Peak Periods	163,682
Three General-Purpose Lanes Alternative	a.m. Peak Hour	14,658
Three General-Purpose Lanes Alternative	p.m. Peak Hour	42,122
Three General-Purpose Lanes Alternative	Total Modeled Peak Periods	145,784
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	a.m. Peak Hour	14,722
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	p.m. Peak Hour	37,670
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	Total Modeled Peak Periods	141,390

For the total modeled a.m. and p.m. peak periods, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative achieves the lowest VHT, reflecting a 23 percent decrease relative to projected peak period delay under the No Action Alternative. This indicates that while more trips and longer distances are accommodated, vehicles are traveling more efficiently with reduced congestion levels and delays. The combined increase in VMT and decrease in VHT highlight the effectiveness of the Build Alternatives by addressing No Action Alternative unmet demand and improving traffic flow across the network.

12.2 Travel Time and Reliability

TransModeler provides vehicle travel time results between selected points on the model network. The average travel time for these selected segments is calculated from the recorded travel times, for all vehicles that pass both the start point and the destination point during the evaluation period. Vehicles that have not reached the destination point or have been denied entry are not included in the travel time results.

The network performance statistics provided insights into the performance of the overall study area. The travel time metrics help understand the impacts of the proposed improvements included in the Build Alternatives to travel time and reliability on the I-270 corridor.

Table 12 summarizes the travel time results for westbound travel through the I-270 corridor from the on-ramps from I-70 and Central Park Boulevard on the east end to the off-ramps to westbound US 36 and northbound I-25 on the west end.

Table 12. Westbound I-270 Average Travel Time (Min) – From I-70/Central Park Boulevard to Westbound US 36/Northbound I-25

Alternative	GPL Passenger Vehicles (a.m.)	GPL Passenger Vehicles (p.m.)	Freight Vehicles (a.m.)	Freight Vehicles (p.m.)	EL Vehicles (a.m.)	EL Vehicles (p.m.)
No Action Alternative	27	31	30	38	N/A	N/A
Three General-Purpose Lanes Alternative	7	34	7	37.	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	7	20	7	21	6	9

GPL – general-purpose lane
EL – Express Lane

As shown in Table 12, vehicles in the general-purpose lanes, during the a.m. peak hour, both the Three General-Purpose Lanes Alternative and Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative are projected to experience a 7-minute westbound travel time, reflecting a 20-minute improvement, as compared to the No Action Alternative. In the p.m. peak hour, the westbound corridor-wide trip is projected to experience a 3-minute increase in travel time. Observations from the microsimulation model suggested that vehicles completing the full corridor westbound trip experience delays approaching I-25 and US 36 where vehicles traveling in the added general-purpose lane are required to exit to northbound I-25 or merge to the left to continue through on westbound US 36. Vehicles in the general purpose lanes in the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative do not experience a similar phenomenon as the vehicles traveling in these lanes have the option to use the outermost lane to either exit to northbound I-25 or continue straight to westbound US 36; these vehicles are projected to experience an 11-minute reduction in travel time, as compared to the No Action Alternative. Travel time for trucks (freight vehicles) are projected to experience similar patterns in travel time improvements as the vehicles traveling in general purpose lanes. For the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative, the Express Lane option provides a reliable trip option for a.m. and p.m. peak hour passenger vehicle travel that reflects a 21-minute and 22-minute travel-time reduction, respectively, when compared against the No Action Alternative passenger vehicle travel time.

The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative demonstrates the best overall performance in improving westbound corridor-wide travel time, particularly by providing a reliable express lane option. During the a.m. peak hour, this alternative achieves up to a 21-minute reduction in passenger vehicle travel time compared to the No Action Alternative, while also mitigating congestion in the general-purpose lanes. Additionally, freight vehicles experience similar travel time improvements. By reducing overall travel time and alleviating bottlenecks, particularly near I-25 and US 36, this alternative offers enhanced travel time reliability, ensuring more consistent and predictable trips for both passenger and freight traffic. Freight vehicles can achieve greater travel time savings, by paying the toll to use the Express Lanes. To be conservative, the analysis only reports freight vehicle travel times for freight vehicles operating in the general-purpose lanes.

Table 13 summarizes the travel time results for eastbound travel through the I-270 corridor from the on-ramps from eastbound US 36 and southbound I-25 on the west end to the off-ramps to I-70 and Central Park Boulevard on the east end.

Table 13. Eastbound I-270 Average Travel Time (Min) – From Eastbound US 36/Southbound I-25 to I-70/Central Park Boulevard

Alternative	GPL Passenger Vehicles (a.m.)	GPL Passenger Vehicles (p.m.)	Freight Vehicles (a.m.)	Freight Vehicles (p.m.)	Express Lane Vehicles (a.m.)	Express Lane Vehicles (p.m.)
No Action Alternative	22	22	25	57	N/A	N/A
Three General-Purpose Lanes Alternative	7	8	7	8	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	11	7	12	7	7	6

GPL – general-purpose lane

As shown, the Build Alternatives result in faster a.m. and p.m. peak hour travel times across the I-270 corridor than the No Action Alternative.

For vehicles in the eastbound general-purpose lanes during the a.m. peak hour, the Build Alternatives are projected to result in over10-minute reductions in travel times, when compared to the No Action Alternative. The Three General-Purpose Lanes Alternative is projected to be approximately 4 minutes faster than the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative. Microsimulation observations indicate that both Build Alternatives benefit from the addition of the continuous lane between the consolidated I-76 on-ramps and the Vasquez Boulevard interchange, improving flow and operations through this currently congested area.

During the a.m. peak hour, the Three General-Purpose Lanes Alternative is projected to provide a 7-minute eastbound corridor-wide trip, demonstrating a 15-minute improvement over the project No Action travel time. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to provide an 11-minute a.m. peak hour travel time in the general-purpose lanes, demonstrating less travel time improvement than the Three General-Purpose Lanes Alternative, but offering a competitive travel time of 7-minutes in the Express Lanes. The larger a.m. peak hour travel patterns and preliminary Express Lane modeling did not show as much demand for the trip in the Express Lane.

Under the p.m. peak hour, under the Build Alternatives, the eastbound corridor wide trip is similarly projected to experience a 14-minute reduction in travel time for the Three General-Purpose Lanes Alternative and a 15-minute reduction in travel time in general-purpose lanes for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative, when compared to the No Action Alternative.

Travel time for trucks (freight vehicles) are projected to experience similar patterns in travel time improvements as the vehicles traveling in general purpose lanes.

In the p.m. peak hour, the Three General-Purpose Lanes Alternative is projected to provide an 8-minute eastbound corridor wide travel time while the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to provide a 7-minute corridor wide travel time in both the general-purpose and Express Lanes. Both Build Alternatives provide more than a 14-minute improvement over the No Action Alternative.

A decrease in travel time corresponds to an increase in travel speeds, as vehicles experience less congestion and are able to move more efficiently through the corridor. As shown in Table 14 and Table 15 below, the projected travel time improvements translate into higher average speeds on the corridor. It is important to note that the p.m. peak hour does not see as much improvement in travel times and travel speeds as are projected under the a.m. peak hour. While the build alternatives strive to better serve the demand on the corridor, the peak hour demand still exceeds the corridor capacity.

Table 14. Westbound I-270 Average Travel Speed (mph) – From I-70/Central Park Boulevard to Westbound US 36/Northbound I-25

Alternative	GPL Passenger Vehicles (a.m.)	GPL Passenger Vehicles (p.m.)	Freight Vehicles (a.m.)	Freight Vehicles (p.m.)	Express Lane Vehicles (a.m.)	Express Lane Vehicles (p.m.)
No Action Alternative	13.60	11.98	12.29	9.80	N/A	N/A
Three General-Purpose Lanes Alternative	55.65	10.97	53.90	9.86	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	54.71	18.49	53.90	17.72	56.97	40.55

GPL – general-purpose lane

As shown in Table 14, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative demonstrates the best overall performance in improving westbound corridor-wide travel speeds, particularly during the p.m. peak hour, where general-purpose lane vehicles experience a 7 mph increase over the No Action Alternative, nearly 8 mph faster than the Three General-Purpose Lanes Alternative. During the a.m. peak hour, both Build Alternatives allow general-purpose lane vehicles to travel at speeds approximately equal to the posted speed limit, reflecting substantially reduced congestion. Additionally, the express lane in the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative provides a consistently reliable and higher-speed travel option, with projected speeds of 57 mph in the a.m. and 40 mph in the p.m. peak hour, further enhancing travel time savings. The improved travel speeds indicate greater network efficiency, reduced congestion, and improved travel time reliability, ensuring more predictable and consistent trips for both passenger and freight vehicles.

Table 15. Eastbound I-270 Average Travel Speed (mph) - From Eastbound US 36/Southbound I-25 to I-70/Central Park Boulevard

Alternative	GPL Passenger Vehicles (a.m.)	GPL Passenger Vehicles (p.m.)	Freight Vehicles (a.m.)	Freight Vehicles (p.m.)	Express Lane Vehicles (a.m.)	Express Lane Vehicles (p.m.)
No Action Alternative	7.99	7.35	7.31	6.35	N/A	N/A
Three General-Purpose Lanes Alternative	35.58	9.85	34.72	8.94	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	28.85	15.52	28.28	14.94	34.62	28.89

GPL – general-purpose lane

As shown in Table 15, and consistent with patterns observed for eastbound corridor wide travel times, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative demonstrates the best overall performance in improving eastbound corridor-wide travel speeds, particularly during the p.m. peak hour, where general-purpose lane vehicles experience a 5 mph higher travel speed than the Three General-Purpose Lanes Alternative.

While the Three General-Purpose Lanes Alternative achieves slightly higher speeds in the a.m. peak, both Build Alternatives substantially improve over the No Action Alternative, where highly congested conditions currently limit speeds to 7 to 8 mph.

The Express Lane in the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative provides the most reliable and fastest travel option, with speeds reaching 35 mph in the a.m. peak hour (6 mph faster than general-purpose lanes) and 29 mph in the p.m. peak hour (13 mph faster than general-purpose lanes).

These improvements indicate a major reduction in congestion and an increase in travel time reliability, ensuring more consistent and predictable travel conditions for both commuters and freight traffic.

The Texas Transportation Institute's Travel Time Index (TTI) indicates the extra delay associated with congestion on the system and is calculated as the ratio of peak-period travel time to free-flow travel time. Freeway TTI on I-270 has been used to evaluate travel time reliability on the corridor.

The FHWA Traffic Analysis Toolbox Volume VI: Definition, Interpretation, and Calculation of Traffic Analysis Tools and Measures of Effectiveness provides the following interpretation of the TTI:

- For more focused systems of mixed freeway and arterial facilities (no local streets), a TTI of under 2.5 roughly indicates generally uncongested conditions and good signal coordination
- For a system of solely unsignalized facilities (freeways, highways, and two-lane, rural roads), a TTI of over 1.4 indicates a facility that is over-capacity for the entire length of the analysis period
- A qualifier of “Good” for TTIs <= 1.5, “Potentially Acceptable” for TTIs between 1.5 and 2.5, and “Less Desirable” for TTIs > 2.5

The TTIs for the No Action Alternative and Build Alternatives have been evaluated on the “Good,” “Potentially Acceptable,” and “Less Desirable” levels outlined in the FHWA Toolbox. Table 16 through Table 19 compare the a.m. and p.m. peak hour calculated TTIs for the 2050 No Action Alternative and Build Alternatives for general-purpose passenger vehicles, trucks and, where applicable, vehicles using the Express Lanes in the eastbound and westbound directions along the I-270 corridor.

Table 16. Westbound I-270 Travel Time Index – From I-70/Central Park Boulevard to Westbound US 36/Northbound I-25 – a.m. Peak Hour

Alternative	TTI (GPL)	GPL Passenger Vehicles Interpretation	TTI (Trucks)	Trucks Interpretation	TTI (EL)	EL Vehicles Interpretation
No Action Alternative	4.4	Less Desirable	4.9	Less Desirable	N/A	N/A
Three General-Purpose Lanes Alternative	1.1	Good	1.1	Good	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	1.1	Good	1.1	Good	1.0	Good

GPL – general-purpose lane
EL – Express Lane

Table 17. Westbound I-270 Travel Time Index - From I-70/Central Park Boulevard to Westbound US 36/Northbound I-25 - p.m. Peak Hour

Alternative	TTI (GPL)	GPL Passenger Vehicles Interpretation	TTI (Trucks)	Trucks Interpretation	TTI (EL)	EL Vehicles Interpretation
No Action Alternative	5.0	Less Desirable	6.1	Less Desirable	N/A	N/A
Three General-Purpose Lanes Alternative	5.5	Less Desirable	6.1	Less Desirable	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	3.2	Less Desirable	3.4	Less Desirable	1.5	Good

GPL - general-purpose lane
EL - Express Lane

Table 18. Eastbound I-270 Travel Time Index - From Eastbound US 36/Southbound I-25 to I-70/Central Park Boulevard - a.m. Peak Hour

Alternative	TTI (GPL)	GPL Passenger Vehicles Interpretation	TTI (Trucks)	Trucks Interpretation	TTI (EL)	EL Vehicles Interpretation
No Action Alternative	3.8	Less Desirable	4.3	Less Desirable	N/A	N/A
Three General-Purpose Lanes Alternative	1.2	Good	1.2	Good	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	1.8	Potentially Acceptable	1.9	Potentially Acceptable	1.2	Good

GPL - general-purpose lane
EL - Express Lane

Table 19. Eastbound I-270 Travel Time Index - From Eastbound US 36/Southbound I-25 to I-70/Central Park Boulevard - p.m. Peak Hour

Alternative	TTI (GPL)	GPL Passenger Vehicles Interpretation	TTI (Trucks)	Trucks Interpretation	TTI (EL)	EL Vehicles Interpretation
No Action Alternative	3.9	Less Desirable	4.8	Less Desirable	N/A	N/A
Three General-Purpose Lanes Alternative	1.2	Good	1.2	Good	N/A	N/A
Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative	1.1	Good	1.2	Good	1.1	Good

GPL - general-purpose lane
EL - Express Lane

The TTI is projected to approach “potentially acceptable” and even “good” thresholds under eastbound a.m. and p.m. peak hours and the westbound a.m. peak hour, for both of the two Build Alternatives. However, under the westbound direction in the p.m. peak hour, all alternatives projected to continue to operate at “less desirable levels”; with the two Build Alternatives still showing improvement over the No Action Alternative.

While the westbound p.m. peak hour does not see as much improvement in travel time reliability, travel times, and travel speeds as the a.m. peak hour, the Express Lanes included in the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative are projected to provide a more reliable trip option, ranking “good” in both directions and under both peak hours.

12.3 Queuing – Intersection Operations

Queue reports include the following queuing metrics[2]:

- **Average Queue** – The average queue length measured in the lane during the peak hour and peak period.
- **95th Percentile Queue** – The queue length that 95 percent of queues are at or shorter than (only 5 percent of queues exceed this length); the 95th percentile queue measured in the lane during the interval.

Queuing at ramp terminal intersections will be used to inform the geometric design for auxiliary lanes, and ramp design to minimize spill back queuing onto the mainline. The queuing has been rounded to the nearest 5-foot increment. See Table 20 and Table 21 below.

[2] TransModeler measures queues from each node in each lane using superlinks. Superlinks are a series of model links grouped together to report delay and queue measurements. Superlinks allow queueing and delay to be recorded continuously across links that are split to accommodate turn lanes, driveways, lane add/drops, etc. Superlinks will be used to report queuing and delay at all ramp terminal intersections.

Table 20. Average Queue Length (feet) for Key Ramp Terminal Intersection Movements

Node	Intersection	Dir/Mvmt[1]	No Action Alternative (a.m. Peak Hour)	3GP[2] (a.m. Peak Hour)	2+1[3] (a.m. Peak Hour)	No Action Alternative (p.m. Peak Hour)	3GP (p.m. Peak Hour)	2+1 (p.m. Peak Hour)
201	I-270 Westbound Off-Ramp to York Street	WBL	30	55	70	10	20	45
202	I-270 Eastbound On-Ramp from York Street	SBL	55	80	85	40	130	125
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	WBL	Free	15	20	Free	10	10
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	EBL	Free	10	10	Free	50	25
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	EBR	Free	25	15	Free	20	15
220	I-270 Westbound On-Ramp from Quebec Street	NBL	25	25	25	255	115	115
221	I-270 Eastbound Off-Ramp to Quebec Street	EBL	35	75	80	120	270	200
221	I-270 Eastbound Off-Ramp to Quebec Street	EBT	20	45	40	225	130	190

[1]Direction/Movement, WBL - westbound left, SBL - southbound left, EBL - eastbound left, EBR - eastbound right, NBL - northbound left, EBT - eastbound through
[2]Three General-Purpose Lanes Alternative
[3] Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

Table 21. 95th Percentile Queue Length (feet) for Key Ramp Terminal Intersection Movements

Node	Intersection	Dir/Mvmt[1]	No Action Alternative (a.m. Peak Hour)	3GP[2] (a.m. Peak Hour)	2+1[3] (a.m. Peak Hour)	No Action Alternative (p.m. Peak Hour)	3GP (p.m. Peak Hour)	2+1 (p.m. Peak Hour)
201	I-270 Westbound Off-Ramp to York Street	WBL	85	195	260	55	95	165
202	I-270 Eastbound On-Ramp from York Street	SBL	280	240	245	180	250	245
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	WBL	Free	70	70	Free	45	55
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	EBL	Free	60	55	Free	165	105
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	EBR	Free	160	80	Free	65	80
220	I-270 Westbound On-Ramp from Quebec Street	NBL	135	130	135	485	315	325
221	I-270 Eastbound Off-Ramp to Quebec Street	EBL	145	210	235	535	850	850
221	I-270 Eastbound Off-Ramp to Quebec Street	EBT	165	190	175	855	615	755

[1]Direction/Movement, WBL - westbound left, SBL - southbound left, EBL - eastbound left, EBR - eastbound right, NBL - northbound left, EBT - eastbound through

[2]Three General-Purpose Lanes Alternative

[3] Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

As shown in both queuing tables, the longer queues are projected to occur for vehicles waiting to enter onto I-270. These queues are impacted by signal timings, demand, as well as existing and planned ramp meters to help regulate the flow of vehicles onto I-270. For the off-ramps, all ramps have at least 1,000 feet of storage, and the 95th percentile queues are not projected to exceed these storage lengths. However, it is important to note that just because the queues themselves are not projected to routinely extend back to mainline, I-270 queuing on the ramps has the potential to impact mainline traffic as queues grow. This phenomenon is primarily observed during the p.m. peak hour. As queuing at ramp terminal intersections grows, there is less space on the ramp for deceleration and vehicles may have to start their deceleration prior to exiting I-270. In the Build Alternatives, deceleration lengths have been extended to provide space for vehicles exiting I-270 to begin their deceleration, once they have exited the general-purpose lanes.

12.4 Delay – Intersection Operations

TransModeler results are compiled from each individually simulated vehicle and the interaction between vehicles. Intersection operations have been evaluated at all ramp terminal and key study area intersections.

Total Delay – Total delay experienced at the intersection, summed over all vehicles on the approach to the intersection during the analysis interval.
Average Delay – Delay experienced at the intersection, averaged over all vehicles on the approach to the intersection during the analysis interval.
Average Control Delay – Control delay is measured as soon as a vehicle starts to brake and to join the back of queue forming at an intersection and concludes when the vehicle passes through the intersection and returns to speed, the average control delay in seconds per vehicle.

Table 22 summarizes the level of service (LOS) thresholds applied to the ramp terminal intersections.

Table 22. Intersection Level of Service Thresholds

Level of Service (LOS)	Control Delay (seconds per vehicle)
A	Control Delay ≤ 10.0
B	10.0 < Control Delay ≤ 20.0
C	20.0 < Control Delay ≤ 35.0
D	35.0 < Control Delay ≤ 55.0
E	55.0 < Control Delay ≤ 80.0
F	Control Delay > 80.0

All ramp terminal intersections are projected to be signalized under the 2050 horizon. The exceptions are the No Action Alternative loop ramp intersections at the Vasquez Boulevard Interchange that would remain unsignalized. These intersections are signalized under the Build Alternatives as part of the interchange reconfiguration and ramp consolidation. Table 23 through Table 26 summarize the delays associated with the ramp terminal intersections.

Table 23. Ramp Terminal Intersections - Peak Hour Total Delay (hr)

Node	Intersection	No Action Alternative (a.m. Peak Hour)	No Action Alternative (p.m. Peak Hour)	Three General-Purpose Lanes Alternative (a.m. Peak Hour)	Three General-Purpose Lanes Alternative (p.m. Peak Hour)	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative (a.m. Peak Hour)	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative (p.m. Peak Hour)
201	I-270 Westbound Off-Ramp to York Street	5.28	1.93	99.24	116.45	100.77	123.02
202	I-270 Eastbound On-Ramp from York Street	K8?*I12.27	7.55	17.98	14.98	15.08	14.27
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	4.35	14.01	3.92	12.13
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	42.16	13.11	31.16	10.79
221	I-270 Westbound On-Ramp from Quebec Street	17.91	78.24	26.23	81.19	31.11	80.40
222	I-270 Eastbound Off-Ramp to Quebec Street	17.46	38.54	17.97	87.06	18.67	86.18

Table 24. Ramp Terminal Intersections - Average Delay (sec/veh)

Node	Intersection	No Action Alternative (a.m. Peak Hour)	No Action Alternative (p.m. Peak Hour)	Three General-Purpose Lanes Alternative (a.m. Peak Hour)	Three General-Purpose Lanes Alternative (p.m. Peak Hour)	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative (a.m. Peak Hour)	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative (p.m. Peak Hour)
201	I-270 Westbound Off-Ramp to York Street	12.22	4.58	240.08	264.21	235.03	271.38
202	I-270 Eastbound On-Ramp from York Street	26.76	16.89	40.49	27.36	33.12	25.80
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	21.63	35.71	20.64	29.47
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	58.51	25.45	42.91	20.55
221	I-270 Westbound On-Ramp from Quebec Street	20.40	97.07	28.47	65.22	30.75	62.31
222	I-270 Eastbound Off-Ramp to Quebec Street	25.03	56.05	17.40	63.43	17.99	59.99

Table 25. Ramp Terminal Intersections - a.m. Peak Hour Average Control Delay (sec/veh)

Node	Intersection	No Action Alternative - Delay	No Action Alternative - LOS	Three General-Purpose Lanes Alternative - Delay	Three General-Purpose Lanes Alternative - LOS	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Delay	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - LOS
201	I-270 Westbound Off-Ramp to York Street	9.49	A	235.02	F	229.85	F
202	I-270 Eastbound On-Ramp from York Street	22.29	C	33.37	C	26.54	C
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	7.07	A	7.75	A
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	48.74	D	33.42	C
221	I-270 Westbound On-Ramp from Quebec Street	14.38	B	24.23	C	24.45	C
222	I-270 Eastbound Off-Ramp to Quebec Street	20.80	C	11.35	B	12.00	B

Table 26. Ramp Terminal Intersections - p.m. Peak Hour Average Control Delay (sec/veh)

Node	Intersection	No Action Alternative - Delay	No Action Alternative - LOS	Three General-Purpose Lanes Alternative - Delay	Three General-Purpose Lanes Alternative - LOS	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Delay	Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - LOS
201	I-270 Westbound Off-Ramp to York Street	2.72	A	260.24	F	267.00	F
202	I-270 Eastbound On-Ramp from York Street	13.83	B	21.97	C	21.38	C
206	I-270 Westbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	24.98	C	19.22	B
209	I-270 Eastbound Off-Ramp to Vasquez Boulevard	Unsignalized - Free Flow	Unsignalized - Free Flow	13.60	B	11.71	B
221	I-270 Westbound On-Ramp from Quebec Street	91.57	F	58.79	E	55.83	E
222	I-270 Eastbound Off-Ramp to Quebec Street	51.21	D	57.85	E	54.54	D

Ramp terminal intersection LOS was included as a metric to evaluate how improvements on I-270 were projected to impact the arterial and local network. Signal timing plans were adjusted to better match the demands of each alternative and to minimize the impact of increased demand on I-270 under the Build Alternative to intersection operations. As shown in Tables 23 through 26 above, the ramp terminal intersections under the Build Alternatives generally operate at the same LOS or better than the No Action Alternative, except for at the following locations:

- York Street Ramp Terminal Intersections: The widening of the York Street bridge over I-270 to tie into the Adams County York Street widening project as part of the Build Alternatives alleviates a capacity constraint in the network. Combined with the improvements on I-270 and the ramp meter for the I-270 eastbound on-ramp, there is more demand for vehicles to use York Street. During the peak hours, the throughput capacity of these closely spaced intersections can be limited by the number of vehicles the ramp meter allows to flow onto eastbound I-270. The added delay at ramp terminal intersections with ramp meters improves overall freeway operations (see Section 12.5, Density – Freeway Operations, below) by regulating the flow of vehicles entering the freeway, reducing congestion and preventing bottlenecks. As a result, the delay experienced at the ramp is more than offset by smoother and faster travel, once on the freeway.
- I-270 Westbound on Ramp from Quebec Street: During the a.m. peak hour, the intersection is projected to operate at LOS C under both Build Alternatives, slightly worse than the projected LOS B under the No Action. The change is associated with the greater demand to access I-270 under the Build Alternatives. LOS D is generally deemed acceptable for peak hour urban intersections and the intersection is projected to exceed this threshold under the Build Alternatives.
- I-270 Eastbound off Ramp to Quebec Street: During the p.m. peak hour, the intersection is projected to operate at LOS E under the Three General-Purpose Lanes Alternative, slightly worse than the projected LOS D under the No Action. The Build Alternatives project a higher demand coming from I-270 and traveling through northbound Quebec to access the westbound ramp. While both Build Alternatives projected slight increases to average delay at the intersection, the overall average delay for the Three General Purpose Lanes Alternative increased the most, by 6 seconds, pushing the peak hour alternative over the LOS E threshold.
- I-270 Westbound off Ramp to Vasquez Boulevard: Under the No Action Alternative, this movement would remain unsignalized. The elimination of the off-ramp loop ramps at the Vasquez Interchange requires signalization under the Build Alternatives. The intersection is projected to operate at LOS C or better, a generally acceptable condition, for all Build Alternatives under both peak hours.
- I-270 Eastbound off Ramp to Vasquez Boulevard: Like the westbound off-ramp, this movement would remain unsignalized under the No Action. The elimination of the off-ramp loop ramps at the Vasquez Interchange requires signalization under the Build Alternatives. The intersection is projected to operate at LOS D or better, a generally acceptable condition, for the Build Alternatives under both peak hours.

The peak hour intersection LOS for the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is the same as or better than the Three General-Purpose Lanes Alternative across both peak hours. Ramp terminal intersections where the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to operate at a better LOS than the Three General-Purpose Lanes Alternative include:

- I-270 Westbound Off-Ramp to Vasquez Boulevard: As previously noted, the elimination of the off-ramp loop ramps at the Vasquez Interchange requires signalization under the Build Alternatives. The intersection is projected to operate at LOS A for both Build Alternatives under the a.m. peak hour. For the p.m. peak hour, the intersection is projected to operate at LOS B under the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative and LOS C under the Three General-Purpose Lanes Alternative.
- I-270 Eastbound Off-Ramp to Vasquez Boulevard: As previously noted, the elimination of the off-ramp loop ramps at the Vasquez Interchange requires signalization under the Build Alternatives. For the a.m. peak hour, the intersection is projected to operate at LOS C under the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative and LOS D under the Three General-Purpose Lanes Alternative. The intersection is projected to operate at LOS B for both Build Alternatives under the p.m. peak hour.
- I-270 Eastbound Off-Ramp to Quebec Street: The intersection is projected to operate at LOS B for both Build Alternatives under the a.m. peak hour. For the p.m. peak hour, the intersection is projected to operate at LOS D under the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative and LOS E under the Three General-Purpose Lanes Alternative.

12.5 Density – Freeway Operations

Microsimulation is especially useful for analyzing freeway operations. Freeway density is a critical metric used to assess the performance and efficiency of a freeway or highway system. Density is reported from the model as passenger cars per mile per lane (pc/mi/ln). Density has been used to evaluate operations on freeway facilities (basic freeway segments, merge segments, weaving segments, and diverge segments).

Table 27 summarizes the relationship between density and LOS for merging, diverging, and basic freeway segments.

Table 27. Freeway Level of Service Thresholds

Level of Service (LOS)	Merging and Diverging Segment Density (pc/mi/ln)	Basic Freeway Segment Density(pc/mi/ln)
A	Density ≤ 10.0	Density ≤ 11.0
B	10.0 < Density ≤ 20.0	11.0 < Density ≤ 18.0
C	20.0 < Density ≤ 28.0	18.0 < Density ≤ 26.0
D	28.0 < Density ≤ 35.0	26.0 < Density ≤ 35.0
E	Density > 35.0	35.0 < Density ≤ 45.0
F	Demand Exceeds Capacity	Density > 45.0 or Demand Exceeds Capacity

For the No Action Alternative, 23 out of 36 segments (64 percent) operate at LOS F during the a.m. peak hour, while 22 of 36 segments (61 percent) operate at LOS F during the p.m. peak hour.

Meanwhile, the Three General-Purpose Lanes Alternative experiences no LOS F (0 percent) segments during the a.m. peak hour, while 16 of 36 (44 percent) of segments operate at LOS F during the p.m. peak hour.

For the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative, 5 out of 12 segments (14 percent) operate at LOS F during the a.m. peak hour, while 12 of 36 (33 percent) of segments operate at LOS F during the p.m. peak hour. The following sections provide more detailed information about the projected freeway operations under the 2050 horizon for each alternative.

12.5.1 No Action Alternative Freeway Operations (2050)

During the a.m. peak hour, eastbound vehicles experience a high level of congestion and delay starting at the east end of the corridor, where they merge onto eastbound I-270 from southbound I-25 and eastbound US 36. This congestion persists until reaching the Vasquez Boulevard Interchange. The existing turbulence at the Vasquez Boulevard interchange loop ramps continues to cause congestion, and once vehicles pass through this congested area, travel speeds and congestion improve. East of the Vasquez Boulevard interchange, the freeway operates at LOS C and D, with a segment of LOS F near the Quebec Street exit. In the westbound direction, travelers continue to experience substantial delays associated with the challenges at the Vasquez Boulevard interchange. The demand growth anticipated under the 2050 horizon indicates that the congestion extending east of the Vasquez Boulevard interchange results in a.m. peak hour queuing and delays on westbound I-270 that extend back to I-70. Once travelers traverse the Vasquez Boulevard interchange, the freeway LOS improves to LOS B and C. This is largely due to the congestion at the Vasquez Boulevard interchange metering westbound flow to the west of the interchange.

The p.m. peak hour (the overall corridor peak hour) experiences several of the same challenges as the a.m. peak hour due to demand for higher volumes of traffic traveling through the corridor.

Table 28 summarizes the 2050 No Action Alternative a.m. and p.m. peak hour freeway LOS for mainline I-270.

Table 28. 2050 No Action Alternative - Peak Hour Freeway Level of Service

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - East of I-25	Basic	112.87	F	113.65	F
Eastbound - On-Ramp from Southbound I-25 Express Lanes	Basic	80.68	F	83.80	F
Eastbound - On-Ramp from Southbound I-25 General-Purpose Lanes	Merge	192.08	F	195.50	F
Eastbound - Off-Ramp to Eastbound I-76	Diverge	151.18	F	161.94	F
Eastbound - Between I-76 Ramps	Basic	170.05	F	159.46	F
Eastbound - On-Ramp from Westbound I-76	Merge	145.45	F	138.50	F
Eastbound - On-Ramp from Eastbound I-76	Merge	120.61	F	131.41	F
Eastbound - Between I-76 and York Street Ramps	Basic	134.71	F	148.86	F
Eastbound - On-Ramp from York Street	Merge	73.29	F	78.56	F
Eastbound - Between York Street and Vasquez Boulevard	Basic	49.45	F	38.35	E
Eastbound - Off-Ramp to Southbound Vasquez Boulevard	Diverge	65.19	F	67.24	F
Eastbound - Between Off-Ramp to Southbound Vasquez Boulevard and On-Ramp from Southbound Vasquez Boulevard	Basic	28.06	D	26.11	D
Eastbound - Between On-Ramp from Southbound Vasquez Boulevard and Off-Ramp to Northbound Vasquez Boulevard	Weaving	21.59	C	19.70	B
Eastbound - Between Vasquez Boulevard and Quebec Street	Basic	30.37	D	28.20	D
Eastbound - Off-Ramp to Eastbound I-70 Express Lanes	Diverge	23.72	C	23.17	C
Eastbound - Off-Ramp to Quebec Street	Diverge	154.25	F	161.96	F

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - Between Quebec Street and Central Park Boulevard	Basic	22.39	C	21.11	C
Eastbound - Off-Ramp to Central Park Boulevard	Diverge	24.20	C	22.21	C
Eastbound - Off-Ramp to Eastbound I-70 General-Purpose Lanes	Basic	22.47	C	16.26	B
Westbound - On-Ramp from Westbound I-70	Basic	173.34	F	87.59	F
Westbound - On-Ramp from Central Park Boulevard General-Purpose Lanes	Merge	165.66	F	156.57	F
Westbound - Between Central Park and Quebec Ramps	Basic	112.77	F	114.17	F
Westbound - On-Ramp from Central Park Boulevard Express Lanes	Basic	167.18	F	168.91	F
Westbound - On-Ramp from Quebec Street	Merge	123.34	F	142.30	F
Westbound - Between Quebec Street and Vasquez Boulevard	Basic	130.56	F	138.47	F
Westbound - Off-Ramp to Northbound Vasquez Boulevard	Diverge	123.91	F	141.96	F
Westbound - Between Off-Ramp to Northbound Vasquez Blvd and On-Ramp from Northbound Vasquez Boulevard	Basic	139.46	F	142.88	F
Westbound - Between On-Ramp from Northbound Vasquez Boulevard and Off-Ramp to Southbound Vasquez Boulevard	Weaving	95.04	F	101.42	F
Westbound - Between Off-Ramp to Southbound Vasquez Blvd and On-Ramp from Southbound Vasquez Boulevard	Basic	114.63	F	113.69	F
Westbound - On-Ramp from Southbound Vasquez Boulevard	Merge	61.51	F	62.20	F

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Westbound – Off-Ramp to I-76/York Street	Diverge	38.05	E	36.13	E
Westbound - Between I-76 Ramps	Basic	16.75	B	18.03	C
Westbound - On-Ramp from Westbound I-76	Basic	16.08	B	19.26	C
Westbound - Off-Ramp to Northbound I-25 Express Lanes	Basic	13.88	B	15.55	B
Westbound - Off-Ramp to Northbound I-25 General-Purpose Lanes	Diverge	22.98	C	25.02	C
Westbound - West of I-25	Basic	14.21	B	18.78	C

12.5.2 2050 Three General-Purpose Lanes Alternative Freeway Operations

Under the Three General-Purpose Lanes Alternative, the freeway operations approach consistency across the corridor. As shown in Table 29, during the a.m. peak hour, the majority of the I-270 corridor operates at LOS B and LOS C. The exception being in the eastbound direction starting east of Vasquez Boulevard and approaching Quebec Street, the freeway LOS is projected to be LOS D and E, reflecting the segments are approaching capacity. The models indicated some friction as the third general-purpose lane ends and the direct connect ramp to the I-70 Express Lanes forms that may contribute to the slightly more congested conditions on these segments.

This eastbound phenomenon is also projected to occur during the p.m. peak hour, with some of the previously noted congestion and queuing at the Quebec Street off-ramp intersection having the potential to influence deceleration and operations on mainline I-270. In the westbound direction, much of the corridor is projected to operate at LOS F during the p.m. peak hour. This moderate congestion spread along the I-270 corridor is safer and more operationally preferable compared to severe congestion concentrated in specific locations, as projected under the No Action Alternative. When congestion is evenly distributed, traffic flow becomes more predictable, reducing the likelihood of sudden stops and rear-end collisions. By balancing moderate and consistent congestion levels, the corridor can better manage traffic flow, minimize safety risks, and improve overall travel reliability.

Table 29 summarizes the 2050 Three General-Purpose Lanes Alternative a.m. and p.m. peak hour freeway LOS for mainline I-270.

Table 29. 2050 Three General-Purpose Lanes Alternative - Peak Hour Freeway Level of Service

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - East of I-25	Basic	17.82	B	17.81	B
Eastbound - On-Ramp from Southbound I-25 Express Lanes	Basic	14.86	B	16.88	B
Eastbound - On-Ramp from Southbound I-25 General-Purpose Lanes	Basic	15.41	B	17.92	B
Eastbound - Off-Ramp to Eastbound I-76	Basic	18.92	C	22.32	C
Eastbound - Between I-76 Ramps	Basic	23.10	C	27.57	D
Eastbound - On-Ramp from Westbound and Eastbound I-76	Basic	19.63	C	22.57	C
Eastbound - On-Ramp from York Street	Merge	20.88	C	21.14	C
Eastbound - Between York Street and Vasquez Boulevard	Basic	23.16	C	25.38	C
Eastbound - Off-Ramp to Northbound and Southbound Vasquez Boulevard	Diverge	21.83	C	22.25	C
Eastbound - Between Off-Ramp to Vasquez Boulevard and On-Ramp from Southbound Vasquez Boulevard	Basic	23.33	C	27.00	D

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - Between On-Ramp from Southbound Vasquez Boulevard and On-Ramp from Northbound Vasquez Boulevard	Basic	21.71	C	21.53	C
Eastbound - On-Ramp from Northbound Vasquez Boulevard	Basic	17.43	B	17.73	B
Eastbound - Between Vasquez Boulevard and Quebec Street	Basic	36.30	E	40.42	E
Eastbound - Off-Ramp to Eastbound I-70 Express Lanes	Basic	36.30	E	40.42	E
Eastbound - Off-Ramp to Quebec Street	Basic	30.90	D	47.69	F
Eastbound - Between Quebec Street and Central Park Boulevard	Basic	33.93	D	36.07	E
Eastbound - Off-Ramp to Central Park Boulevard	Diverge	35.07	E	37.15	E
Eastbound - Off-Ramp to Eastbound I-70 General-Purpose Lanes	Basic	27.60	D	20.25	C
Westbound - On-Ramp from Westbound I-70	Basic	16.85	B	11.03	B
Westbound - On-Ramp from Central Park Boulevard General-Purpose Lanes	Merge	21.05	C	42.81	E

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Westbound - Between Central Park and Quebec Ramps	Basic	24.52	C	56.12	F
Westbound - On-Ramp from Central Park Boulevard Express Lanes	Basic	16.79	B	70.04	F
Westbound - On-Ramp from Quebec Street	Merge	19.86	B	99.42	F
Westbound - Between Quebec Street and Vasquez Boulevard	Basic	22.10	C	126.51	F
Westbound - Off-Ramp to Northbound and Southbound Vasquez Boulevard	Diverge	15.64	B	96.71	F
Westbound - Between Off-Ramp to Vasquez Boulevard and On-Ramp from Northbound Vasquez Boulevard	Basic	20.56	C	136.81	F
Westbound - Between On-Ramp from Northbound Vasquez Boulevard and On-Ramp from Southbound Vasquez Boulevard	Basic	19.76	C	147.47	F
Westbound - On-Ramp from Southbound Vasquez Boulevard	Merge	13.60	B	122.36	F

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Westbound - Between Vasquez Boulevard and York Street	Basic	20.83	C	134.78	F
Westbound - Off-Ramp to York Street	Basic	17.83	B	101.92	F
Westbound - Off-Ramp to I-76	Basic	18.63	C	108.10	F
Westbound - Between I-76 Ramps	Basic	22.33	C	123.16	F
Westbound - On-Ramp from Westbound I-76	Basic	22.53	C	113.07	F
Westbound - Off-Ramp to Northbound I-25 Express Lanes	Basic	23.98	C	67.29	F
Westbound - Off-Ramp to Northbound I-25 General-Purpose Lanes	Basic	23.97	C	51.05	F
Westbound - West of I-25	Basic	18.40	C	24.02	C

12.5.3 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Freeway Operations (2050)

The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative freeway operations project similar operational results to the Three General-Purpose Lanes Alternative. During the a.m. peak hour, the westbound I-270 freeway operations similarly reflect LOS B and LOS C. In the eastbound direction, there are improved operations near the direct connect ramp to the I-70 Express Lanes (likely due to the continuity from the ability of the I-270 Express Lane to flow directly into the I-70 Direct Connect ramp). However, operations reflect LOS F near the Vasquez Boulevard interchange during the a.m. peak hour.

During the p.m. peak hour, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is projected to accommodate the eastbound peak hour demands on the corridor, as reflected in LOS D or better, for most of the corridor. The segments approaching and at the Central Park Boulevard exit are projected to operate at LOS E during both the a.m. and p.m. peak hours. For the westbound direction, the freeway is projected to operate at LOS F during the p.m. peak hour. However, it is important to note that while also LOS F, the projected densities are lower than those projected under the No

Action and the Three General-Purpose Lanes Alternatives. From I-76 to the end of the corridor, the freeway operations are projected to be LOS D. Again, the ability of the I-270 Express Lanes to flow seamlessly into the I-25 and US 36 Direct Connect ramps helps reduce friction in this highly active system-to-system interchange area (see Table 30).

Table 30. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative - Freeway Operations Peak Hour Freeway Level of Service (2050)

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - East of I-25	Basic	17.93	B	18.33	C
Eastbound - On-Ramp from Southbound I-25 Express Lanes	Basic	16.36	B	17.40	B
Eastbound - On-Ramp from Southbound I-25 General-Purpose Lanes	Basic	16.53	B	21.29	C
Eastbound - Off-Ramp to Eastbound I-76	Basic	19.58	C	24.41	C
Eastbound - Between I-76 Ramps	Basic	22.98	C	27.68	D
Eastbound - On-Ramp from Westbound and Eastbound I-76	Basic	19.93	C	22.82	C
Eastbound - On-Ramp from York Street	Merge	44.66	E	25.74	C
Eastbound - Between York Street and Vasquez Boulevard	Basic	48.69	F	26.35	D
Eastbound - Off-Ramp to Northbound and Southbound Vasquez Boulevard	Diverge	69.94	F	29.89	D
Eastbound - Between Off-Ramp to Vasquez Boulevard and On-Ramp from Southbound Vasquez Boulevard	Basic	67.15	F	28.58	D

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Eastbound - Between On-Ramp from Southbound Vasquez Boulevard and On-Ramp from Northbound Vasquez Boulevard	Basic	84.15	F	22.72	C
Eastbound - On-Ramp from Northbound Vasquez Boulevard	Merge	80.15	F	14.17	B
Eastbound - Between Vasquez Boulevard and Quebec Street	Basic	34.30	D	33.92	D
Eastbound - Off-Ramp to Eastbound I-70 Express Lanes	Basic	23.02	C	23.95	C
Eastbound - Off-Ramp to Quebec Street	Basic	30.46	D	33.65	D
Eastbound - Between Quebec Street and Central Park Boulevard	Basic	36.32	E	35.90	E
Eastbound - Off-Ramp to Central Park Boulevard	Diverge	37.18	E	37.21	E
Eastbound - Off-Ramp to Eastbound I-70 General-Purpose Lanes	Basic	30.69	D	21.66	C
Eastbound - East of I-25	Basic	17.93	B	18.33	C
Westbound - On-Ramp from Westbound I-70	Basic	13.68	B	13.25	B
Westbound - On-Ramp from Central Park Boulevard General-Purpose Lanes	Merge	18.90	B	86.55	F
Westbound - Between Central Park and Quebec Ramps	Basic	18.17	C	73.10	F

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Westbound - On-Ramp from Central Park Boulevard Express Lanes	Basic	14.12	B	64.92	F
Westbound - On-Ramp from Quebec Street	Merge	22.45	C	97.10	F
Westbound - Between Quebec Street and Vasquez Boulevard	Basic	23.91	C	71.51	F
Westbound - Off-Ramp to Northbound and Southbound Vasquez Boulevard	Diverge	20.60	C	75.46	F
Westbound - Between Off-Ramp to Vasquez Boulevard and On-Ramp from Northbound Vasquez Boulevard	Basic	23.53	C	80.30	F
Westbound - Between On-Ramp from Northbound Vasquez Boulevard and On-Ramp from Southbound Vasquez Boulevard	Basic	21.90	C	90.10	F
Westbound - On-Ramp from Southbound Vasquez Boulevard	Merge	16.99	B	93.86	F
Westbound - Between Vasquez Boulevard and York Street	Basic	22.46	C	85.32	F
Westbound - Off-Ramp to York Street	Basic	18.98	C	59.43	F
Westbound - Off-Ramp to I-76	Basic	20.00	C	52.23	F
Westbound - Between I-76 Ramps	Basic	23.67	C	30.45	D
Westbound - On-Ramp from Westbound I-76	Basic	22.35	C	32.75	D

Segment	Facility Type	a.m. Peak Hour Density (pc/mi/ln)	a.m. Peak Hour LOS	p.m. Peak Hour Density (pc/mi/ln)	p.m. Peak Hour LOS
Westbound - Off-Ramp to Northbound I-25 Express Lanes	Basic	22.35	C	32.75	D
Westbound - Off-Ramp to Northbound I-25 General-Purpose Lanes	Basic	21.84	C	34.50	D

Under the No Action Alternative, the eastbound a.m. peak hour freeway operations perform at LOS F from I-25 to the Vasquez Interchange. This bottleneck limits eastbound traffic flow approaching and past the Vasquez Interchange. The eastbound a.m. peak hour diverge for the Quebec Street Off-Ramp also performs at a LOS F; this was observed to be the result of the lack of adequate deceleration space provided at the off-ramp that causes vehicles to slow down in the through-lanes and impacting eastbound flow.

For eastbound a.m. peak hour operations, the freeway LOS is better for the Three General-Purpose Lanes Alternative is projected to improve to LOS C or better through the Vasquez Boulevard Interchange. Eastbound a.m. peak hour freeway operations under the Three General-Purpose Lanes Alternative are projected to operate at LOS E or better for the length of the corridor. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative similarly sees eastbound a.m. peak hour operations improve to LOS C or better through the York Street Interchange. However, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative has poorer freeway operations on the portion of I-270 between the York Street on-ramp and the Vasquez Interchange. Model observations indicate that this may be related to the impacts of vehicles entering and exiting the Express Lanes at the ingress/egress location between these two locations. Past the Vasquez Interchange, the alternative also operates at LOS E or better through the remainder of the corridor.

Under the No Action Alternative, eastbound freeway operations during the p.m. peak hour are projected to perform at LOS F from I-25 through the Vasquez Interchange, reflecting exacerbated congestion at the existing major bottleneck that constrains traffic flow. East of the Vasquez Interchange, the higher p.m. peak hour demand is projected to result in the diverge for the Quebec Street Off-Ramp performing at LOS F. The third general-purpose lane ends at the Quebec Street Off-Ramp and the resulting friction created by vehicles changing lanes to exit at Quebec Street or from the third lane to continue traveling eastbound on I-270 causes operations to perform at LOS F at this location.

The Three General-Purpose Lanes Alternative improves operations to LOS D or better through the Vasquez Interchange, reflecting the alternative's ability to alleviate congestion. However, east of Vasquez, freeway operations degrade to LOS F at the Quebec Street Off-Ramp. This is primarily due to lane-changing friction as drivers either exit at Quebec or merge left to continue eastbound past the end of the added third general-purpose lane. The turbulence created by these movements increases delay and congestion at this location.

In contrast, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative maintains LOS D or better through the Vasquez Interchange, with the entire corridor performing at LOS E or better during the p.m. peak. The only segments at LOS E are located between Quebec Street and the Central Park Boulevard Off-Ramp, where some delay is introduced by concentrated diverging traffic. However, this alternative avoids the abrupt lane drop and associated merging issues seen in the Three General-Purpose Lanes Alternative. As a result, it exhibits more stable operations, with density remaining consistently between 20 and 35 pc/mi/ln through the core of the corridor, indicating a smoother and more predictable traffic flow.

Under the No Action Alternative, westbound operations are projected to operate at LOS F from I-70 to the Vasquez Boulevard Interchange during both peak periods. The Vasquez Interchange continues to act as a chokepoint, restricting flow through the segment. Once past the bottleneck, freeway operations recover, with LOS C or better observed west of Vasquez.

Under the a.m. peak hour, both Build Alternatives are projected to operate at LOS C or better for all westbound segments, demonstrating improvement over the No Action Alternative.

During the p.m. peak hour, the Three General-Purpose Lanes Alternative continues to experience LOS F from the Central Park Boulevard on-ramp through Vasquez Interchange and extend west to the I-25 northbound off-ramp. Although model results show reduced density between I-70 and Vasquez compared to the No Action Alternative, the drop of the added third lane before the I-25 interchange introduces lane-change friction and turbulence, increasing delay and degrading overall freeway LOS in this segment.

By comparison, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative better matches the entering and exiting traffic lane configurations. This is reflected in lower p.m. peak hour densities, with a maximum of 97 pc/mi/ln, compared to 147 pc/mi/ln in the Three General-Purpose Lanes Alternative and 169 pc/mi/ln under the No Action Alternative. While LOS F conditions are still present between Central Park and I-76, the smoother operations and reduced density indicate notable performance improvement and enhanced travel time reliability for westbound drivers, as compared to the No Action and Three General-Purpose Lanes Alternatives.

13.0 Summary of Traffic Impacts

The traffic operational analysis compares corridor performance and identifies areas where the Build Alternatives are projected to improve traffic operations and travel time reliability compared to the No Action Alternative.

The No Action Alternative retains the existing I-270 configuration of two general-purpose lanes in each direction but is expected to face increasing traffic demand and operational challenges that fail to meet the corridor's travel needs.

The traffic analysis highlights several key metrics that distinguish the effectiveness of the two Build Alternatives in comparison to the No Action Alternative. In terms of overall demand processing, both Build Alternatives accommodate substantially more peak-hour trips than the No Action Alternative, particularly during the p.m. peak hour when demand is highest. The

Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative processes 8 percent more trips than the Three General-Purpose Lanes Alternative, indicating a superior ability to handle peak demand and reduce network congestion.

Average total delay reduction is another critical network performance metric. Both Build Alternatives are projected to reduce total average delay compared to the No Action Alternative, with the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative achieving the greatest reduction, particularly in the p.m. peak hour, where it results in a 34 percent decrease in total delay. However, during the a.m. peak hour, both Build Alternatives experience an 11 percent increase in total delay compared to the No Action Alternative, attributed to increased vehicle throughput and the network's ability to process more demand. Notably, while the Three General-Purpose Lanes Alternative records slightly lower average delay per vehicle in the a.m. peak, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative outperforms it in the p.m. peak when congestion highest.

Network VMT and VHT metrics indicate that the Build Alternatives accommodate increased travel demand while improving traffic flow. While both alternatives experience VMT growth, the corresponding increase in average trip length is moderate, suggesting that the improvements are not simply facilitating longer trips but are instead effectively meeting existing demand. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative achieves the lowest VHT, reflecting a 23 percent decrease in peak period travel delay relative to the No Action Alternative.

Corridor wide travel time and speed metrics also demonstrate the effectiveness of the Build Alternatives to address travel time and reliability needs. In the p.m. peak hour, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative results in a more than 50 percent increase in average speeds compared to the No Action Alternative, outperforming the Three General-Purpose Lanes Alternative, which achieves a smaller 24 percent increase. However, during the a.m. peak hour, the Three General-Purpose Lanes Alternative records higher average speeds, at 31.1 mph, approximately 7 percent higher than the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative. This is likely due to the additional capacity of the general-purpose lane allowing a greater number of vehicles to distribute across available lanes during the morning commute. Despite this, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative provides greater overall travel time savings throughout the day, particularly in the p.m. peak hour when congestion is at its worst. Express Lane users benefit from the most consistent and reliable travel conditions, with projected speeds reaching 57 mph in the a.m. and 40 mph in the p.m., providing a reliable trip option for travel on the corridor.

The freeway operations analysis reveals that while both Build Alternatives improve traffic flow, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative generally provides better LOS outcomes, particularly in critical segments, such as east of the Vasquez Boulevard Interchange. Although the Three General-Purpose Lanes Alternative performs slightly better in isolated segments, most notably in the eastbound direction approaching Vasquez where the Express Lane Alternative experiences localized impacts from lane-change activity at ingress and egress points, these effects are limited in scope. Overall, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative more effectively manages congestion, resulting in lower density, fewer LOS F segments, and more consistent travel conditions throughout the corridor, particularly during peak periods. Additionally, ramp terminal intersections under the Express Lane Alternative achieve comparable or better LOS, supporting strong connectivity between the freeway and surrounding arterial network and reinforcing its advantage as the more balanced and resilient long-term solution.

Overall, while the Three General-Purpose Lanes Alternative performs slightly better in a few specific metrics (particularly in a.m. peak-hour speeds and eastbound general-purpose travel time). the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative consistently demonstrates the best ability to improve overall operations and improve travel time and reliability. The Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative processes more trips, better reduces congestion-related queues, decreases total and per-trip delay, improves travel speeds, and enhances travel time reliability for both passenger and freight traffic. The Express Lane provides an opportunity for reliable travel, especially during the p.m. peak hour when network-wide congestion is most severe. While the Three General-Purpose Lanes Alternative provides some advantages in general-purpose lane flow, the added benefit of the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative allows for better overall traffic conditions. Given these advantages, the Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative is the alternative that is expected to result in the best operational performance along I-270.

14.0 Required Permits and Coordination

There are no permits required for transportation and traffic resources. Coordination will be continued throughout the project development process with the local agencies and Colorado State Patrol.

15.0 References

Colorado Department of Transportation (CDOT). 2017a. Policy Directive 1602 Elevating Bicycle and Pedestrian Opportunities in Colorado. https://www.codot.gov/programs/bikeped/documents/1602-0-policy-bike-pedestrian. January 19.

Colorado Department of Transportation (CDOT). 2017b. Procedural Directive 1602.1 Elevating Bicycle and Pedestrian Opportunities in Colorado. https://www.codot.gov/programs/bikeped/documents/1602-1-2013-bicycle-and-pedestrian-policy. March 3.

Colorado Department of Transportation (CDOT). January 2023. Traffic Analysis and Forecasting Guidelines. Accessed online at https://www.codot.gov/safety/traffic-safety/assets/traffic_analysis_forecasting_guidelines, December 2024.

Colorado Department of Transportation (CDOT). 2023. Managed lanes policy directive (Policy Directive 1603.0). Colorado Department of Transportation. Accessed online at https://www.codot.gov/safety/traffic-safety/operations, 2024.

Colorado Department of Transportation (CDOT). June 2024. CDOT NEPA Manual. Accessed online at https://www.codot.gov/programs/environmental/nepa-program/nepa-manual/03_chapter-3_2024-2.pdf, December 2024.

Colorado Department of Transportation (CDOT). (2024). CDOT's NEPA-specific Planning and Project Development Elements. In CDOT NEPA Manual (Version 7, Chapter 3). Colorado Department of Transportation. Accessed online at https://www.codot.gov/programs/environmental/nepa-program/nepa-manual/03_chapter-3_2024-2.pdf, 2024.

Colorado Department of Transportation (CDOT). September 2024. Policy Directive 14 (PD 14). Accessed online at https://www.codot.gov/performance/assets/a-pd-14-0-201cpolicy-guiding-statewide-transportation-plan-goals-and-performance-measures201d.pdf, December 2024.

Denver Regional Council of Governments (DRCOG). May 2024. 2050 Metro Vision Regional Transportation Plan. Accessed online at https://drcog.org/sites/default/files/acc/TPO-RP-50MVRTP-EN-ACC-17x11-24-06-04-V1.pdf, December 2024.

Federal Highway Administration (FHWA). (2008). *Traffic Analysis Toolbox Volume VI: Definition, Interpretation, and Calculation of Traffic Analysis Tools and Measures of Effectiveness (FHWA-HOP-08-054)*. U.S. Department of Transportation.

Federal Highway Administration (FHWA). 2012. 23 U.S.C. 135(f)(1). Accessed online at https://www.fhwa.dot.gov/map21/docs/title23usc.pdf, December 2024.

Federal Highway Administration (FHWA). 2019. Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software 2019 Update to the 2004 Version. Accessed online at https://ops.fhwa.dot.gov/publications/fhwahop18036/index.htm, December 2024.

Federal Highway Administration (FHWA). 2024. 23 CFR Part 450 Subparts B and C. Accessed online at https://www.ecfr.gov/current/title-23/chapter-I/subchapter-E/part-450?toc=1, December 2024.

Texas A&M Transportation Institute. 2023. Urban Mobility Report. Texas A&M University.

Transportation Research Board of the National Academies. 2014. National Cooperative Highway Research Program Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design. Accessed online at https://nap.nationalacademies.org/catalog/22366/analytical-travel-forecasting-approaches-for-project-level-planning-and-design, December 2024.

Attachment A. Microsimulation Methods and Assumptions Technical Memorandum

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.

Attachment B. Traffic Analysis Data Collection Plan

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.

Attachment C. Cluster Analysis Technical Memorandum

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.

Attachment D. Microsimulation Calibration Technical Memorandum

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.

Attachment E. Travel Demand Model Calibration Methodology Technical Memorandum

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.

Attachment F. Travel Demand Model Calibration Results Technical Memorandum

NOTE: This attachment is not able to be included with the EIS at this time due to accessibility. If you would like a copy of this attachment or to sit down with a project team member to review this attachment, please contact the project team at cdot_i270@state.co.us or 303-512-4270.