FINAL

Existing Transportation Conditions Report

I-70 & Kipling Interchange | PEL Study

May 2012

Table of Contents

List of Tables

List of Figures

Kipling Street under I-70 bridges

Introduction

I-70/Kipling Interchange Planning and Environmental Linkage (PEL) Study

The Colorado Department of Transportation (CDOT) initiated a Planning and Environmental Linkage (PEL) Study to provide an understanding of the existing conditions at the I-70 and Kipling Street (State Highway 391) interchange while considering future surrounding development and community plans. The goal of the study is to develop a range of improvements to reduce congestion and improve operations and safety at the I-70 and Kipling interchange.

The project study area, illustrated in **Figure 1**, is focused around the I-70 and Kipling interchange. The traffic study area extends along Kipling Street from just north of 51st Avenue to just south of 44th Avenue and along I-70 from west of the interchange at Ward Road to east of the interchange at Wadsworth Avenue. 44th Avenue from Ward Road to Wadsworth Boulevard is also included in the traffic study area for the assessment of traffic conditions. The study area for review of potential environmental resource impacts is focused around the area of most likely physical impacts of interchange improvements, so it focused around the I-70 and Kipling interchange.

The I-70 and Kipling interchange is located within the City of Wheat Ridge in Jefferson County. The boundary for the City of Arvada runs between the 50th Avenue and 51st Place intersections. **Figure 2** illustrates the city boundaries surrounding the interchange.

This Existing Transportation Conditions report summarizes data collected as part of this study effort, data already available from CDOT, City of Wheat Ridge, City of Arvada, Jefferson County and other agencies, and the results of the evaluation of existing transportation conditions. This data will be used as the basis for confirmation of current travel conditions and trends, determination of improvement needs, and calibration of the travel forecast model that will be used in development and analysis of improvement alternatives.

Figure 1: Study Area

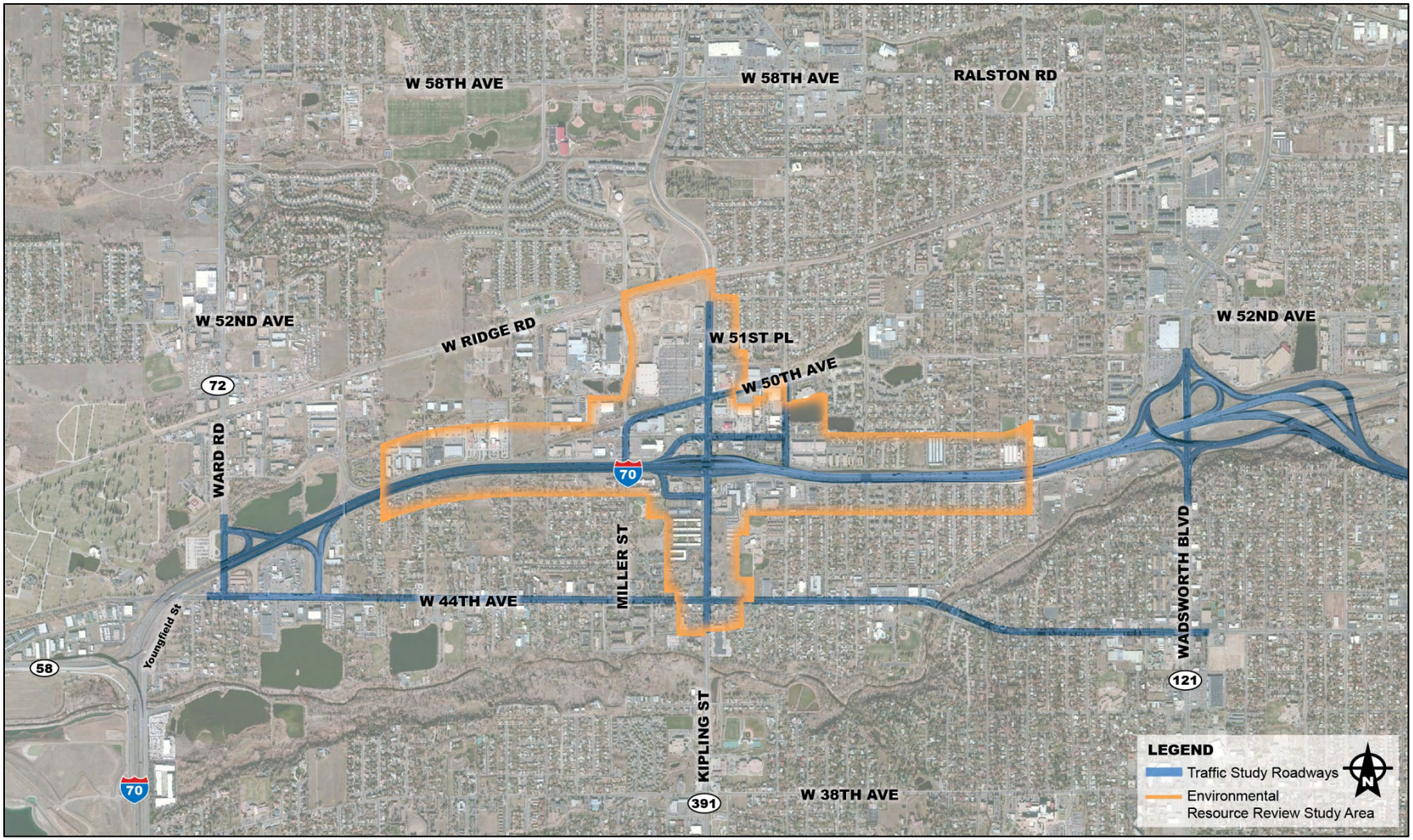


Figure 2: Jurisdictional Boundary

Kipling Street north of I-70 interchange

Roadway Network

The current interchange at I-70 and Kipling Street was constructed in 1967. The interchange is a diamond interchange with two bridge structures (E-16-GX and E-16-GY) on I-70 over Kipling Street (SH 391). The interchange provides access to commercial and residential areas in the City of Wheat Ridge and retail, residential, and new transit-oriented development currently under construction in the City of Arvada.

Interstate 70

I-70 is a major east-west interstate highway that crosses the United States from Baltimore, Maryland to I-15 south of Salt Lake City, Utah. I-70 crosses central Colorado and travels through the middle of the Denver metropolitan area.

Within the study area between Ward Road and Kipling Street, I-70 has six through lanes. East of Kipling Street to Wadsworth Boulevard, I-70 has three through lanes eastbound and four through lanes westbound with the inside through lane merging at the Kipling Street bridge. There is also a westbound continuous auxiliary lane between the Wadsworth and Kipling interchanges.

Approximately ½ mile east of the Kipling interchange, I-70 was reconstructed in the early 1990s as part of the final connection of I-76. The Wadsworth interchange is a complex interchange including directional ramps from Wadsworth Boulevard and an eastbound exit ramp and westbound entrance ramp to/from I-76. Auxiliary and acceleration/deceleration lanes

Westbound I-70 approaching Kipling Street interchange

are provided through the Wadsworth and I-76 interchanges. East of I-76, I-70 provides six through lanes through the I-25 interchange and beyond.

The speed limit along I-70 from the Ward Road interchange through the Wadsworth Boulevard interchange is 65 miles per hour (MPH).

Kipling Street (SH 391)

Kipling Street is a principal north-south arterial within the Denver metropolitan area, providing almost 30 miles of continuity through the western Denver suburbs from C-470 in southern Jefferson County to Ralston Road in Arvada. It is designated State Highway 391 (SH 391) between US 285 in Lakewood and 49th Avenue in Wheat Ridge. Within the study area, CDOT defines the functional classification of Kipling Street as Other – Principal Arterial.

Kipling Street is typical of many suburban arterials developed in the 1960s-1970s with numerous private driveway accesses, close intersection spacing, and limited storage for left turning traffic in the median.

Kipling Street has four through lanes and two continuous turn lanes from 44th Avenue to 51st Place with a posted speed limit of 40 MPH. The section north of I-70 contains six lanes with the additional lanes providing continuous auxiliary lanes between the westbound I-70 ramps and 50th Avenue.

There are seven traffic signals along Kipling Street at the intersections shown in **Figure 3**, which also illustrates the intersection lane configurations. Only the southbound approach at the eastbound I-70 ramps and northbound approach at the 50th Avenue intersection have double left turn lanes within the study area.

The Denver Regional Council of Governments (DRCOG) provided traffic signal timing and coordination improvements along Kipling Street within the study area in 2009. That project resulted in travel time and speed improvements for travelers during peak hours in both directions of travel from 51st Place to Alameda Avenue in the City of Lakewood. The signal cycle lengths along Kipling Street are 100 seconds during the AM peak period, 120 seconds during the PM peak period, and 90 seconds during the remainder of the day.

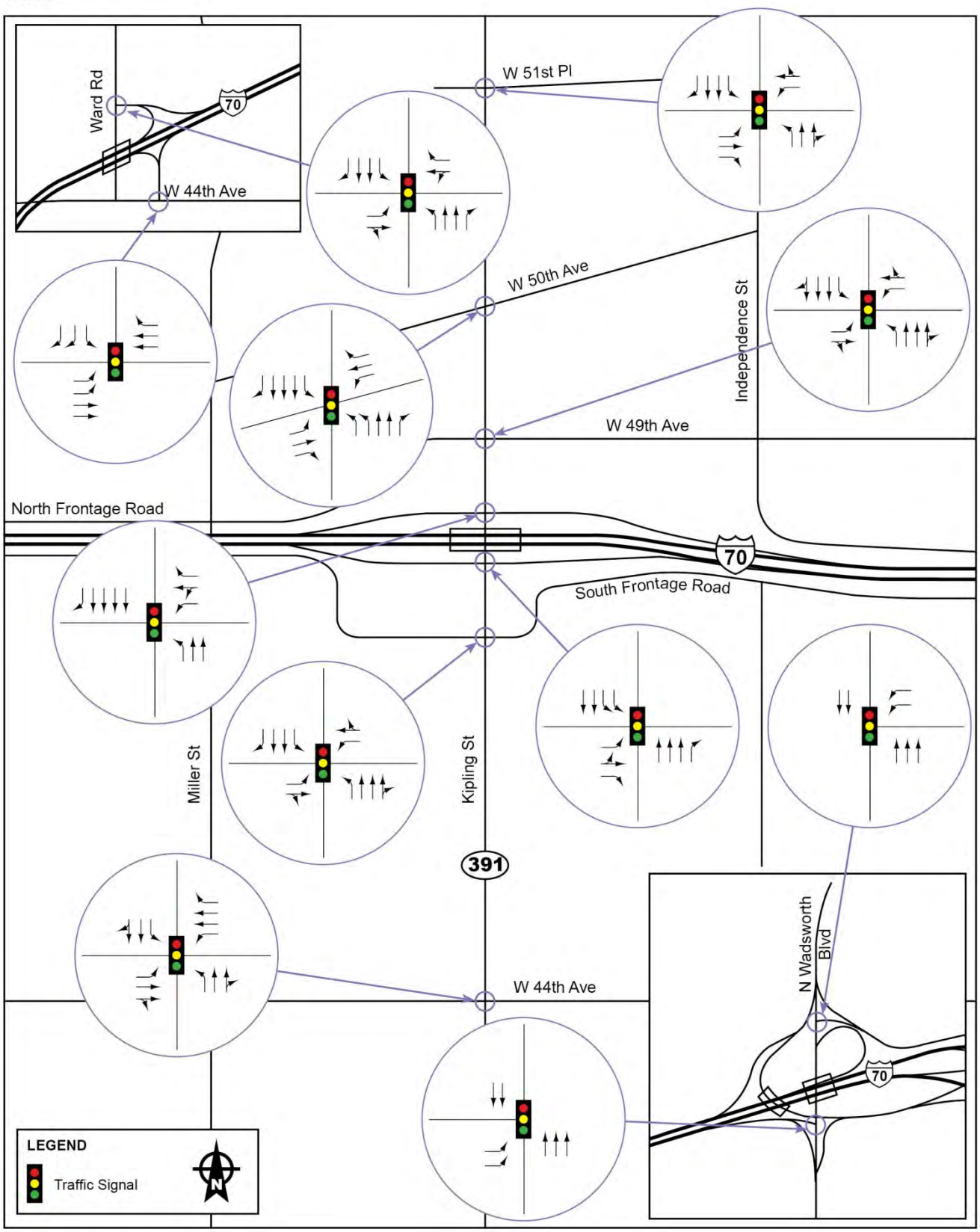
Southbound Kipling Street approaching I-70 interchange

Surrounding Roadways

51st Place

West of Kipling Street, 51st Place provides access to the Arvada Ridge development. The traffic signal at 51st Place will also provide access to the future Gold Line Station and related transit-oriented development along Ridge Road and west of Kipling Street. East of Kipling Street, 51st Place is a collector street serving the single family and multi-family residential area between Kipling Street and Independence Street.

Figure 3: Existing Intersection Laneage



50th Avenue

West of Kipling Street, 50th Avenue is a four-lane divided arterial that was reconstructed with the Arvada Ridge development with alternate access from Kipling Street to the North Frontage Road. East of Kipling Street, 50th Avenue is a two-lane roadway that provides access to adjacent commercial development and office buildings and terminates at Independence Street.

North (49th Avenue) and South Frontage Roads

The frontage roads intersect Kipling Street at signals north and south of I-70. The frontage roads are two through lanes with frequent access to adjacent businesses.

South frontage road west of Kipling Street

Each frontage road intersection with Kipling Street is approximately 350 feet from the adjacent ramp signal and the total spacing of the four signals through the interchange is less than 1,000 feet. This is a substantial contributing factor to the poor existing traffic operations at the interchange. The short spacing between the Westbound I-70 Off Ramp and the 49th Avenue/North Frontage Road intersection is a particular issue due to the high intersecting traffic volume and a notable weave movement from the off ramp to make a left onto the North Frontage Road.

44th Avenue

Located about ½ mile south of the I-70 and Kipling interchange, 44th Avenue is an east-west arterial street. It runs parallel to I-70 from Youngfield Street in Wheat Ridge to east of Federal Boulevard in Denver. The roadway has a narrow, undivided, four-lane cross-section with turn lanes generally only provided at major signalized intersections. It narrows to a two-lane cross section east of Sheridan Boulevard.

Ward Road

Ward Road is a north-south arterial within Jefferson County. It is SH 72 from I-70 north to 64th Avenue/Ralston Road and it is discontinuous south of I-70. The I-70 and Ward interchange is about 1.5 miles west of Kipling Street. The eastbound I-70 ramps at the interchange have recently been improved, but generally the ramps remain in the same configuration with button-hook ramps connecting eastbound I-70 with 44th Avenue. The westbound I-70 ramps are a partial cloverleaf configuration with a diamond off ramp and loop ramp for westbound I-70.

Wadsworth Boulevard (SH 121)

Wadsworth Boulevard is defined by CDOT as Other-Principal Arterial and runs parallel and east of Kipling Street. It is designated as SH 121 and is identified as part of the National Highway System (NHS). It extends from C-470 in southern Jefferson County to the junction of US 36 and US 287 in Broomfield. The I-70 and Wadsworth interchange is located approximately 1.5 miles east of Kipling Street. Wadsworth Boulevard is a four-lane arterial south of I-70 and provides six lanes north of I-70.

Kipling Street and 50th Avenue intersection

Roadway Features

Field visits of the interchange study area were completed in January and February 2012 to document the locations and types of existing relevant roadway features, such as shoulder and median treatments, curb and gutter, guardrail, fence, lighting, and design deficiencies. The existing roadway features collected within the study area and highlighted design deficiencies are illustrated in **Figure 4**.

Shoulder and Median

Table 1 provides an outline of the number and type of lanes, shoulder treatment, curb and gutter type, and general location of each feature along I-70 and Kipling Street within the study area.

Raised median on Kipling Street north of I-70 interchange

Figure 4: Existing Roadway Features and Deficiencies

Table 1: Shoulder Treatment and Curb and Gutter

Roadway Section	Lanes	Shoulder Treatment
Westbound I-70		
at Wadsworth Blvd	5 general purpose	12 ft shoulders
at Wadsworth Blvd On Ramp	5 general purpose, 1 acceleration	12 ft shoulders
at Dover St	4 general purpose, 1 exit only	12 ft shoulders
at Kipling St Off Ramp	3 general purpose, 1 exit only	16 ft inside shoulder, 12 ft outside shoulder
at Kipling St Bridge	3 general purpose	2 ft shoulders
at Kipling St On Ramp	3 general purpose, 1 acceleration	4 ft inside shoulder, 12 ft outside shoulder
west of Kipling St On Ramp	3 general purpose	4 ft inside shoulder, 12 ft outside shoulder
at Ward Rd Off Ramp	3 general purpose, 1 exit	4 ft inside shoulder, 12 ft outside shoulder
Eastbound I-70		
at Ward Rd	3 general purpose	4 ft inside shoulder, 16 ft outside shoulder
at Ward Rd On Ramp	3 general purpose, 1 acceleration	4 ft inside shoulder, 12 ft outside shoulder
at Routt St	3 general purpose	4 ft inside shoulder, 12 ft outside shoulder
at Kipling St Off Ramp	3 general purpose, 1 exit	4 ft inside shoulder, 8 ft outside shoulder
at Kipling St Bridge	3 general purpose	2 ft shoulders
at Kipling St On Ramp	3 general purpose, 1 acceleration	12 ft shoulders
at Holland St	3 general purpose	12 ft shoulders
at Everett St	4 general purpose	12 ft shoulders
at Cody St	5 general purpose	12 ft shoulders
at Carr St	6 general purpose	12 ft shoulders
at Wadsworth Blvd On Ramp	5 general purpose, 1 exit	12 ft shoulders
at Wadsworth Blvd Bridge	5 general purpose	12 ft shoulders
Northbound Kipling Street		
44th Ave to S Frontage Rd	2 through, acceleration lane from 44th	Curb and gutter
44th Ave at S Frontage Rd	2 through	Curb and gutter
Kipling St at I-70 Ramps	2 through	Curb and gutter
I-70 Ramps to 49th Ave/N Frontage Rd	3 through	Curb and gutter
49th Ave to 50th Ave	2 through	Curb and gutter
50th Ave to 51st Pl	2 through	Curb and gutter
Southbound Kipling Street		
51st Pl to 50th Ave	3 through	Curb and gutter
49th Ave/N Frontage Rd to I-70 Ramps	2 through	Curb and gutter
Kipling St at I-70 Ramps	2 through	Curb and gutter
S Frontage Rd to 44th Ave	2 through	Curb and gutter

Source: Field visit by David Evans and Associates, February 2012

A summary of the types and general location of existing median treatments is presented in **Table 2**. The median width varies greatly along I-70 from areas with barrier separation to a median width of 20 feet or greater. Kipling Street has portions of raised and painted median. The width of the median shows on the existing aerials and was not included in the table. Mountable curb and gutter placed on the median is used as a barrier or safety object.

Table 2: Median Treatment

Roadway Section	Median	Curb and Gutter
I-70		
Wadsworth Blvd to Kipling St	Concrete barrier with paved shoulders	N/A
Kipling St to Ward Rd	Grass median with guardrail in the center	N/A
Kipling Street		
51st Pl to 50th Ave	Center double yellow line	None - No median
50th Ave to I-70 Ramps	Raised median with median cover material	Curb and gutter
I-70 Ramps to 44th St	Painted median, varying width	None – No raised median

Source: Field visit by David Evans and Associates, February 2012

Guardrail

Various types of guardrail exist along I-70 both in the median and along the outside shoulders within the Kipling Street interchange area. The guardrail is placed to protect against obstructions, steep slopes and errant cross-over traffic. Guardrail is placed on Kipling Street, under the I-70 bridges in front of bridge piers and slope paving.

Concrete barrier on Kipling Street under the I-70 bridges

The general location, length, and type of guardrail within the study area is outlined in **Table 3**.

Table 3: Study Area Guardrail

Roadway Section	Guardrail Type	Approximate Length
I-70 (Median)		
Wadsworth Blvd to Kipling St	Concrete barrier	1.5 miles
Kipling St to Ward Rd	Guardrail	1.5 miles
Westbound I-70		
Wadsworth Blvd On Ramp	Guardrail	250 ft
Wadsworth Blvd On Ramp (in ramp gore)	Concrete barrier	200 ft
Wadsworth Blvd On Ramp to Carr St	Concrete barrier	1600 ft
Carr St Bridge	Concrete bridge rail	120 ft

Table 3: Study Area Guardrail (continued)

Roadway Section	Guardrail Type	Approximate Length
Carr St to Garrison St	Concrete barrier	2600 ft
Garrison St Bridge	Concrete bridge rail	170 ft
Garrison St to west of Holland St	Concrete barrier	750 ft
Independence St to Kipling St Off Ramp	Concrete barrier with guardrail ends	1200 ft
East of Oak St (at overhead sign)	Guardrail	150 ft
Robb St to Tabor St (along frontage road)	Guardrail	600 ft
Kipling St to Tabor St	Cable Barrier	5,000 ft
Tabor St to Ward Rd Off Ramp	Guardrail	1600 ft (120 ft placed in slope paving under Tabor Street Bridge)
Eastbound I-70		
Ward Rd Interchange	Guardrail	200 ft
Tabor St to Routt St	Guardrail	1200 ft
Kipling St Off Ramp	Guardrail	150 ft
Kipling St Interchange – West of Kipling Bridge	Guardrail	550 ft
Kipling St Interchange – East of Kipling Bridge	Guardrail	650 ft
Independence St to Garrison St	Concrete barrier	1600 ft
Garrison St Bridge	Concrete bridge rail	170 ft
Garrison St to Carr St	Concrete barrier	2600 ft
Carr St Bridge	Concrete bridge rail	120 ft
Carr St to Wadsworth Blvd Off Ramp	Concrete barrier	1600 ft
Kipling Street		
Under I-70 Bridge	Concrete barrier	120 ft

Source: Field visit by David Evans and Associates, February 2012

Fence/Wall

There are a few notable fences along Kipling Street. There is a significant length of sound wall along I-70 and segments of wooden and chain link fence. All fences are located behind sidewalk or curb and gutter and offset from the roadway. There are no fences that pose an issue with clear zone within the study area.

The location and type of fence and sound walls within the study area are summarized in **Table 4**.

Noise wall along north side of I-70

Table 4: Study Area Fence/Wall

Roadway Section	Fence/Wall Type
Westbound I-70	
Carr St to east of Independence St	Masonry sound wall
Independence St to Kipling St Off Ramp	Chain link fence
Kipling St Interchange	Chain link fence
Routt St to Tabor St	Masonry sound wall
Tabor St to Ward Rd Off Ramp	Chain link fence
Eastbound I-70	
Ward Rd Interchange	Chain link fence
Tabor St to east of Kipling St Off Ramp	Masonry sound wall
Kipling St Interchange	Chain link fence
Independence St to Wadsworth Blvd Off Ramp	Masonry sound wall
Wadsworth Blvd Interchange	Chain link fence
Southbound Kipling Street	
S Frontage Rd to 44th Ave	Brick decorative wall

Source: Field visit by David Evans and Associates, February 2012

Lighting

I- 70 is continuously illuminated between Wadsworth Boulevard and Ward Road, with high mast lights at interchanges. There is illumination at intersections along Kipling Street from 51st Place to 44th Avenue. There is pedestrian lighting with specialty poles along segments of sidewalk on the west side of Kipling Street south of the interchange and along the development between 51st Place and 50th Avenue north of the interchange. The locations of the illuminated areas are outlined in **Table 5** and shown on **Figure 4**.

West side of Kipling Street south of I-70 interchange

Table 5: Study Area Lighting

Roadway Section	Description
Westbound I-70	
Wadsworth Blvd to Kipling St	Entire section illuminated
Eastbound I-70	
Ward Rd to Wadsworth Blvd	Entire section illuminated
Kipling Street	
51st Pl	Intersection illumination
51st Pl to 50th Ave	Pedestrian illumination
50th Ave	Intersection illumination
49th Ave/N Frontage Rd	Intersection illumination

Table 5: Study Area Lighting (continued)

Roadway Section	Description
49th Ave/N Frontage Rd to I-70 Ramps	Entire northbound section illuminated
I-70 Ramps to S Frontage Rd	Pedestrian illumination
	Entire northbound section illuminated
S Frontage Rd to 44th Ave	Pedestrian illumination
	Entire northbound section illuminated
44th Ave	Intersection illumination

Source: Field visit by David Evans and Associates, February 2012

Guide Signs

Guide signs, large signs with green backgrounds providing directional information, are located along I-70 between Wadsworth Boulevard and Ward Road.

All of these signs are protected by concrete barrier or guardrail. The locations of the guide signs are outlined in **Table 6** and shown on **Figure 4**.

Cantilever-mounted guide sign at Eastbound I-70 Off Ramp

Sign Mounting:

- Ground mounted – sign panel mounted on posts outside of freeway shoulder
- Overhead on bridge – sign panel mounted over lanes on bridge spanning across freeway
- Cantilever – sign panel mounted over outside lane on post from one side of freeway
- Butterfly cantiliever – sign panel mounted on large post in median of freeway

Table 6: Guide Signs

Roadway Section	Type of Sign Mounting
Westbound I-70	
Estes St	Overhead on bridge
East of Garrison St	Cantilever (in median)
Kipling Off Ramp	Cantilever
Between Oak St and Miller St	Overhead on bridge with Variable Message Sign
Between Robb St and Parfel St	Butterfly cantilever (in median)
East of Tabor St Bridge	Cantilever
West of Tabor St Bridge	Ground mounted
Ward Rd Off Ramp	Cantilever
Eastbound I-70	
Ward Rd Interchange	Cantilever
Kipling St Off Ramp	Cantilever
Holland St	Overhead on bridge
Cody St	Overhead on bridge
West of Allison St	Overhead on bridge
Kipling Street	
I-70 Interchange	Ground mounted

Source: Field visit by David Evans and Associates, February 2012

Traffic Signals

Traffic signals exist at major intersections along Kipling Street from 51st Avenue to 44th Avenue. Descriptions of the traffic signal poles are summarized in **Table 7**. At the I-70 interchange ramp signals, the span wire signal poles show signs of rust and corrosion.

Table 7: Kipling Street Traffic Signals

Kipling Intersection	Description
51st Pl	Mast arm signal poles
50th Ave	Mast arm signal poles with separate pedestal poles for pedestrian push buttons and signals
49th Ave/N Frontage Rd	Mast arm signal poles
I-70 Ramps	Signal poles with span wires
S Frontage Rd	Mast arm signal poles
44th Ave	Mast arm signal poles

Source: Field visit by David Evans and Associates, February 2012

Design Deficiencies

The project identified locations of design deficiencies. Potential defiencies were evaluated for in clear zone/obstructions, side slope (i.e., too steep without guardrail), horizontal and vertical sight distance, landscaping, and tapers (i.e., diagonal line at the end of an acceleration lane). Listed in **Table 8** and shown in **Figure 4** are the areas that appeared to be deficient in design.

Table 8: Study Area Design Deficiencies

Location	Description	Condition
Westbound I-70		
Kipling St Off Ramp	Sight distance	Limited sight distance on off ramp
Tabor St Bridge	Design deficiency	Guardrail located in slope paving
Eastbound I-70		
Tabor St Bridge	Design deficiency	Guardrail located in slope paving
Southbound Kipling Street		
I-70 Bridge	Design deficiency	Steep sidewalk grades, narrow sidewalk width, no landing areas behind pedestrian ramps
S Frontage Rd to 44th Ave	Design deficiency	Acceleration length, three locations
Northbound Kipling Street		
44th Ave to S Frontage Rd	Design deficiency	Acceleration length
	Design deficiency	Sidewalk width and connectivity

Source: Field visit by David Evans and Associates, February 2012

Bayou Ditch under Kipling Street

Drainage

The I-70 and Kipling interchange study area lies within the jurisdictional area for the Urban Drainage and Flood Control District (UDFCD), City of Arvada, and City of Wheat Ridge. The study area lies entirely within the Clear Creek Drainage Basin. There are three major storm sewer systems (the I-70 system, Kipling system, and Arvada Channel system) within the study area. All storm sewers are tributary to Clear Creek.

Figure 5 illustrates the existing drainage features within the interchange study area.

Major Storm Sewer Systems

I-70 System

Runoff from I-70 at Kipling Street drains via an underground storm sewer system. The I-70 system also collects runoff from the North Frontage Road. The trunk line runs east along the north side of I-70 from the west side of Kipling Street to Wadsworth Boulevard before crossing under I-70 and discharging to Clear Creek southwest of the I-70 and Wadsworth Boulevard interchange.

Several lateral lines convey runoff from the south side of I-70, north, to the trunk line. The diameter of the trunk line varies from 30 inches at Kipling Street to 48 inches at the outfall. The I-70 system was not constructed with water quality treatment facilities. Any construction within the public right-of-way in the I-70 and Kipling interchange area will require water quality treatment in accordance with CDOT's Municipal Separate Storm Sewer System (MS4) permit process.

Lateral lines are sewer lines that connect the main trunk line to inlets.

Kipling System

South of I-70, runoff is collected and conveyed via a second underground storm sewer system. Several laterals convey runoff to the 36-inch trunk line of the Kipling system, which runs south along the west side of Kipling Street to an outfall at the northwest corner of Kipling Street and Clear Creek.

Figure 5: Major Drainage Features

Arvada Channel System

A Type D inlet is a CDOT standard design for drainage inlets in swales or ditches.

Runoff between 51st Place and 50th Avenue, west of Independence Street, is conveyed to a third storm sewer system in Kipling Street, north of I-70. From there, the storm sewer flows west to the Arvada Ridge development to a detention pond at the northeast corner of Miller Street and 50th Avenue. The pond discharges via a modified Type D inlet and connects to the Arvada Channel. In this case, the inlet structure functions as an outlet for the pond. The Arvada Channel is a major drainageway that flows east approximately 3.5 miles from Ward Road to Wadsworth Boulevard, where it discharges to Clear Creek. Through the project area, the Arvada Channel flows through a 12-foot by 6-foot concrete box culvert along the north side of 50th Avenue.

An irrigation ditch, Bayou Ditch, flows through the study area along 50th Avenue via a 54-inch underground pipe. The pipe parallels the Arvada Channel box culvert west of Kipling Street. At Kipling Street, the irrigation pipe crosses to the south before opening into a concrete-lined, trapezoidal channel east of Kipling. The channel flows east along the south side of 50th Avenue.

Area Drainage Reports

There are several relevant drainage reports that cover the study area, shown in **Table 9**. The studies provide information on the existing drainage capacities, which may be impacted by roadway changes at the I-70 and Kipling Street interchange.

Table 9: Relevant Study Area Drainage Reports

Report	Author	Date	Client	Coverage Area
Outfall System Planning, Phase B – Columbine Basin	Muller Engineering Co., Inc.	December 1994	Urban Drainage and Flood Control District partnered with City of Wheat Ridge and City of Arvada	North of I-70, South of West 58th Ave, East of Eldridge St, and West of Sheridan Blvd at the outfall to Clear Creek
Hydrologic and Hydraulic Analysis, Arvada Ridge Drainage Improvements	Anderson Consulting Engineers, Inc.	March 2005	Unknown	Unknown
Flood Hazard Area Delineation – Clear Creek	Icon Engineering, Inc.	April 2007	Urban Drainage and Flood Control District partnered with Adams County, Jefferson County, City and County of Denver, City of Golden, and City of Wheat Ridge	Clear Creek from the confluence with the South Platte River to approximately 2,000 feet upstream of Highway 6 in Golden
Major Drainageway Planning, Phase B – Conceptual Preliminary Design for Clear Creek	Icon Engineering, Inc.	February 2008	Urban Drainage and Flood Control District partnered with Adams County, Jefferson County, City and County of Denver, City of Golden, and City of Wheat Ridge	Clear Creek from the confluence with the South Platte River to approximately 2,000 feet upstream of Highway 6 in Golden
Arvada Channel, Four Acre Lake to Yarrow St – Drainage Report	Muller Engineering Co., Inc.	April 2008	City of Arvada	West 51st Ave between Garrison St and Yarrow Street

Overhead transmission lines west of Kipling Street

Utilities

Utility information within the I-70 and Kipling interchange study area was obtained from Denver Water, City of Arvada, and field investigations.

The known utilities along the Kipling corridor are summarized in **Table 10**.

Table 10: Existing Study Area Utilities

Utility	Location	Description
Water Line	Kipling St/51St Pl Intersection	12 inch waterline with fire hydrant; water line make a 90 degree bend and runs west down 51st Pl
Water Line	Kipling St from 51st Pl to 50th Ave	12 inch water line with fire hydrants mid-block
Water Line	Kipling St/50th Ave Intersection	12 inch waterline with fire hydrant; water line makes 2-90 degree bends and runs west and east down 50th Ave
Water Line	Kipling St from 49th Ave/N Frontage Rd to S Frontage Rd	12 inch waterline; 12 inch tee at eastbound I-70 ramps
Water Line	Kipling St from S Frontage Rd to 44th Ave	12 inch waterline and 6 inch waterline; four fire hydrants, two each on 6 inch and 12 inch lines
Water Line	Kipling St/44th Ave Intersection	12 inch water line and 6 inch water line with fire hydrant; 12 inch water line in West 44th Ave
Power Line	Kipling St/50th Ave Intersection	Overhead transmission towers/lines on north side of 50th Ave
Power Line	Kipling St between S Frontage Rd and 44th Ave	Power pole on east side of roadway
Sanitary Sewer Line	Kipling St from 53rd Pl to 51st Pl	8 inch sanitary sewer line runs down west side, makes 90 degree bend and runs east down 51st Pl

Source: Denver Water, City of Arvada, and field visit by David Evans and Associates, March 2012

Kipling Street at eastbound I-70 ramps intersection

Vehicular Traffic Operations

Traffic count data were collected within the I-70 and Kipling interchange study area during February 2012. This data included peak hour turning movements at intersections, detailed ramp meter traffic data, and daily traffic on the major roadways. Vehicle classification data was collected at all of the daily traffic locations. Daily traffic count data were also available from CDOT, City of Wheat Ridge, and City of Arvada.

The traffic count data are included in **Appendix A**.

Daily Traffic Volumes

Daily traffic provides a perspective on how traffic levels compare for the intended facility type. These existing traffic volumes will be used to calibrate the study travel forecasting model. The traffic forecasting methodology and results for the project will be described in a subsequent project report.

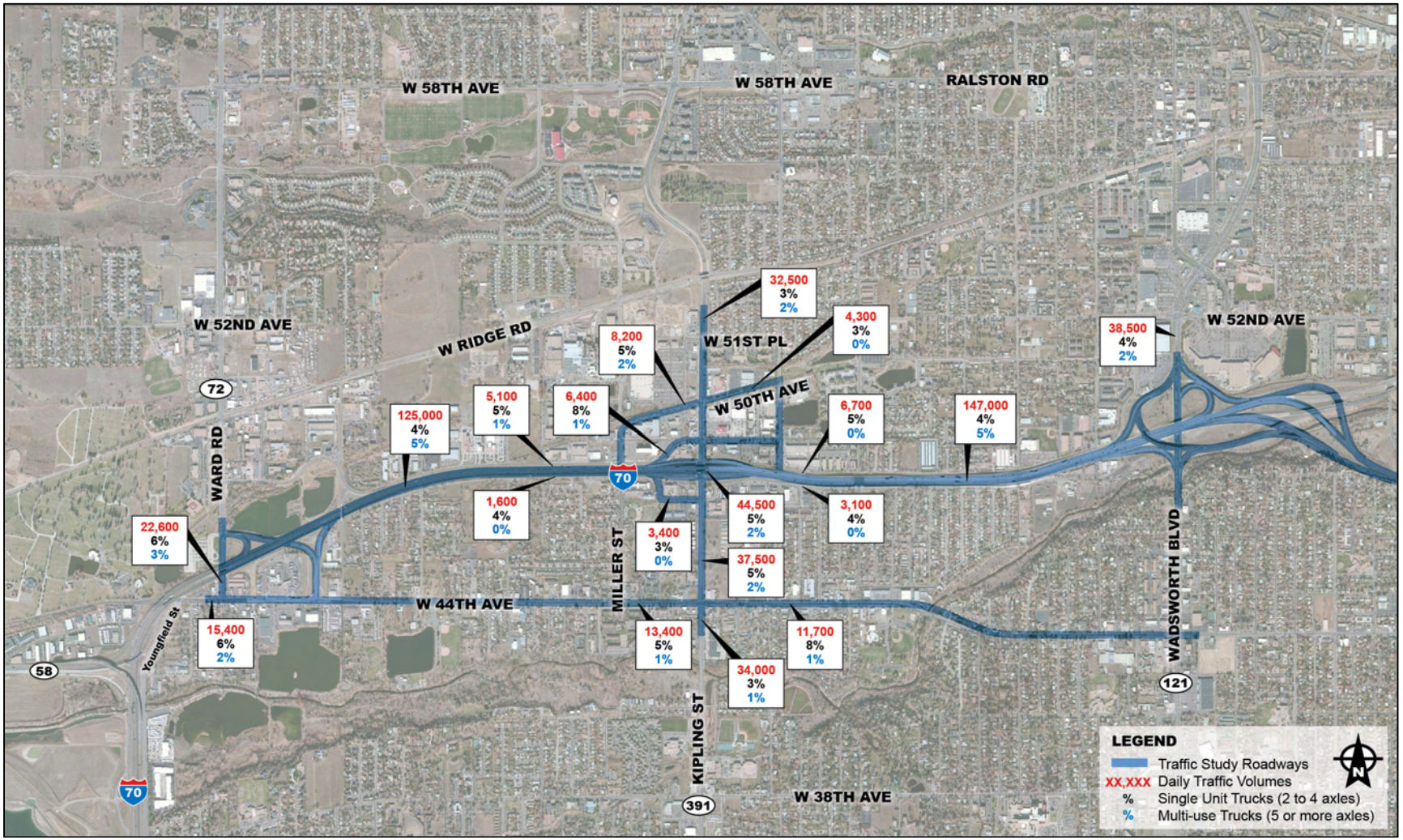
The daily traffic counts collected for the project are shown in **Figure 6**. Traffic on the North Frontage Road is over double the traffic volumes on the South Frontage Road, and the percentage of trucks is particularly high on the North Frontage Road west of Kipling Street.

Traffic volumes on I-70 east of the Kipling interchange are much higher than on the west.

The daily traffic volumes of approximately 28,000 to 30,000 vehicles per day (vpd) on Kipling Street are near the planning-level capacity limits for a four-lane arterial. The daily percentage of trucks traveling on Kipling Street are higher south of the I-70 interchange.

The traffic volumes on 44th Avenue east and west of Kipling Street are less than 14,000 vpd, which is well within the capacity of a four-lane minor arterial, although the daily truck percentage is relatively high for a suburban minor arterial. Higher traffic volumes occur on 44th Avenue near Ward Road.

Figure 6: Daily Traffic Volume Counts



Source: All Traffic Data, February 2012

Historic and Hourly Trends

The economic conditions over the past few years may be a contributing factor to reduced traffic volumes in many areas. In addition, seasonal variation in traffic can effect some operations aspects, although seasonal variation is more noticeable when looked at on a daily basis as compared to a peak hour basis.

Historic traffic data is available from an Automatic Traffic Recorder (ATR) on I-70 just east of Sheridan, about three miles east of the project area. Data at this counter is available dating back to the year 2000, although there are month-to-month gaps in the data between 2000 and 2005. Reviewing the monthly distribution, the traffic volumes on I-70 in the winter months are generally ten percent lower than the peak summer months.

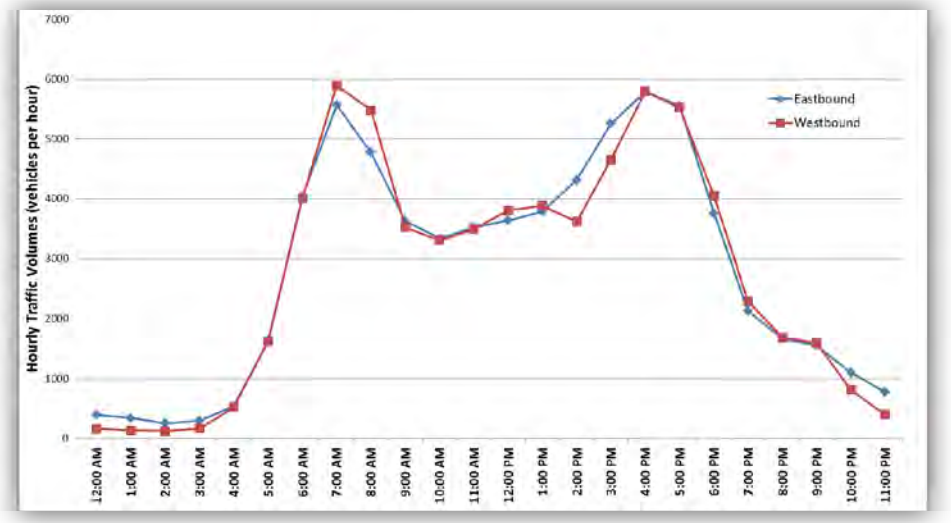
2011 traffic on I-70 at Sheridan was about 1.2% lower than traffic in 2004-2005.

When peak hour traffic is reviewed on a month-to-month basis, the variability between seasons is reduced. Reviewing the I-70 counter at Sheridan, February is one of the higher peak hour volume months, but the variability between highest and lowest months are generally less than five percent. For this reason, no seasonal adjustments were made to the peak hour traffic counts conducted in February 2012.

One interesting aspect to the traffic growth trends on I-70 over the past ten years is that even though the peak hour traffic volumes in the peak direction do not appear to be growing very much, the traffic in the off-peak direction has been growing at about one percent per year.

The hourly breakdown of volumes on I-70 shows the hourly fluctuations of I-70 at Kipling Street. As shown in **Figure 7**, the traffic is characterized by distinct peaks in traffic volumes during the typical AM and PM commuting hours, from 7:00am to 9:00am and from 4:00pm to 6:00pm. However, there is <u>not</u> a distinct directionality focused around commuting eastbound towards downtown Denver or I-25 during the AM peak hours and in the westbound direction during the PM peak hours. This is also demonstrated at the I-70 and Kipling interchange because the movements on and off the I-70 ramps to the east are of the same magnitude during the AM and PM peak hours.

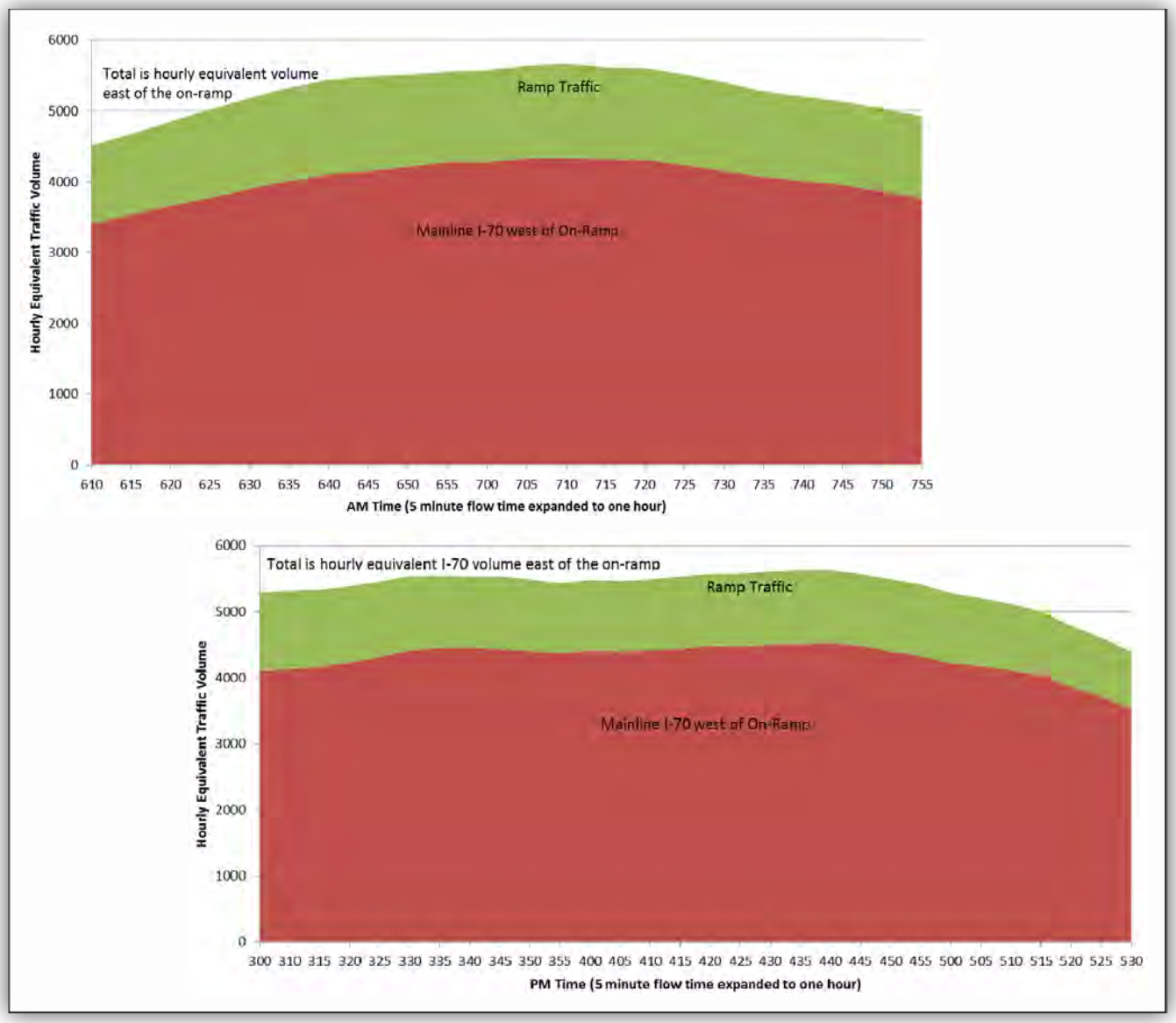
Figure 7: I-70 East of Kipling Hourly Traffic Volumes



Ramp Meter Traffic Data

The ramp meter on the Eastbound I-70 On Ramp at the Kipling Street interchange has traffic data available in five-minute intervals for every day it is in operation. This allows for a detailed evaluation of traffic flow at a key merge point on I-70 that affects both mainline I-70 traffic and traffic at the Eastbound I-70 On Ramp traffic signal on Kipling Street. The ramp meter traffic data is shown in **Figure 8**, with five-minute data expanded to an hourly-equivalent volume for comparison.

Figure 8: Kipling Eastbound On Ramp, AM and PM Hourly Equivalent Data



The following are key findings from the review of the Eastbound I-70 On Ramp data:

- The two inside mainline lanes are typically carrying 1,600-1,800 vehicles per hour (vph), while the outside mainline lane carries less than 900 vph due to the ramp merging volume. This merge causes the speed differential

between the adjacent lanes to be usually more than 10 MPH during congested times.

- In the AM peak period, the timing of the ramp meter allows a maximum of about 1,300 vph onto the freeway, or two vehicles about every 5.5 seconds. This flow rate is crucial because it is necessary to release vehicles from the ramp meter so they do not queue back into the Kipling intersection.
- The PM peak traffic demand for the Eastbound I-70 On Ramp is about 100 vph less than during the AM peak, but some of the ramp backup and mainline merge problems still exist during these evening peak times.

Peak Hour Intersection Traffic Volumes

Peak hour intersection traffic volumes are used to evaluate and quantify traffic operations and capacity of an urban arterial roadway system. Peak hour intersection counts were collected at the seven signalized intersections along Kipling Street within the study area, as well as the signalized intersections at the Ward Road and Wadsworth Boulevard interchanges.

Peak hour intersection counts were available at the same intersections along Kipling Street for 2003 and 2009. Comparing the 2012 data collected for this study to the 2003 data reveals that peak hour traffic at the two signals at the interchange has not substantially changed between 2003 and 2012. In addition to the recent economic conditions, the lack of traffic growth may also be a reflection of the interchange operating at capacity for several of the movements through the interchange during the morning and afternoon peak periods.

Peak hour traffic at the I-70 and Kipling interchange ramp signals has not substantially changed in the last ten years.

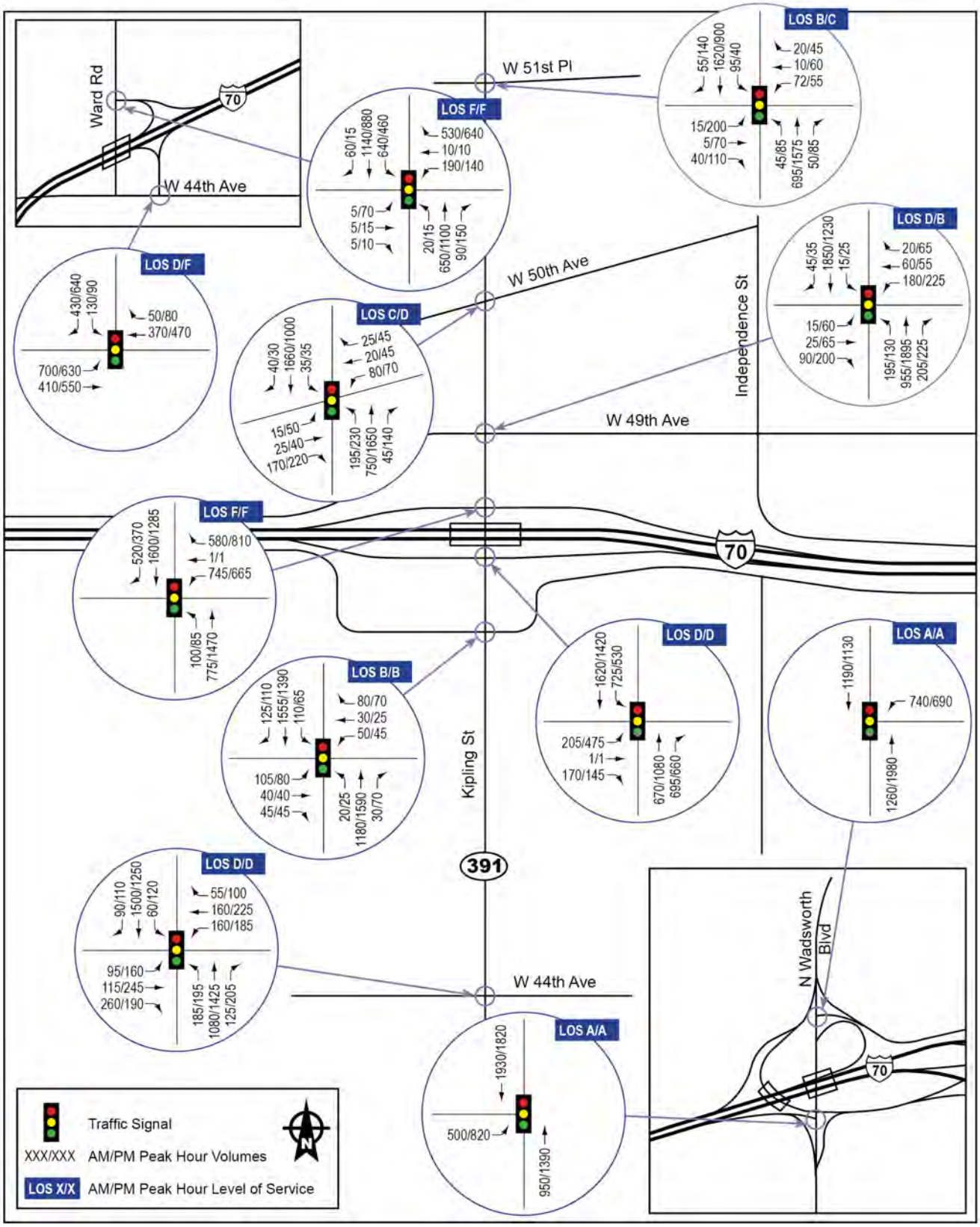
At the 44th Avenue and Kipling Street intersection, the volumes are heaviest for the northbound and southbound through movements during the peak hours. The eastbound and westbound through movements at the intersection are almost balanced during both peak hours with the highest turning movements coming from and going to the south.

Kipling Street and South Frontage Road traffic signal

Level of service (LOS) is a method of describing traffic operations in general and comparable terms based on letter grading of A through F. LOS A describes the best operations with little or no delay, and LOS F describes over-capacity conditions with poor traffic operations and high delay.

In order to analyze and simulate traffic operations along Kipling Street with the Synchro traffic analysis software, a network of AM and PM peak hour traffic with volumes balanced between major intersections was created. The counts collected for this study were utilized in conjunction with other available traffic volume data to estimate peak hour traffic volumes balanced through the Kipling corridor and the study area interchanges. The peak hour intersection traffic counts and results of the signalized operational analysis (discussed in the next section of the report) are illustrated in **Figure 9**.

Figure 9: Peak Hour Traffic Counts and Levels of Service



Operational Analysis

An assessment of traffic operations and levels of service (LOS) was completed for the existing peak hour traffic volumes for freeway, ramp merge/diverge, and signalized intersections in the study area. LOS is a method of describing traffic operations in general and comparable terms based on letter grading of A through F. LOS A would describe the best operations with little or no delay, and LOS F describes over-capacity conditions with poor traffic operations and high delay. Generally LOS D would be a reasonable expectation for peak-hour traffic operations where reasonable roadway capacity was provided. Besides the standard LOS descriptions for different aspects of the operations, there are unique operational issues in the I-70 and Kipling interchange area that are not evident in the reported level of service results. These are noted for each area of analyses areas below.

Freeway Operational Analysis

The Highway Capacity Manual (HCM 2010) and software (HCS) were used to establish the existing peak hour level of service for mainline I-70 east and west of the Kipling interchange. The results are shown in **Table 11**.

The maximum possible volume and level of service for eastbound I-70 from Kipling to Wadsworth is controlled by the capacity of the merge from the Kipling On Ramp during the peak hours.

Westbound I-70 approaching Kipling Street interchange

The westbound I-70 LOS for the segment from Wadsworth to Kipling includes four freeway lanes, including the lane that drops at the Kipling Off Ramp. The inside mainline lane that merges at the Kipling bridge was not included in the analysis. The merging of the inside, high-speed lane does affect the mainline freeway operations and capacity, which will be evaluated with the traffic simulation analysis to be completed with this study.

Table 11: Existing (2012) Peak Hour I-70 Mainline Level of Service

Freeway Segment	Peak Hour Level of Service	
	AM	PM
Eastbound I-70 – Ward to Kipling	D	D
Eastbound I-70 – Kipling to Wadsworth	E	E
Westbound I-70 – Wadsworth to Kipling	C	C
Westbound I-70 – Kipling to Ward	D	C

Ramp Merge / Diverge Operational Analysis

The HCS software was used to estimate peak hour level of service for the Kipling interchange ramp merge and diverge locations on I-70. The results are shown in **Table 12**. The ramp meter at the Eastbound I-70 On Ramp from Kipling controls the entering ramp volume and effectively keeps the calculated level of service above LOS F.

Table 12: Existing (2012) Peak Hour Ramp Merge/Diverge Level of Service

Ramp	Peak Hour Level of Service	
	AM	PM
I-70/Kipling Westbound On Ramp	D	C
I-70/Kipling Westbound Off Ramp	E	E
I-70/Kipling Eastbound On Ramp	E	E
I-70/Kipling Eastbound Off Ramp	D	D

Intersection Operational Analysis

Intersection operational analysis was completed utilizing methods outlined in the latest Highway Capacity Manual (HCM 2010) and Synchro traffic analysis software. The existing lane configurations and balanced peak hour volumes developed for this study were used to analyze the levels of service at each study intersection during the AM and PM peak hours. The peak hour intersection traffic counts and results of the signalized operational analysis are illustrated in **Figure 8** and shown in **Table 13**.

Table 13: Existing (2012) Peak Hour Signalized Intersection Level of Service

Kipling Street Intersection	Peak Hour Level of Service	
	AM	PM
51st Place	B	C
50th Avenue	C	D
49th Avenue/North Frontage Road	D	B
Westbound I-70 Ramps	F	F
Eastbound I-70 Ramps	D	D
South Frontage Road	B	B
44th Avenue	D	D

At the 49th Avenue/North Frontage Road and Kipling Street intersection, the LOS experienced during the peak hours is worse than indicated by the reported LOS D. The poor traffic operations are due to the interruption in progression for northbound traffic, which is necessary for the timing requirements of the adjacent interchange signals.

Drivers at the Westbound I-70 Off Ramp do not utilize the westbound "free" right turn effectively, reducing the capacity of the ramp signal.

Based on field observations at the westbound I-70 ramps signal, drivers making the right turn movement from the off ramp do not utilize the right turn lane leading to a

continuous acceleration lane on Kipling Street as a "free" right turn. Instead, many drivers yield to northbound traffic on Kipling. This may be due to the short weave distance to make a left turn onto 49th Avenue from the I-70 off ramp. This contributes to the excessive queues on the freeway ramp.

In the PM peak hour, the signal timing necessary for the progression and queues clearance on Kipling Street between the interchange signals causes the westbound left turn from the I-70 off ramp to experience poor LOS. This creates long back ups on the freeway ramp and encourages drivers to continue into and stop in the intersection when southbound Kipling Street is congested, blocking the northbound Kipling movement.

General Operational Issues

There are numerous traffic operations issues at the I-70 and Kipling interchange area that do not lend themselves to a simple LOS description.

Eastbound I-70 On Ramp

The eastbound I-70 ramp meter at Kipling Street is necessary to maintain acceptable freeway traffic flow during peak hours. However, in order to achieve freeway benefits, the ramp meter queues traffic from the meter back to the Kipling signalized intersection.

Eastbound I-70 congestion at Kipling Street On Ramp in AM peak hour

Westbound I-70 Off Ramp

The Westbound I-70 Off Ramp has a very heavy westbound to northbound right turn volume. Although this right turn leads to a continuous acceleration lane on Kipling Street that is about 850 feet long, the acceleration lane is minimally utilized and it causes traffic to queue up the off ramp and onto the I-70 mainline.

About 10% - 20% of drivers making the right turn from the Westbound I-70 Off Ramp want to turn left at the 49th Avenue/North Frontage Road intersection, located 375 feet to the north. These drivers yield to northbound through traffic before weaving across the two northbound lanes into the left turn lane for 49th Avenue. Even making a left turn at the next intersection to the north, at 50th Avenue, requires drivers to weave across the two northbound lanes of Kipling within 750 feet.

Although signs at the signal tell drivers that want to turn west on 49th Avenue to use the center lane and the ramp signal to turn right, few drivers do this, and most do not obey the "No Left Turn at 49th" sign that is displayed to drivers in the free right turn lane.

This weaving situation between the closely-spaced ramp and frontage road intersection also exists at the south side of the interchange. With lower volumes, the movements on the south side do not cause as much of an issue with vehicular queues on the ramp or on Kipling Street.

Kipling Interchange Traffic Signals

The traffic signals serving the I-70 ramps are only 270 feet apart, where a typical diamond interchange design would have at least 600 feet between intersections. The effective vehicle storage between the signals is about 200 feet, or eight vehicles per lane. This causes substantial recurring operational issues.

Because of the close spacing, the two signals must be timed to minimize or eliminate vehicle queuing between the two signals under the I-70 bridge. Otherwise, vehicles would queue into adjacent intersections, which would cause gridlock. The signal timing to manage the vehicle queues within the interchange is effective, but it causes additional queuing to occur on the approaches to the two signals. This is a particular concern for the Westbound I-70 Off Ramp in the PM peak hour, where the queues extend onto mainline I-70.

The signal timing necessary to reduce queuing between the ramps creates congestion on the outside approaches to the interchange.

The signal timing necessary for the queue management is inefficient for the progression of Kipling Street traffic through the interchange, causing multiple stops for some directions. Also, there is ample green time for some traffic movements (e.g., the northbound Kipling through movement at the Westbound I-70 Off Ramp intersection) that is not utilized because traffic is being held at an upstream signal.

The close traffic signal spacing is also an issue for driver visibility. Drivers can see multiple and conflicting signal indications, particularly at night. Drivers may be confused by a green light at the far intersection while the traffic signal they should be watching is red.

Kipling Street Access Control

The lack of access control along Kipling Street, particularly south of the interchange toward 44th Avenue, creates numerous unmanaged left turns and crossing movements of traffic, which can be a safety issue. Private driveways exist on three of the four quadrants of the interchange adjacent to the ramp signal. Simply closing these driveways would not be easily accomplished unless a property is purchased or unless the property undergoes redevelopment.

44th Avenue as Diversion Route

A parallel east-west minor arterial to I-70 is 44th Avenue from Youngfield Street west of Ward Road to Federal Boulevard. It has been noted that during incidents (accidents), some drivers on eastbound I-70 will exit the freeway and use 44th Avenue to bypass the congestion. Based on the available accident data, this type of incident may occur two-to-three times per month. This diversion may also occur if the congestion caused by the merge of the Kipling On Ramp causes mainline I-70 traffic to extend back to Ward Road, where drivers have an opportunity to recognize the congestion and exit I-70.

Traffic volumes on 44th Avenue were evaluated for key travel patterns during typical weekday traffic conditions and congestion on I-70. **Figure 10** shows the hourly variation of directional traffic on 44th Avenue west of Kipling Street from counts collected for this study on a Wednesday in February (February 15, 2012). As shown, 44th Avenue experiences traffic volumes distributed almost equally in the eastbound and westbound directions without a defined AM peak period. Traffic volumes build throughout the day to peak in the evening.

Figure10: 44th Avenue west of Kipling Hourly Traffic Volumes

Distinctively different than the peak hour commuting traffic patterns on I-70, this weekday traffic pattern is indicative of a corridor comprised of local trips to/from residential and commerical development within the immediate area. The 44th Avenue corridor may be used as a diversion route when there are incidents on I-70, but it does not appear that 44th Avenue is used as an alternate route for regional I-70 travelers during typical weekday freeway congestion.

Kipling Street and westbound I-70 ramps intersection

Crash History

The specific data and analysis presented in this section are summarized from the *Safety Assessment Report for SH070A MP 267.00 to MP 267.90 and SH 391A MP 8.87 to MP 9.94*. Crash data for the safety assessment was examined for the three-year period of January 1, 2008 through December 31, 2010. The study area for the safety assessment included the section of I-70 from Milepost 267.00, just west of Kipling Street, to Milepost 267.90, at Garrison Street. The safety assessment also included an evaluation of accidents along Kipling Street from Milepost 8.87, at Clear Creek south of 44th Avenue, to Milepost 9.64, at 49th Avenue, which is the end of the state highway designation and CDOT maintenance.

The severity of crashes is summarized in **Table 14**. Approximately 90% percent of the crashes along I-70 and Kipling Street in the study area are Property Damage Only (PDO), which is consistent with the recurring congestion in the study area that reduces the traveling speed of vehicles and consequential crash severity.

Table 14: Study Area Crash Severity (2008-2010)

Segment	Crash Severity						
	Property Damage Only (PDO)		Injury		Fatal		Total
	Number	Percent	Number	Percent	Number	Percent	
I-70	215	89%	24	10%	1	< 1%	240
Kipling Street	277	91%	29	9%	0	0%	306
Total	**492**	**90%**	**53**	**9%**	**1**	**< 1%**	**546**

Source: CDOT Safety Assessment Report, April 2012

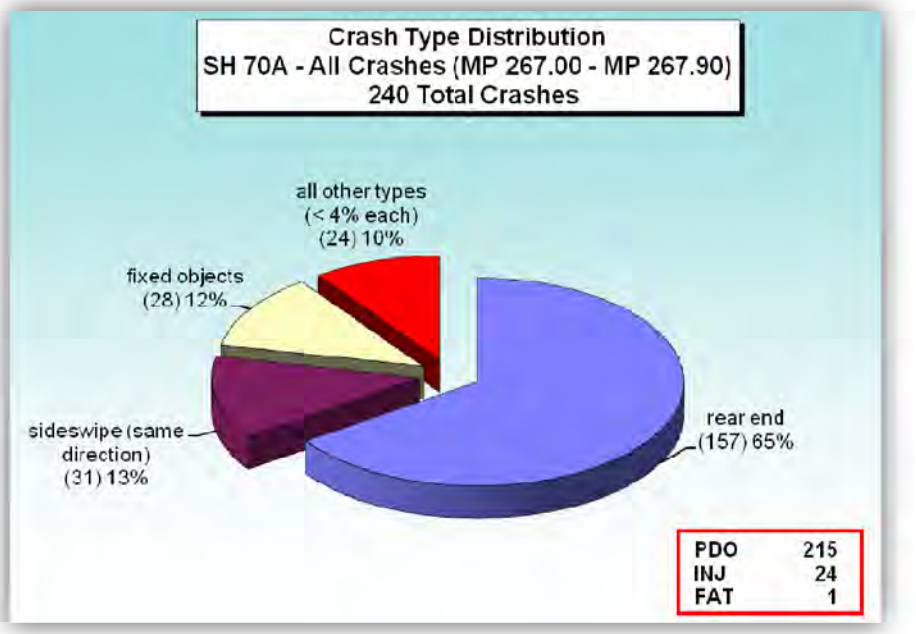
The one fatal crash occurred in June 2010 on westbound I-70 in the vicinity of the off ramp to Kipling Street. The crash occurred at about 3:30 in the morning when a vehicle traveling eastbound in the westbound lanes collided head on with a westbound vehicle. The driver of the eastbound vehicle was under the influence of

alcohol. Immediately after the collision, a semi truck in the westbound direction struck the two vehicles. The drivers of each vehicle were killed in the crash. The driver of the semi was unharmed.

Interstate 70

During the three-year study period there were 240 reported crashes on I-70 within the study limits including mainline and ramp crashes. **Figure 11** presents a graphical representation of the crash types for the I-70 mainline and ramps. Rear end type crashes (65%) were the predominant crash type followed by sideswipe (same direction) type crashes (13%) and fixed object type crashes (12%). The majority of the fixed object crashes were fairly evenly split between guard rail type (10) and concrete highway barrier type (11).

Figure 11: I-70 Crash Type Distribution



Note: Property Damage Only (PDO), Injury (INJ), Fatality (FAT)
Source: CDOT Safety Assessment Report, April 2012

In addition to the examination and comparison of crash rates for the entire study area, the assessment of the magnitude of safety problems on mainline I-70 was refined through the use of Safety Performance Function (SPF) methodology. The SPF reflects the complex relationship between exposure (measured in average daily traffic) and the crash count for a section of roadway measured in crashes per mile per year (CPMPY). The SPF models provide an estimate for the expected crash frequency for an interchange influence area, for a range of average daily traffic (ADT), among similar facilities. SPF functions are limited to mainline crashes only and as such do not include crashes that occur on ramps.

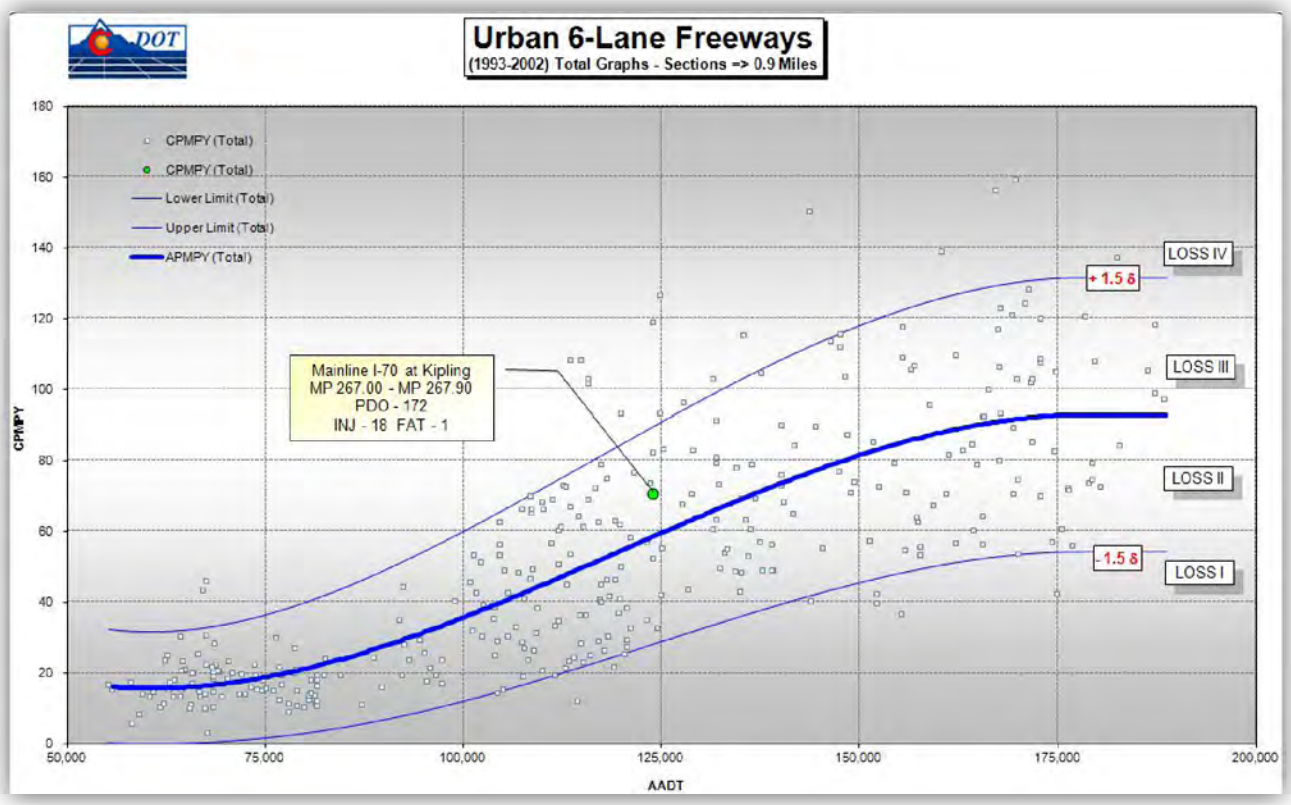
Development of the SPF lends itself well to the conceptual formulation of the Levels of Service of Safety (LOSS). The concept of level of service uses qualitative measures

that characterize safety of a roadway segment in reference to its expected performance and severity. If the level of safety predicted by the SPF will represent a normal or expected number of crashes at a specific level of ADT, then the degree of deviation from the norm can be stratified to represent specific levels of safety.

- LOSS-I – Indicates low potential for crash reduction
- LOSS-II – Indicates better than expected safety performance
- LOSS-III – Indicates less than expected safety performance
- LOSS-IV – Indicates high potential for crash reduction

The portion of I-70 at the Kipling Street interchange is classified as an Urban 6-Lane Freeway. Data for three-years of crash history on mainline I-70 has been plotted for evaluation on **Figure 12**. The graph depicts the total crash SPF of I-70 based on the given accident data. As can be seen, the SPF segment for the I-70 and Kipling interchange is above the average expected crash rate for the given average annual daily traffic (AADT). This places the SPF segment in the LOSS III category, which indicates less than expected safety performance.

Figure 12: I-70 Mainline Crash History



Source: CDOT Safety Assessment Report, April 2012

Mainline I-70 Crash Patterns

During the three-year study period, there were 191 reported crashes on mainline I-70 within the project limits. There were 172 PDO crashes, 18 injury crashes and

one fatal crash. Rear end type crashes (62%) were the predominant crash type followed by sideswipe (same direction) type crashes (15%) and fixed object type crashes (13%).

Based on a review of the crash history, the majority of the rear end type crashes occurred during the afternoon peak hour with an even split between eastbound and westbound crashes. The occurrence of rear end crashes in the vicinity of this interchange are closely tied to heavier peak hour traffic volumes on I-70.

The occurrence of sideswipe (same direction) crashes also tends to coincide with the peak travel times along I-70. There was a larger group of crashes in the westbound direction during the AM peak hour and a group of crashes in the eastbound direction in the afternoon. The occurrence of this crash type tends to be located in the vicinity of the merge and diverge points on I-70.

The majority of the fixed object type crashes were barrier (11) or rail (10) crashes. However, it is also worth noting that the majority of these crashes (13 of 21) occurred in poor road conditions. It is also interesting to note that the majority (16 of 21) barrier/rail crashes involved the barrier or rail in the center median of I-70 so the barrier presumably prevented a more serious crash from occurring in the majority of incidents.

Interchange Ramp Crash Patterns

During the three-year study period, there were a total of 49 crashes on the four ramps at the Kipling interchange. **Table 15** shows the location of the ramp crashes for the interchange and the predominant crash type on each ramp.

Table 15: Interchange Ramp Crashes (2008-2010)

Location	Number of Crashes	Predominant Crash Type
Eastbound Off Ramp	3	No predominant crash type
Eastbound On Ramp	22	20 of 22 were rear end crashes
Westbound Off Ramp	16	12 of 16 were rear end crashes
Westbound On Ramp	8	5 of 8 were rear end crashes

Source: CDOT Safety Assessment Report, April 2012

The majority of the crashes occurred on the Eastbound I-70 On Ramp and the Westbound I-70 Off Ramp and the majority of the crashes were rear end type crashes. In addition, the majority of these rear end type crashes occurred during the PM peak hour. There were only three crashes that occurred on the Eastbound I-70 Off Ramp.

The majority of the crashes on the Eastbound I-70 On Ramp were rear end type crashes, most of which occurred during the PM peak hour. Based on a review of the crash reports, the majority of the rear end crashes on this ramp occurred when one vehicle was stopped at the ramp meter or slowing to find a gap in mainline traffic and was struck from behind by another vehicle attempting to merge. This could be attributed to the short acceleration length at this on ramp, especially given the

ramp meter condition during peak hours when vehicle accelerate from a full stop while the meter is in use.

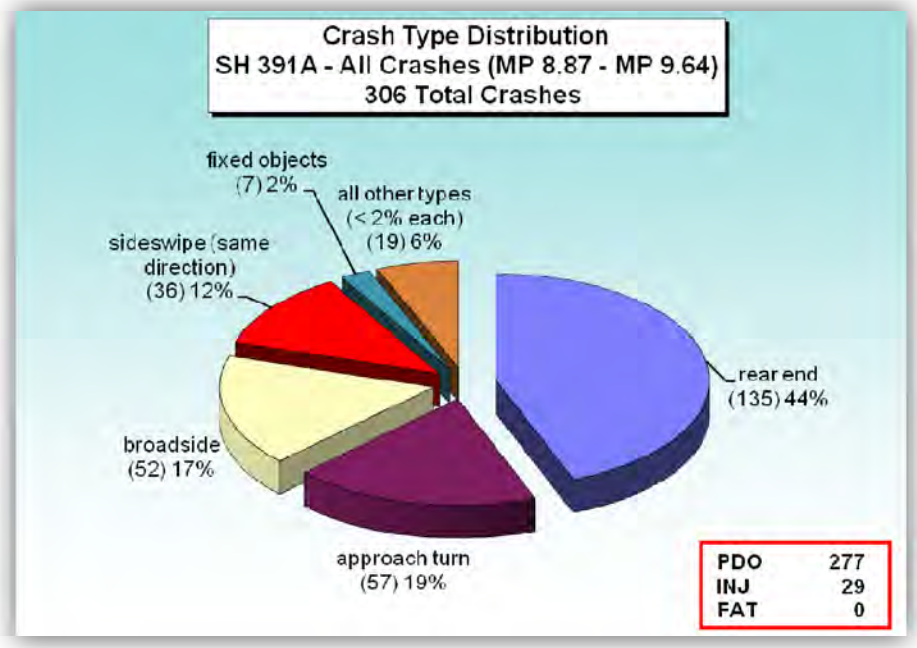
As with the Eastbound I-70 On Ramp, the majority of the crashes on the Westbound I-70 Off Ramp are also rear end type crashes that occurred during the peak hour. However, the majority of these crashes occurred at or near the free flow right turn lane from the off ramp to northbound Kipling Street when the lead vehicle did not utilize the free flow acceleration lane but instead stopped to yield to traffic on Kipling Street. The following vehicle then struck the lead vehicle. There are currently signs in place that clearly mark the right turn as a continuous acceleration lane. However, there are likely some right turning vehicles that are stopping in the continuous flow lane in order to wait for a gap in traffic to get to the northbound left turn at 49th Avenue.

The majority of the crashes on the Westbound I-70 On Ramp were rear end type crashes. Similar to the Eastbound I-70 On Ramp, several of these rear end type crashes occurred when stopped or slowed in an attempt to merge and was struck from behind by another merging vehicle.

Kipling Street (SH 391)

During the three-year study period on Kipling Street, there were 306 reported crashes within the safety assessment limits. **Figure 13** presents a graphical representation of crash types for this area. Rear-end type crashes (44%) were the predominant crash type followed by approach turn type crashes (19%) and broadside type crashes (17%).

Figure 13: Kipling Street Crash Type Distribution



Note: Property Damage Only (PDO), Injury (INJ), Fatality (FAT)
Source: CDOT Safety Assessment Report, April 2012

Of the 102 rear-end type crashes that occurred; 66 were in the northbound direction and 36 in the southbound direction. A review of the crash data indicated that a large portion of the rear-end type crashes occurred during the afternoon between 2:00 pm and 6:00 pm, which correlates to a typical increase in traffic volumes over the same time period.

It is likely that the increase in rear-end type crashes during times of heavier traffic is due to congested conditions, where vehicles must stop frequently. Northbound Kipling Street is often congested through the study segment during the evening peak period.

At the major intersections along Kipling Street, rear-end crashes are the predominant crash type followed by approach turn crashes and broadside crashes. The following list describes the intersection crash types that occur more frequently than expected in the study area and the potential cause:

- Rear-end accidents – related to congestion and frequent traffic signal through the corridor
- Approach turn and broadside – related to congested intersections, signal phasing, and signal head visibility
- Sideswipes when both vehicles are moving in the same direction – related to short weaving and lane-changing maneuvers

Route 100 along Kipling Street

Transit Service

The study area is served by the Regional Transportation District's (RTD) current local and express bus service and two regional bus park-n-Ride facilities. East-west routings along 38th Avenue, 44th Avenue and 58th Avenue provide service to much of the study area and in and out of the Olde Town Arvada park-n-Ride. North-south routings operate along Ward Road, Wadsworth Boulevard and Kipling Street. The study area is also part of the future Gold Line commuter rail service and future rail stations at Arvada Ridge, Olde Town Arvada and Ward Road.

Existing Transit

Facilities

There are two existing regional bus park-n-Ride facilities located within or very near the study area. They are located to the west and east of the study corridor as illustrated in **Figure 14**.

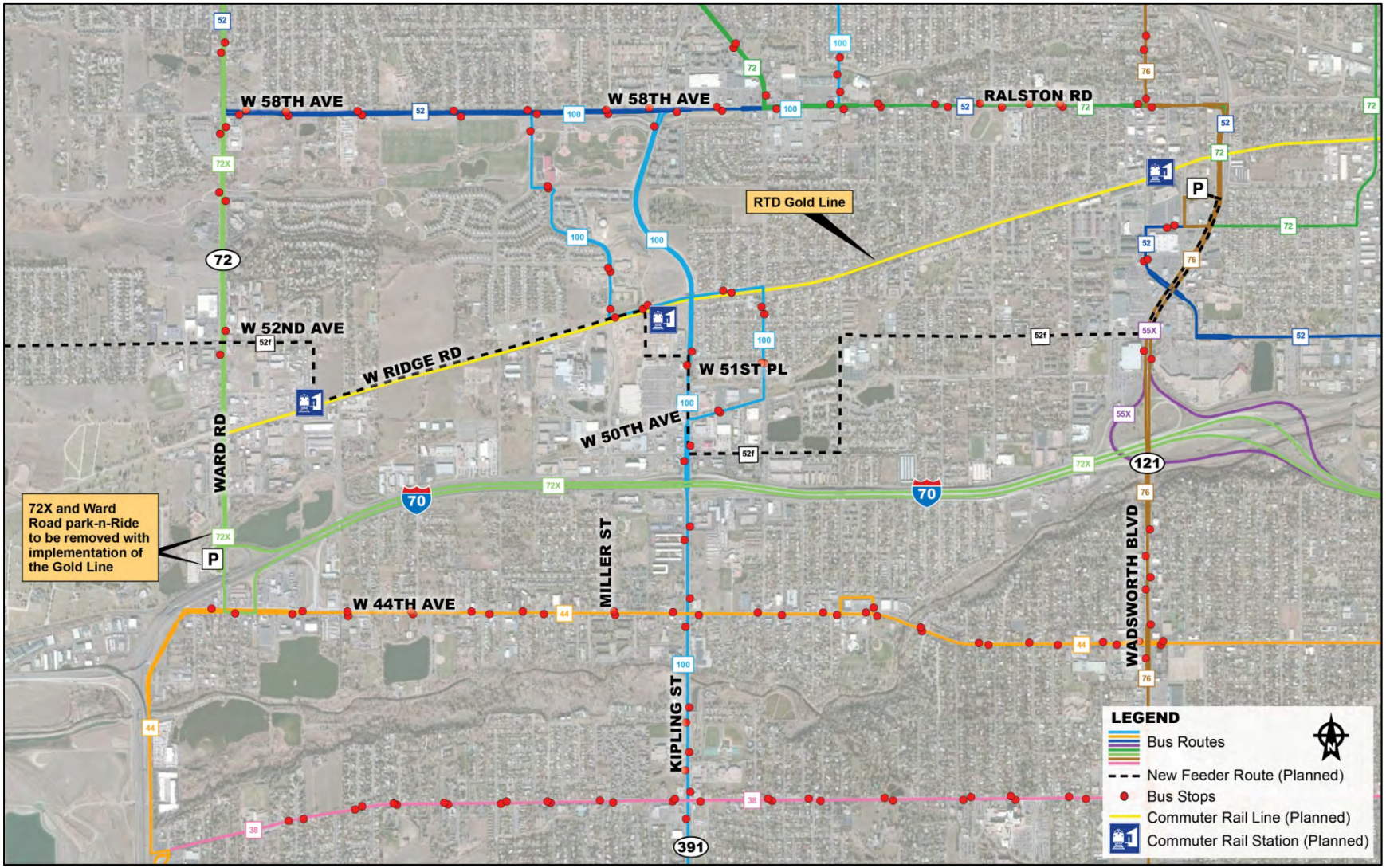
Ward Road park-n-Ride

The existing Ward Road facility is located on Ward Road, less than a quarter mile north of I-70. It is served by the express bus route 72X that runs along I-70 to I-25 and into Denver. The park-n-Ride facility has 491 parking spaces and the average daily use rate for the past 12 months is 215 spaces, or 44% of total capacity (*RTD park-n-Ride Utilization Report, fourth quarter 2011*).

Olde Town Arvada park-n-Ride

The existing Olde Town Arvada park-n-Ride is located just east of Wadsworth Boulevard at 56th Place and Vance. It is served by local routes 52, 72, 76 and the express route 55X. The park-n-Ride facility has 200 parking spaces. Average daily use is reported at 209 spaces, or 105% of the actual capacity (*RTD park-n-Ride Utilization Report, fourth quarter 2011*).

Figure 14: Existing and Planned Transit Routes and Facilities



Bus Routes

There are six local bus routes that serve the study area, Routes 38, 44, 52, 72, 76 and 100. Two additional express routes also serve the study area, Routes 55x and 72x. Operating characteristics of the routes are shown in **Table 16**. Further descriptions and ridership numbers for each route are discussed in this section.

Table 16: Study Area Bus Routes – Operating Characteristics

Route	Days of Service	Weekday Start Time	Weekday End Time	Weekday Peak Frequency	Weekday Off-Peak Frequency	Total Weekday Boardings
38	Daily	4:49 am	1:13 am	6 min	30 min	3,967
44	Daily	4:46 am	12:42 am	15 min	30 min	2,124
52	Daily	4:37 am	11:05 pm	15 min	30 min	3,217
72	Weekdays & Sat	5:30 am	8:08 pm	30 min	One hour	1,258
76	Daily	4:41 am	12:25 am	30 min	30 min	4,407
100	Weekdays & Sat	5:29 am	6:59 pm	30 min	30 min	1,286
55x	Weekdays	6:11 am – 8:16 am southbound	3:55 pm-6:17 pm northbound	15 min	30 min	329
72x	Weekdays	5:26 am – 8:41 am eastbound	3:01 pm -7:08 pm westbound	10 min	50 min	532

Source: Regional Transportation District

Route 38

Route 38 operates weekdays and weekends and provides service between the Applewood Village transit stop at 38th Avenue and Youngfield Street to downtown Denver along 38th Avenue. The route is a heavily used local service route to multiple destinations along the 38th Avenue corridor. Stops for this route on Kipling Street are located at 38th Avenue eastbound (near side and far side) and westbound. Route 38 runs 76 weekday trips through the area; 39 trips eastbound and 37 trips westbound. Total daily weekday ridership for Route 38 is reported as 3,967 riders (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 44

Route 44 operates weekdays and weekends between the Applewood Village transit center at 38th Avenue and Youngfield Street to downtown Denver, Union Station and Market Street Station along 44th Avenue. This local route is also heavily used and has stops on Kipling Street at 44th Avenue, eastbound and westbound. Route 44 runs 77 trips per day on weekdays within the study area; 37 trips eastbound and 40 trips westbound. Total daily weekday ridership for the route is reported as 2,124 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 52

Route 52 operates weekdays and weekends with local service between Ward Road at 64th Avenue and downtown Denver. Route 52 intersects with Route 72 along 64th Avenue, Route 100 at Kipling and 58th Avenue and Route 76 at the Olde Town

Arvada park-n-Ride. This route has stops on Kipling Street at 58th Avenue. Route 52 runs 71 weekday trips through the area; 35 eastbound and 36 westbound. Total daily weekday ridership for the route is reported as 3,217 (*RTD Ridership by Route and Stop Report, January 12, 2012).*

Route 72

Route 72 operates on weekdays and Saturdays between Ward Road at 64th Avenue and the Olde Town Arvada park-n-Ride along 64th Avenue and Ralston Road. Route 72 intersects with the 72x at 64th Avenue, Route 100 at 58th Ave and Route 76 at Ralston Road and Old Wadsworth. Route 72 has no stops on Kipling Street but serves the Old Town Arvada park-n-Ride with 53 weekday trips; 26 eastbound and 29 westbound. Total daily weekday ridership for the route is reported as 1,258 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 76

Route 76 operates on weekdays and weekends and provides north-south service between the US 36 and Broomfield park-n-Ride and Arvada, Wheat Ridge and Lakewood along Wadsworth Boulevard. This cross-town route has no stops along Kipling Street, but intersects with Routes 52, 72 and the 55x at the Olde Town Arvada park-n-Ride. Route 76 provides 85 weekday trips to the park-n-Ride; 42 northbound and 43 southbound. Total daily weekday ridership for the route is reported as 4,407 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 100

Route 100 operates on weekdays and Saturdays and provides north-south service along Kipling Street between the Westminster Center transit center at 88th Avenue and US 36 and Bowles Avenue in Littleton. This route has numerous stops along Kipling Street within the study area. Route 100 runs 39 weekday trips through the study area; 19 northbound and 20 southbound. Total daily weekday ridership on this route is reported as 1,286 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 100 is the main bus route along Kipling Street within the study area.

Bus stop on Kipling Street

Route 55x

Route 55x operates on weekdays during the peak commute hours only. Service is provided between the Olde Town Arvada park-n-Ride to downtown Denver and Union Station along Wadsworth Boulevard and I-70. There are no stops for Route 55x on Kipling Street. Route 55x runs 16 weekday trips to the Arvada park-n-Ride; 8 southbound and 8 northbound. Total daily weekday ridership for the route is reported as 329 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Route 72x

Route 72x operates on weekdays during the peak commute hours only. Service is provided between Quaker Street in Arvada to downtown Denver and Union Station with service to the Ward Road park-n-Ride. There are no stops for the 72x on Kipling Street. Route 72x runs 19 weekday trips to the Ward Road park-n-Ride; 10 eastbound and 9 westbound. Total daily weekday ridership is reported as 532 (*RTD Ridership by Route and Stop Report, January 12, 2012*).

Future Transit

The Record of Decision for the Gold Line Corridor Project dated November 2009 outlines the Gold Line rail operations plan and the Gold Line Environmental Impact Statement, RTD August 2009, outlines the complementary bus network service plan. The Gold Line Corridor is currently planned for implementation in July 2016. The rail operations are planned to include train frequencies of 7.5 minutes during the AM peak, 15 minutes in the PM Peak, and 15 minutes in the off peak. The Gold Line will operate from 4:00 AM to 12:30 AM, 365 days per year.

The future operations of the Gold Line commuter rail are summarized in **Table 17**.

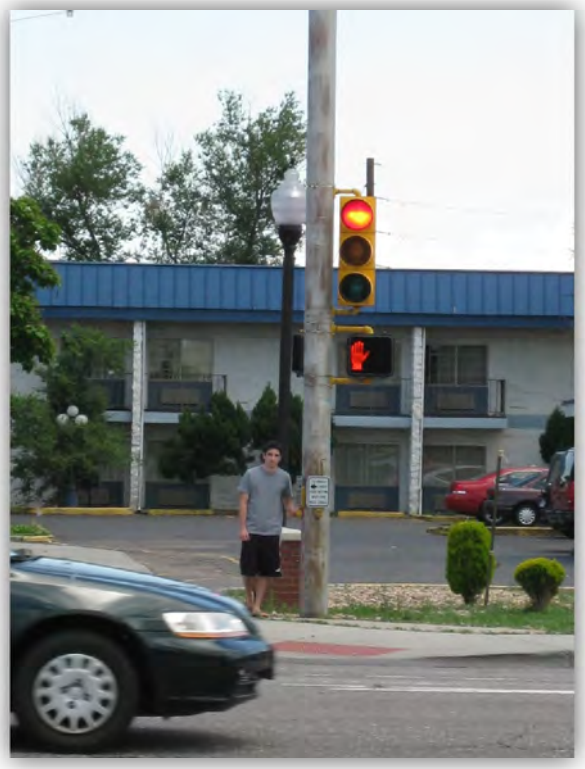
Table 17: Future RTD Gold Line Rail Operations

Hours of Operation	Service Frequency	Headway
Morning and Evening Peak Period Service– Weekdays (6:00 am – 9:00 am and 3:00 pm to 6:30 pm)	Eight/four trains per hour	7.5 minutes/15 minutes
Off-peak service – Weekdays (9:00 am -3:00 pm)	Four trains per hour	15 minutes
Early morning and Late Evening (4:00 am – 6:00 am, 6:30 pm to 12:30 am)	Two trains per hour	30 minutes
Weekend/Holidays (8:00 am -6:30 pm)	Four trains per hour	15 minutes
Weekend/Holidays (4:00 am – 8:00 am, 6:30 pm to 12:30 am)	Two trains per hour	30 minutes

Source: Record of Decision, Gold Line Corridor Project, November 2009

The RTD bus network will be modified to complement the rail system with direct and convenient access to the rail stations at Arvada Ridge, Ward Road, and Olde Town Arvada. The existing Ward Road park-n-Ride will be closed with the opening of the parking provided at the Ward Road rail station. Currently, the proposed local bus service routing within the study area is the same as today's routes; the 38, 44, 52, 72, 76, and 100.

When the Gold Line Corridor opens, it will become the trunk transit service in the area. The express and regional routes will be restructured to feed the main line. The 76x from the Olde Town Arvada park-n-Ride will be eliminated when rail service comes on line. RTD has made no proposed changes to Route 55x at this time. It is anticipated that bus service changes will be refined and reviewed with the public for consideration prior to the opening of the Gold Line rail service.



Kipling Street and South Frontage Road intersection

Pedestrian and Bicycle Conditions

Pedestrian and bicycle infrastructure conditions in the vicinity of the I-70 and Kipling interchange were inventoried for this study in March 2012.

Pedestrian Conditions

Sidewalks along Kipling Street include attached concrete sidewalk, attached asphalt sidewalk, detached concrete sidewalk, and a few segments with no sidewalk. **Figure 15** illustrates the sidewalks within the I-70 and Kipling interchange study area.

A few areas that have newer development adjacent to them have wider, detached sidewalks. There is one segment of sidewalk along Kipling Street in the study area between 44th Avenue and the South Frontage Road intersection on the east side that is attached asphalt in poor condition, although newer sidewalk exists on both ends of the section. There are two segments along Kipling Street that have no sidewalk; between 43rd and 44th Avenue on the east side of Kipling Street and between 50th Avenue and 51st Place on the east side of Kipling Street.

West side of Kipling Street under I-70 bridges

East side of Kipling Street south of interchange – attached asphalt sidewalk

The sidewalk on the west side of Kipling Street under the I-70 bridge is unusual in terms of its proximity to the bridge piers and its vertical profile.

Figure 15: Existing Sidewalk Facilities

There are several streets that intersect or are parallel to Kipling Street with no sidewalk on either side of the street including:

- North Frontage Road between Parfet Street and Oak Street
- North Frontage Road between Holland Street and Garland Street
- North Frontage Road between Garrison Street and Everett Street
- Oak Street just north of the North Frontage Road
- Independence Street between 50th Avenue and 49th Avenue
- South Frontage Road between Simms Street and Miller Street
- South Frontage Road between Holland Street and Garrison Street
- Parfet Street just south of the South Frontage Road
- 48th Avenue near the South Frontage Road
- Garland Street just south of the South Frontage Road

Pedestrian Crossings

A primary focus of the field inventory was the condition of facilities along and across Kipling Street from south of 44th Avenue to north of 51st Place. Kipling Street is a busy major arterial with a cross section of four to six lanes with turn lanes that is difficult for pedestrians to cross except at signalized intersections.

Signalized crossings of Kipling Street in the interchange study area are:

- 44th Avenue - marked as a school crossing that connects Pennington Elementary School, Compass Montessori School, and Bethany Christian Montessori School to neighborhoods on both sides of Kipling Street.
- South Frontage Road
- I-70 South Ramp - the north leg does not allow pedestrian crossings
- I-70 North Ramp - the south leg does not allow pedestrian crossings
- 49th Avenue/North Frontage Road
- 50th Avenue - intersection was recently reconstructed and includes islands on all but the northwest corner and pedestrian signal indications with count down timers for all legs of the intersection
- 51st Place

Non-directional pedestrian curb ramp at 49th Avenue/North Frontage Road intersection

There are a mix of older style curb ramps and newer style curb ramps with tactile strips along Kipling Street. There is also a mix of directional and non-directional curb ramps. Directional curb ramps are perpendicular to the curb and users generally travel perpendicular to vehicular traffic when they enter the street at the bottom of the ramp. A non-directional curb ramp consists of one ramp on each intersection corner that is located at the apex of the corner of the intersection. Users are traveling diagonal to traffic when they enter the street at the bottom of a non-directional ramp.

Directional ramps are in place at:

- The northwest and southwest corners of 51st Place/Kipling Street
- The southwest, southeast, and northeast corners of 50th Avenue/Kipling Street
- Both I-70 ramp intersections with Kipling Street

There is an unsignalized mid-block crosswalk across 50th Avenue, between Kipling Street and Independence Street in front of the Crossroads Church. Although outside the study area boudary, there is also an unsignalized mid-block crosswalk across 44th Avenue, just east of Miller Street in front of the Compass Montessori School.

Bicycle Conditions

Bicycling in the larger area surrounding the interchange is an important mode of transportation and recreation. There are few bicycle facilities in the area immediately adjacent to the I-70 and Kipling interchange. However, there are several regional trails, regional trail connectors, and several on-street facilities located in the surrounding area and there are also several park oriented trail systems with loop trails in the parks themselves that serve recreational users.

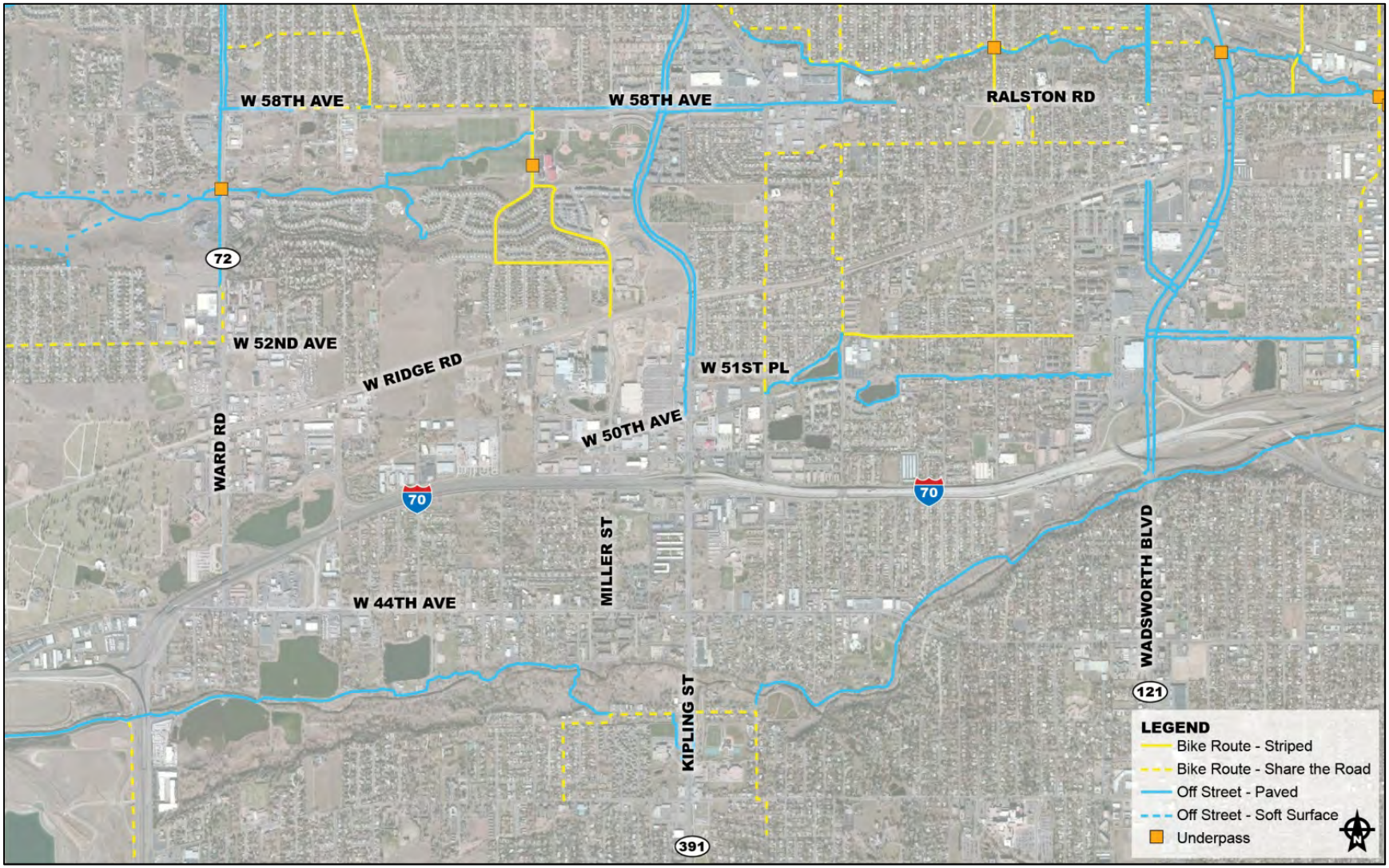
There are several important bike/multi use paths in the area as well as significant on-street facilities. Existing bicycle and multi-use facilities are shown in **Figure 16**.

Bicycle/Multi Use Paths

There are several regional trails and regional trail connections within the area surrounding the I-70 and Kipling interchange, including:

- The Clear Creek Trail - This is a regional trail that connects Golden on the west to the Platte River Trail on the east.
- The Van Bibber Creek Trail - This is a local trail system that connects Jeffco Open Space and Arvada Parks and Recreation facilities.
- The Ralston Creek Trail - This is a regional trail that connects the western part of Arvada near Colorado Highway 93 to the Clear Creek Trail on the far east side of Arvada.
- Bike path/sidewalk along the west side of Ward Road between 52nd Avenue and 58th Avenue - This is a local trail that connects the Van Bibber trail system to neighborhoods to the south and north.
- Bike path/sidewalk along Kipling north of 51st Place - This is the beginning of a proposed regional type connector along Kipling Street. It currently connects the Arvada Ridge development near 51st Place to neighborhoods to the north.

Figure 16: Existing Bike and Multi-use Facilities



On-Street Bicycle Lanes and Routes

There are no bike lanes provided on Kiplilng Street. However, there are several on-street bicycle facilities within the area around the interchange, including:

- Independence Street/Garrison Street/57th Avenue bicycle route - This local bike route connects neighborhoods in Arvada.
- Miller Street/Parfet Street/54th Avenue bike lanes - This system of bike lanes connects residential areas north of 58th Street to the commercial areas near Ridge Road/Kipling Street.
- 52nd Avenue bike lanes between Garrison Street and Allison Street - These bike lanes connect the commercial area near Wadsworth Boulevard to neighborhoods to the west.

Pedestrian and Bicycle Planning

There are several planning documents related to bicycle and pedestrian infrastructure that apply to the study area including:

- Arvada Pedestrian and Bicycle Transit Oriented Development (TOD) Access Plan (December 2009)
- City of Wheat Ridge Bicycle and Pedestrian Master Plan (July 2010)
- Draft Jefferson County Bicycle and Pedestrian Master Plan (December 2011)

Each of these plans has proposed infrastructure improvements in the area but most importantly, each calls for the construction of improved bicycle and pedestrian facilities along Kipling Street north and south of the I-70 interchange, including bicycle lanes and sidewalk/multi-use path improvements.

Trail along west side of Kipling Street south of Ridge Road

Area Transportation Projects

There are no current transportation improvement projects within the area immediately adjacent to the I-70 and Kipling interchange. However, there are a number of engineering and planning efforts taking place in the near term within the larger area surrounding the interchange. Each of these programmed improvements is shown in **Figure 17**.

These projects will be considered as part of the base condition when improvement alternatives are identified for this project. The projects include only those projects that have committed funding sources.

Kipling Multi-Use Path, 32nd Avenue to 44th Avenue

Project includes the construction of a new detached, multi-use trail on the east side of Kipling Street.

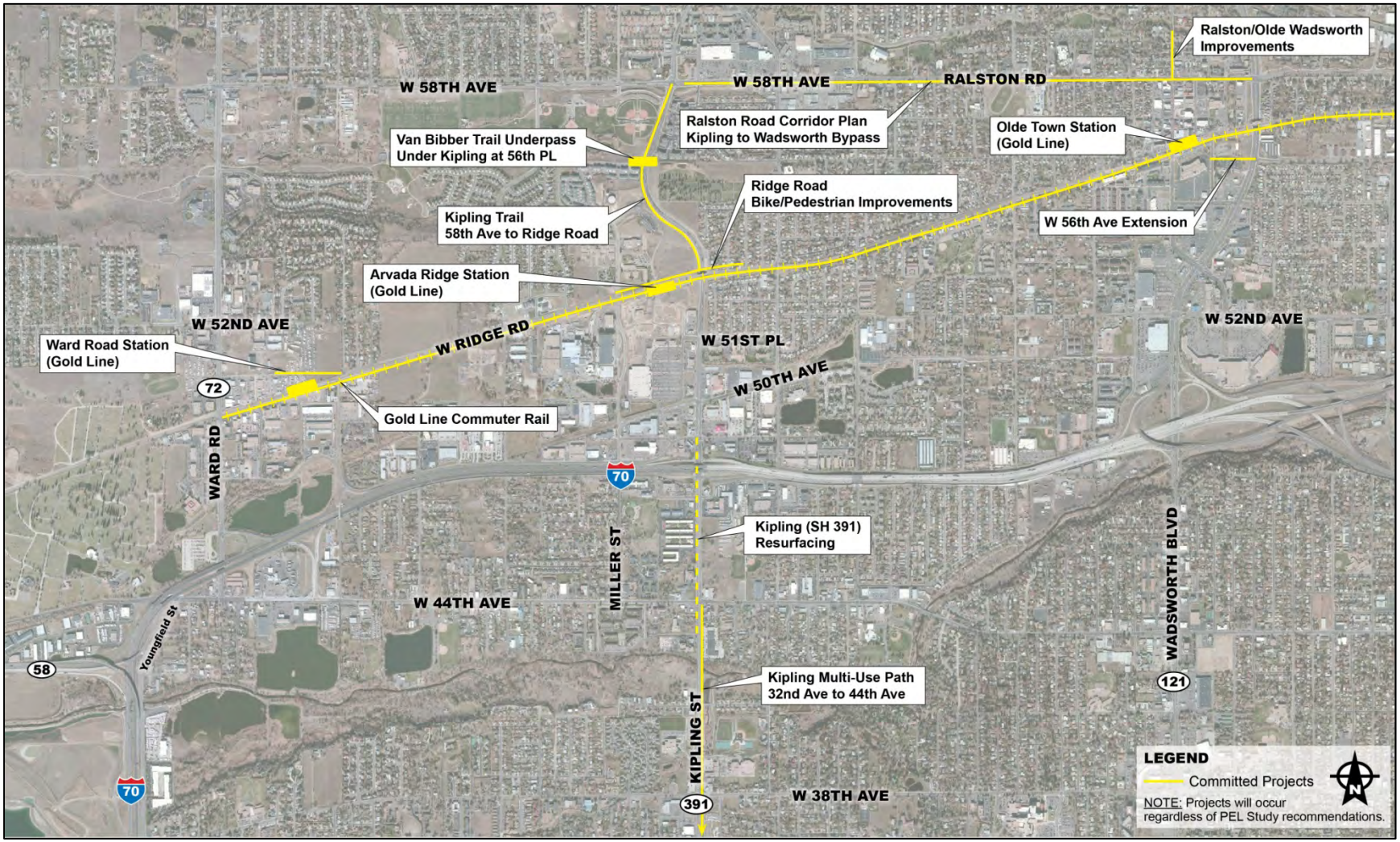
Kipling Trail, 58th Avenue to Ridge Road

The project includes construction of a new detached, multi-use trail connection on the west side of Kipling Street as part of the TOD Access Plan for the Gold Line Arvada Ridge rail station.

Ridge Road Bike/Pedestrian Improvements

The project includes widening Ridge Road to provide an improved bicycle and pedestrian connection to the Gold Line Arvada Ridge rail station.

Figure 17: Committed Area Transportation Projects



RTD Gold Line

The commuter rail project includes future parking and transportation connection improvements at three stations surrounding the I-70 and Kipling interchange, at the Arvada Ridge Station (at Kipling Street and Ridge Road), Ward Road Station, and Olde Town Station.

Van Bibber Trail Underpass

This includes a new underpass of Kipling Street at 56th Place to provide a connection for the residential areas east of Kipling to the recreational areas and Van Bibber Trail west of Kipling.

Ralston Road Corridor Plan

This planning project includes recommendations and preliminary design for multimodal transportation improvements along Ralston Road between Kipling Street and Wadsworth Bypass.