Revised Final
Alternatives Development and Analysis Report



I-70 & Kipling Interchange | PEL Study

I-70 & Kipling Interchange
PEL Study

June 2013

CDOT Project No. C 0703-333(16549)

Revised Final
Alternatives Development and Analysis Report

June 2013

Prepared for:

Colorado Department of Transportation
4670 Holly Street
Denver, Colorado 80222

Prepared by:

David Evans and Associates, Inc.
1331 17th Street, Suite 900
Denver, Colorado 80202

In association with:

ArLand Land Use Economics

OV Consulting

Tsiouvaras Simmons Holderness

Table of Contents

Introduction 1
Study Area 1
Purpose and Need 3
Purpose of the Project 3
Need for Interchange Improvements 3
Alternatives Evaluation Process 8
Agency and Public Coordination 9
Initial Alternatives Development 10
Level 1 (Purpose and Need) Alternatives Screening 12
Level 2 Alternatives Screening 12
Level 3 Alternatives Refinement 13
Next Steps 14
Level 1 Alternatives Screening 15
Level 1 Alternatives 15
Level 1 Screening Evaluation 20
Level 1 Screening Results 25
Level 2 Alternatives Screening 29
Level 2 Alternatives 29
Alternative Conceptual Layout 30
Level 2 Performance Measures 31
Level 2 Screening Results 38
Level 3 Alternatives Screening 86
Level 3 Alternatives 86
Initial Level 3 Screening 91
Alternatives Refinement 93

Appendix A – Conceptual Design Parameters

Appendix B – Level 2 Screening Matrix

List of Figures

Figure 1: Study Area 2
Figure 2: Display of Interchange Needs 7
Figure 3: Area Transportation Projects in No Action Alternative 11
Figure 4: Overall Project Process 14
Figure 5: Level 1 Screening Matrix 21
Figure 6: Alternatives Eliminated from Further Consideration 26
Figure 7: Alternatives Eliminated as a Stand-Alone Alternative 27
Figure 8: Alternatives Carried Forward 28
Figure 9: No Action 40
Figure 10: Alternative 1 - Single Point Urban Interchange (SPUI) 43
Figure 11: Alternative 3 - Diamond with Roundabout at Ramps & Frontage Road 46
Figure 12: Alternative 4 - Diamond with Six-Leg Roundabout at Ramps & Frontage Roads 49
Figure 13: Alternative 6 - Fully Directional Interchange 52
Figure 14: Alternative 7 - Partial Cloverleaf with Loops Southwest & Northeast Quadrants 55
Figure 15: Alternative 9 - Partial Cloverleaf with Loops Southwest & Northwest Quadrants 58
Figure 16: Alternative 11 - Texas Frontage Road Diamond 61
Figure 17: Alternative 12 - Traditional Diamond 64
Figure 18: Alternative 17 - Button Hook Ramps 67
Figure 19: Alternative 21 - Michigan Lefts for Ramps 70
Figure 20: Alternative 31 - Single Roundabout Interchange 73
Figure 21: Alternative 33 - Southwest Quadrant & Improved Westbound Ramps 76
Figure 22: Alternative 34 - Improved Tight Diamond with Southbound to Eastbound Flyover 79
Figure 23: Alternative 35 - Double Crossover Diamond Interchange 82
Figure 24: Alternative 36 - Button Hook Ramps South and Improved Westbound Ramps 85
Figure 25: Alternative 1 – Single Point Urban Interchange 87
Figure 26: Alternative 7 – Partial Cloverleaf with Loops SW & NE Quadrants 88
Figure 27: Alternative 12 – Traditional Diamond 89
Figure 28: Alternative 17 – Button Hook Ramps 90

Looking north along Kipling Street towards I-70

Introduction

Alternatives Development and Analysis Report

This report documents the development and analysis of alternatives for improvement of the Interstate 70 (I-70) and Kipling Street (State Highway [SH] 391) interchange. The Colorado Department of Transportation (CDOT) initiated a Planning and Environmental Linkages (PEL) Study to develop a range of improvements to reduce congestion and improve operations and safety at the I-70 and Kipling Street interchange. A thorough and inclusive technical and public process helped to identify and screen a wide range of improvement alternatives.

This study was conducted following Federal Highway Administration (FHWA) PEL guidance regarding the integration of transportation planning and the National Environmental Policy Act (NEPA) process, which encourages the use of planning studies to provide information for incorporation into future NEPA documents. The goal of these early integrated planning efforts is to streamline subsequent alternatives analysis during the NEPA process(es).

Study Area

The study area, illustrated in **Figure 1**, is focused around the area of most likely physical impacts of interchange improvements. The I-70 and Kipling Street interchange is located within the City of Wheat Ridge in Jefferson County. The boundary for the City of Arvada is located immediately north of the interchange between the 50th Avenue and 51st Avenue intersections. The study area limits include I-70 from Ward Road to Wadsworth Boulevard. On Kipling Street, the study area limits are 44th Avenue to 51st Place.

The interchange is located in a predominantly urban area and provides access to well-established commercial, residential and light industrial areas, as well as areas identified for urban renewal and new transit-oriented development in Wheat Ridge and Arvada.

Figure 1: Study Area

Kipling Street and westbound I-70 ramps intersection

Purpose and Need

CDOT in cooperation with local communities and other agencies is preparing this PEL study to identify and assess potential transportation improvements at the I-70 and Kipling Street interchange. Thorough documentation of the process and recommendations is a critical element of the PEL process so the decisions can be used in future NEPA process(es). This Purpose and Need was developed in coordination with agency stakeholders with review by the general public.

The specific needs, summarized below and in **Figure 2**, are based on the analysis and findings documented in this report and in separate documents prepared as part of this project, including the *Existing Transportation Conditions Report* (May 2012) and *Purpose and Need Statement* (May 2012).

Purpose of the Project

The purpose of the I-70 and Kipling Street interchange project is to reduce congestion, optimize operations, improve safety, and accommodate multimodal connections at the I-70 and Kipling Street interchange.

Need for Interchange Improvements

The existing design and configuration of the interchange no longer accommodates travel demands. Kipling Street is an important transportation corridor supporting mobility and economic activity in Jefferson County, including the cities of Wheat Ridge and Arvada. Improvements are needed to:

- Meet current and future traffic demands
- Improve operational efficiency of the interchange
- Improve traveler safety through the interchange
- Accommodate multimodal connections

Capacity and Operations

High traffic volumes and frequent congestion issues occur within the study area on Kipling Street north of the interchange and on I-70 east of the interchange. I-70 carries approximately 147,000 vehicles daily east of the Kipling Street interchange as measured by traffic counts taken in 2010. Existing daily traffic on Kipling Street collected for this project south of I-70 is approximately 42,000 vehicles, while north of I-70 the existing daily traffic is about 48,000 vehicles. By 2035, the average daily traffic (ADT) on I-70 is expected to increase about 25% to approximately 184,000 vehicles east of the Kipling Street interchange and the ADT on Kipling Street is expected to increase about 15% to about 55,000 vehicles north of I-70.

The interchange at I-70 and Kipling Street was constructed in 1967. Although it served the communities and traffic conditions when it was constructed, the tight diamond configuration with closely-spaced frontage road intersections can no longer effectively handle current or future traffic demands.

Problems at the interchange have the potential to redirect traffic and create operational and capacity issues on other local roadways.

Existing traffic volumes at the interchange create operating conditions characterized by restricted movements and recurring back ups. Specific movements that currently exhibit operational problems include the peak turning movements from the Westbound I-70 Off Ramp and the AM peak traffic backs up along Kipling Street on the southbound approaches to the interchange.

Many drivers making the right turn from the Westbound I-70 Off Ramp desire to turn left at the Kipling Street and 49th Avenue/North Frontage Road intersection, located 375 feet north of the ramp. There are currently signs that indicate the right turn lane as a continuous acceleration lane, but there are right turning drivers that stop in the continuous flow lane in order to wait for a gap in traffic to get to the northbound left turn lane at 49th Avenue. This reduces the capacity of the ramp signal and causes traffic to queue up the off ramp and onto the I-70 mainline.

Close spacing between frontage road intersections and interchange ramps does not provide adequate distance between traffic signals for traffic to progress through the interchange. Because of the relatively high overall intersection volumes, turn phases and a long signal cycle length are needed during the peak hours. These required signal operations combined with the over-capacity traffic volume conditions create vehicle queues that spill back from the I-70 ramp signals through the adjacent intersections at the frontage roads. Traveling through the four ramp and frontage road traffic signals with queues backing up through intersections requires drivers to slow their speeds through the interchange area, which further limits the capacity of the entire interchange area and adversely affects through traffic on Kipling Street.

The recurring congestion contributes to the difficulties for unfamiliar drivers to maneuver through the interchange area.

Because of the interchange location (on the edge of the I-70 mountain corridor) and the services provided (fuel, food, and lodging), many of the drivers using the interchange to and from the freeway are unfamiliar with the area. There is also a relatively high percentage of single unit trucks within the interchange area, providing area business service deliveries. The overall traffic operations are largely dependent on how easy it is for trucks and unfamiliar drivers to navigate the interchange and access the adjacent businesses.

South of I-70, the numerous driveways and unrestricted median encourages uncontrolled turns across Kipling Street that both increase potential for conflicts (and crashes) and disrupt traffic flow. Side-by-side opposing left turn lanes introduce multiple conflict points and create confusion because of the uncertainty of when and where drivers will enter the median lanes. In addition, drivers stopped in the turn lanes block the view of traffic in the through lanes, resulting in drivers making unsafe turns across through traffic. All of these conditions contribute to turbulence in the Kipling Street traffic flow and reduce its capacity.

Safety

The proposed action is needed to improve traveler safety through the interchange, including vehicles, pedestrians, and bicyclists.

Traffic Safety

The segment of I-70 at the Kipling Street interchange is above the average expected crash rate for the given average annual daily traffic (AADT). The occurrence of rear end crashes on I-70 in the vicinity of the interchange is closely tied to the heavy peak hour traffic volumes on the freeway. Over a three year period from 2008 through 2010, the majority of crashes on the four interchange ramps occurred on the eastbound on ramp and the westbound off ramp and the majority of the crashes were rear end crashes during the PM peak hour. On the westbound off ramp, the majority of the 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.

Many of the crashes along Kipling Street in the study area occur because of congestion, the close signal spacing, driver weaving and lane-changing maneuvers.

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

- Rear-end crashes – related to congestion and frequent traffic signals 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

Pedestrian and Bicycle Safety

High traffic volumes and deficient pedestrian and bicycle facilities create safety concerns for pedestrians and bicyclists traveling through the study area. The interchange presents a particular challenge. The sidewalk on both sides of Kipling Street under the I-70 bridge is uncomfortable to use because of the proximity to the bridge piers and congested traffic lanes. The sidewalk on the west side of Kipling Street under the bridge also has steep sidewalk grades.

Over a three year period from 2008 through 2010, along Kipling Street in the study area, there were three crashes involving pedestrians and three crashes involving

bicycles. One of the pedestrian and one of the bicycle crashes occurred at the Kipling Street and 44th Avenue intersection. Two of the crashes involving bicycles occurred at the Kipling Street and South Frontage Road intersection. One of the pedestrian crashes occurred at the westbound I-70 ramps intersection.

The lack of access control along Kipling Street contributes to pedestrian and bicycle safety concerns. Along Kipling Street, pedestrians and bicyclists must cross many driveways where turning drivers are focused on entering or exiting Kipling Street and are not attentive to potential pedestrian conflicts.

Multimodal Connections

Effective multimodal connections provide direct links between facilities and accommodate efficient connections between modes.

Automobiles, trucks, pedestrians, bicyclists, and buses travel through the I-70 interchange and Kipling Street lacks adequate facilities to accommodate effective connections. Effective multimodal connections provide direct links between facilities, such as existing sidewalks and multiuse paths, as well as accommodate efficient connections between modes, such as sidewalks at bus stops or multiuse paths leading to/from a rail station.

Transit Operations

Existing transit service on I-70 and Kipling Street in the study area includes local and express bus routes operated by the Regional Transportation District (RTD). RTD also plans to implement commuter rail transit along Ridge Road as part of the Gold Line commuter rail project, planned for completion in 2016. A commuter rail station with associated transit-oriented development is planned at Ridge Road west of Kipling Street. With the opening of the commuter rail as currently planned, the proposed local bus service will remain the same as today. However, ridership for the bus route on Kipling Street serving the new rail station is expected to increase.

Buses, like other vehicles, will experience increased delays traveling through the interchange I-70 and Kipling Street interchange area as traffic volumes increase. Buses also contribute to congestion by regularly stopping in the outside through-traffic lane, causing a temporary reduction in roadway capacity.

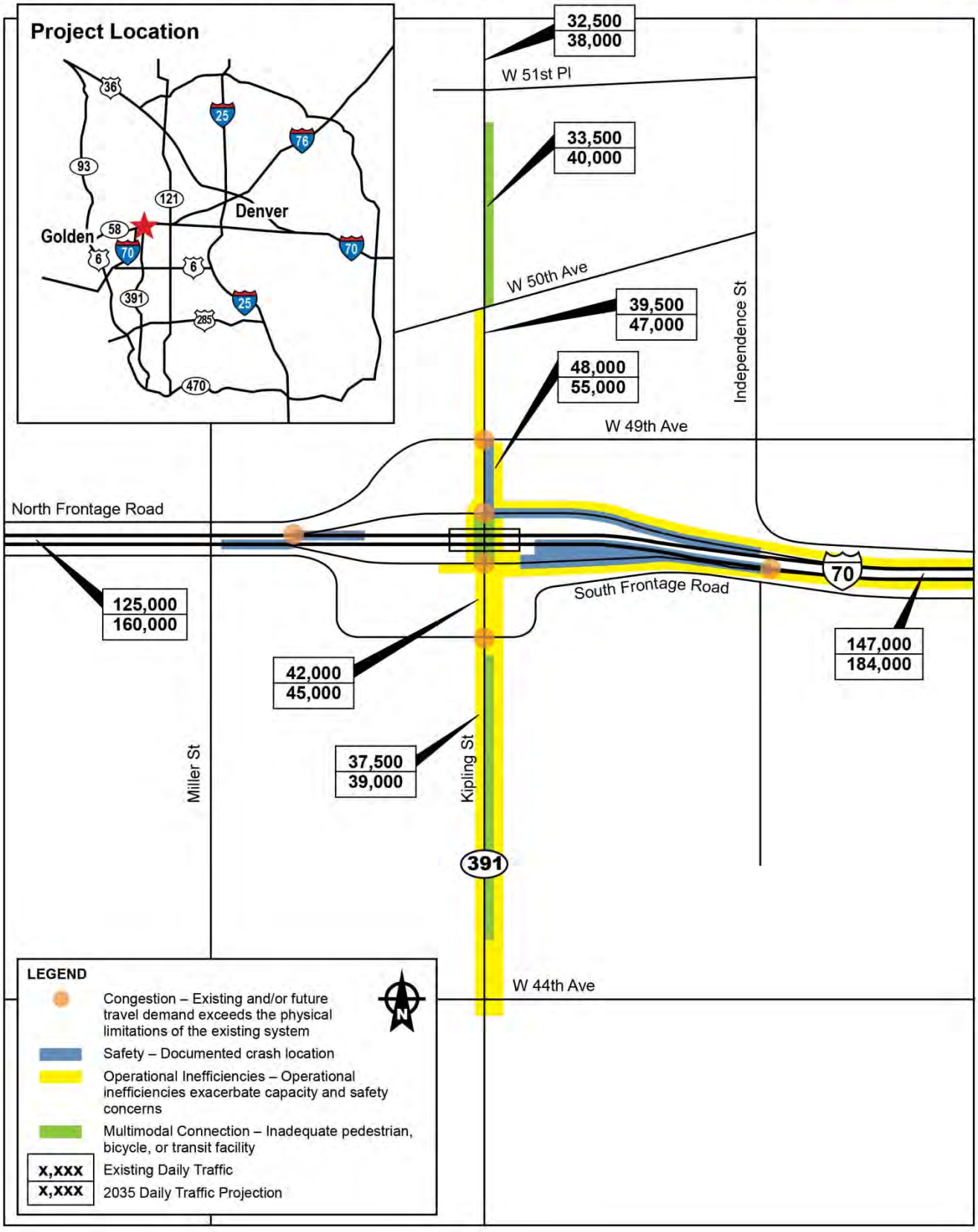
Pedestrian and Bicycle Facilities

Local and regional plans identify the need for pedestrian and bicycle improvements to the Kipling Street corridor and its crossing of I-70. These needs will become more critical as the volume of pedestrian and bicycle travel is anticipated to increase after the opening of the Gold Line commuter rail station at Ridge Road.

Pedestrian and bicycle connections will become more critical with the opening of the Gold Line communter rail station north of the study area.

Most of the existing sidewalks within the study area are attached to the roadway curb, not buffered from travel lanes, and are often too narrow to accommodate both pedestrian and bicycle use. The sidewalk on both sides of Kipling Street under the I-70 bridge is perceived to be unsafe by pedestrians because of the proximity to the bridge piers and congested traffic lanes. A segment of sidewalk between 44th Avenue and the South Frontage Road on the east side is attached, with narrow asphalt pavement in poor condition. There is no sidewalk on the east side of Kipling Street between 50th Avenue and 51st Place.

Figure 2: Display of Interchange Needs



Looking south along Kipling Street towards I-70

Alternatives Evaluation Process

An objective in pursuing this study was to work with stakeholders to analyze and develop a range of short- and long-term improvements to reduce congestion and improve operational performance and safety at the interchange. The alternatives development and evaluation process included developing screening criteria based on the project Purpose and Need, developing a full range of reasonable alternatives, and documenting the elimination of alternatives to limit the need for consideration during future NEPA process(es).

The alternatives development and evaluation process followed the provisions of the regulations of the Council on Environmental Quality (CEQ) (40 CFR 1500-1508).

General alternative concepts were developed and subjected to a Level 1 "fatal flaw" screening to eliminate alternatives that do not meet the project Purpose and Need. Those alternatives that were carried forward for further evaluation were compared to each other in a Level 2 evaluation. The alternatives remaining after the Level 2 evaluation will be further refined through conceptual design in Level 3 for final recommendation in the project PEL Study Report. The final recommendations may include large-scale improvements with short- and long-term elements, as well as separate, short-term improvements.

During the project initiation period, baseline data were collected for the physical, operational, and environmental conditions of the area surrounding the I-70 and Kipling Street interchange. This information led to the development of the project Purpose and Need, presented earlier in this report.

Evaluation criteria were established for the Level 1 and Level 2 screening, prior to the development of alternatives. These criteria were developed by CDOT based on the project Purpose and Need. The project Technical Team, comprised of FHWA, RTD, Denver Regional Council of Governments (DRCOG), and the local agencies, were consulted during the development of evaluation criteria and ultimately concurred with the evaluation criteria in accordance with the chartering agreement established at the beginning of the PEL process. Technical Team members also concurred with the Purpose and Need.

Agency and Public Coordination

Understanding the ideas, perspectives, and needs of key stakeholders in the interchange area is critical to building broadly supported decisions and solutions. Stakeholder involvement throughout the process is critical, soliciting feedback from the community at key decision points to foster acceptance of recommendations.

In an effort to gain as much community input as possible, public and local agency participation was emphasized throughout the study process. It was important that all participants, including potential users of the interchange and roadways in the vicinity, clearly understand the details of each alternative design. Specific tasks were included in the project for creation of a project website and graphics to illustrate proposed improvement alternatives, operational characteristics, appearance, impacts, and costs.

CDOT provided multiple opportunities for the local jurisdictions, regional partners, resource agencies, and general public to engage and inform the study.

This study held two public meetings to introduce the project and discuss interchange travel conditions and the need for improvement, and to present alternatives and preliminary analysis results. A final public notice is planned to describe the recommended improvements and document final public comment on study recommendations.

Community Focus Groups were formed to advise the project team of the concerns of various groups of stakeholders in the area. Three separate focus groups were formed, including representatives from:

- Businesses surrounding the interchange area
- Residents and homeowners' associations
- Multimodal groups

The project team, comprised of CDOT and project consultant staff, met with each focus group two times during the alternatives evaluation to review proposed improvement alternatives and evaluation criteria and to discuss likely impacts of improvements and possible mitigation or resolution techniques.

The study was coordinated with State and Federal resource agencies with an introduction to the PEL process and requests for input on the existing conditions and concerns within the study area. Recommendations for interchange improvements were also coordinated to identify potential resource impacts and next steps required for future NEPA process(es).

The study included the formation of a Technical Team that met frequently with the project team to provide technical input. The Technical Team included staff from CDOT, the cities of Arvada and Wheat Ridge, Jefferson County, Denver Regional DRCOG, RTD, and FHWA. The Technical Team was heavily involved in shaping the alternatives evaluation criteria and performance measures, as well as the alternatives that were considered. Members of the Technical Team kept their respective elected officials updated and brought elected official feedback to the project team. The evaluation criteria, performance measures, alternatives development, and alternatives screening were reviewed and approved by the Technical Team throughout the study agency coordination process.

Initial Alternatives Development

CEQ defines reasonable alternatives as those that are economically and technically feasible, and that show evidence of common sense.

The set of reasonable alternatives were developed to address the interchange's largest issues identified in the Purpose and Need, including the close signal spacing along Kipling Street, the weave movement between the ramp and frontage road intersections, the queuing conditions on the Westbound I-70 Off Ramp, and the merging conditions for the Eastbound I-70 On Ramp. Managed lane configurations were not considered because the scope of this study does not incude through capacity improvements to I-70 or Kipling Street.

The initial improvement alternatives considered for the I-70 and Kipling Street interchange were developed based on input from the Technical Team, public input, and the technical input of the project team. Overall, alternatives discussed focused on interchange alternatives that accommodate high traffic volumes and improve safety within a developed urban area with limited right-of-way.

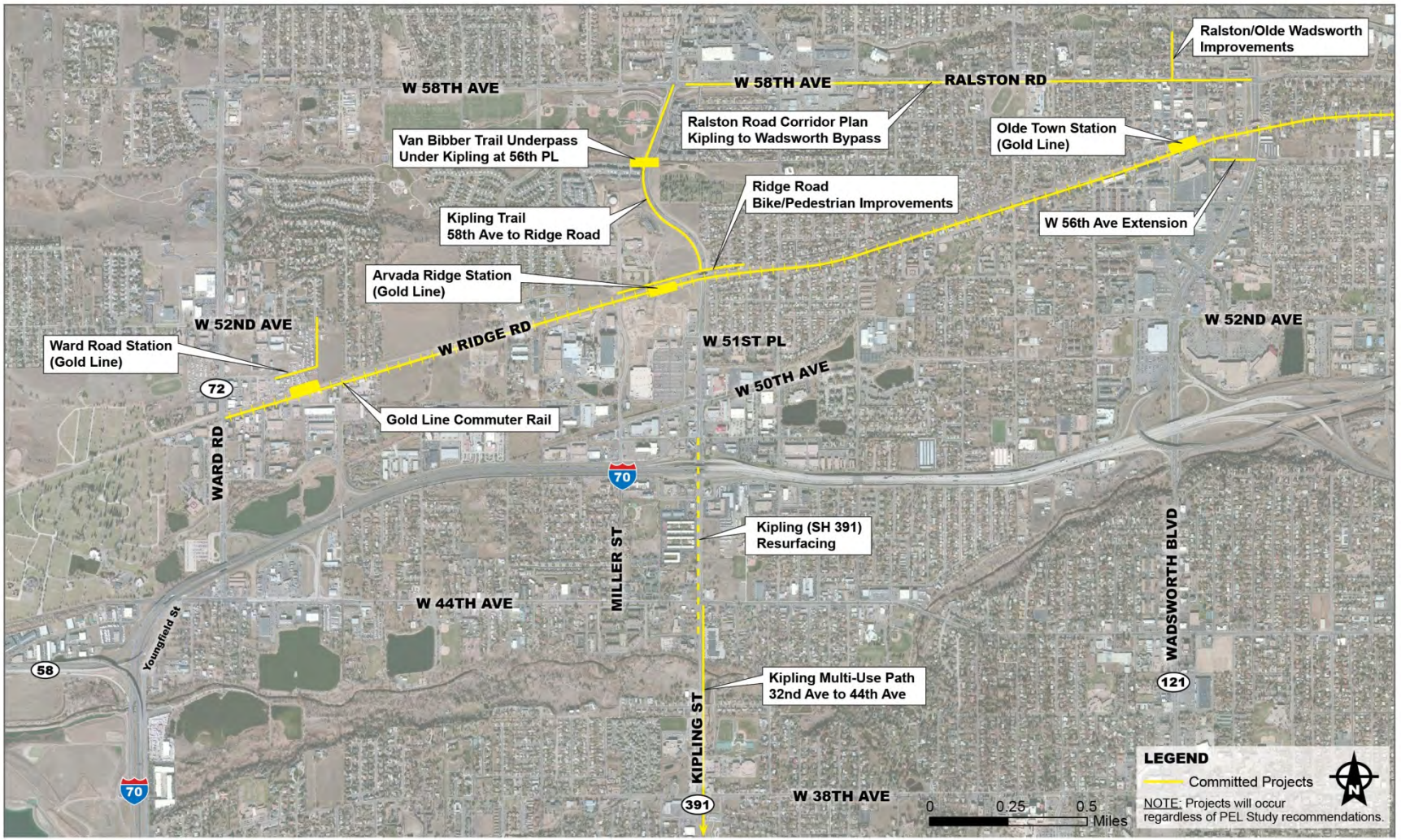
No Action Alternative

Improvements to the pedestrian and bicycle connections through the interchange will become more critical with the opening of the Gold Line commuter rail line and construction of new multi-use trails north and south of the interchange.

The No Action alternative does not meet the Purpose and Need. The No Action alternative is included as a baseline for comparison to the action alternatives. Under the No Action alternative, only improvements that are already planned and funded by CDOT, the County, or cities would be completed. 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 with committed funding sources is shown in **Figure 3**. Although some of these projects are outside the defined study area, they will impact regional travel through the interchange and are considered part of the No Action alternative.

- **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 Transit-Oriented Development (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.
- **RTD Gold Line** - The commuter rail project includes future parking and transportation connection improvements at three stations surrounding the I-70 and Kipling interchange: the Arvada Ridge Station (at Kipling Street and Ridge Road), Ward Road Station, and Olde Town Station.
- **Van Bibber Trail Underpass** - This includes an underpass of Kipling Street at 56th Place connecting the residential areas east of Kipling to the recreational areas and Van Bibbler Trail west of Kipling.
- **Ralston Road Corridor Plan** - This planning project includes preliminary design for multimodal transportation improvements along Ralston Road between Kipling Street and Wadsworth Bypass.

Figure 3: Area Transportation Projects in No Action Alternative



Level 1 (Purpose and Need) Alternatives Screening

Level 1 screening was supported by the baseline data collected at the initiation of the study.

Level 1 screening identified a range of interchange improvements that could meet the project Purpose and Need, while eliminating concepts from detailed consideration that had "fatal flaws" (that did not meet Purpose and Need).

Level 1 screening criteria were developed to screen concepts in the following areas: traffic operations, safety, and multimodal connections. Alternative concepts were evaluated with a "Yes" or "No" answer to the following questions to demonstrate each alternative's ability to meet the project Purpose and Need.

- Traffic Operations:
  - Can the alternative meet current and future traffic demands?
  - Does the alternative improve operations by addressing the interaction of the Kipling interchange with the frontage road intersections?
- Safety:
  - Does the alternative improve existing conditions that contribute to higher than expected crash rates?
- Multimodal Connections:
  - Can the alternative accommodate bicycle, pedestrian, and transit connections through the interchange?

An alternative with a "No" answer to any of the above questions was considered to not meet the project Purpose and Need and was eliminated as a stand-alone solution. At this level of screening, it was determined that some small-scale alternatives eliminated as a stand-alone alternative could be included as elements of larger-scale alternatives in Level 2 screening.

Level 2 Alternatives Screening

The purpose of the Level 2 evaluation was to complete additional and more detailed analysis to determine whether or not each alternative meets the Purpose and Need, compare how well each alternative would perform, and identify what impacts each alternative would have. The Level 2 evaluation expanded measures for each of the criteria from Level 1 screening and provided a method for comparing alternatives.

Alternatives carried forward from the Level 1 screening were reviewed and refined to add more definition to the proposed improvements, to better understand the operational benefits and costs of the alternatives, and to provide information for further assessment in the Level 2 evaluation. The Level 2 screening was a more detailed evaluation of the alternatives that passed the Level 1 screening.

The alternatives were compared to determine how each alternative met the following evaluation criteria relative to each other:

- Optimize operations and reduce congestion

  - Measures considered improvements to operations and reduction in congestion on I-70, Kipling Street, and the ramps through the interchange

- Improve traveler safety
  - Measures considered the ability to improve multimodal safety within the interchange area by addressing the weave movement between the ramp and frontage road intersections, the queuing conditions on the Westbound I-70 Off Ramp, and the merging conditions for the Eastbound I-70 On Ramp

- Accommodate multimodal connections
  - Measures addressed the relative level of accommodation for multimodal connections through the interchange

- Avoid and minimize environmental impacts
  - Measures considered the magnitude of anticipated environmental impacts, such as noise receptors, hazardous material sites, and community resources

- Avoid and minimize community impacts
  - Measures considered the magnitude of anticipated community impacts, such as right-of-way needed, property impacts, access and circulation, and conformance with local plans

- Maximize constructability
  - Measures addressed the practicability for implementation when considering constructability issues, cost, phasing, maintenance, and foreseeable funding for short- and long-term improvements

Specific performance measures were developed to compare each alternative against the evaluation criteria and the project Purpose and Need. These performance measures, described in the Level 2 Screening section of this report, are a mix of qualitative and quantitative assessments, based on the criteria and the availability of data at this stage of development.

Level 3 Alternatives Refinement

Further steps are being taken to refine the conceptual design elements of the recommended alternatives, considering design solutions to minimize costs and community impacts and maximize operational benefits. This third level of screening considers more detailed interchange operations relative to impacts to the community, environment, and constructability considerations.

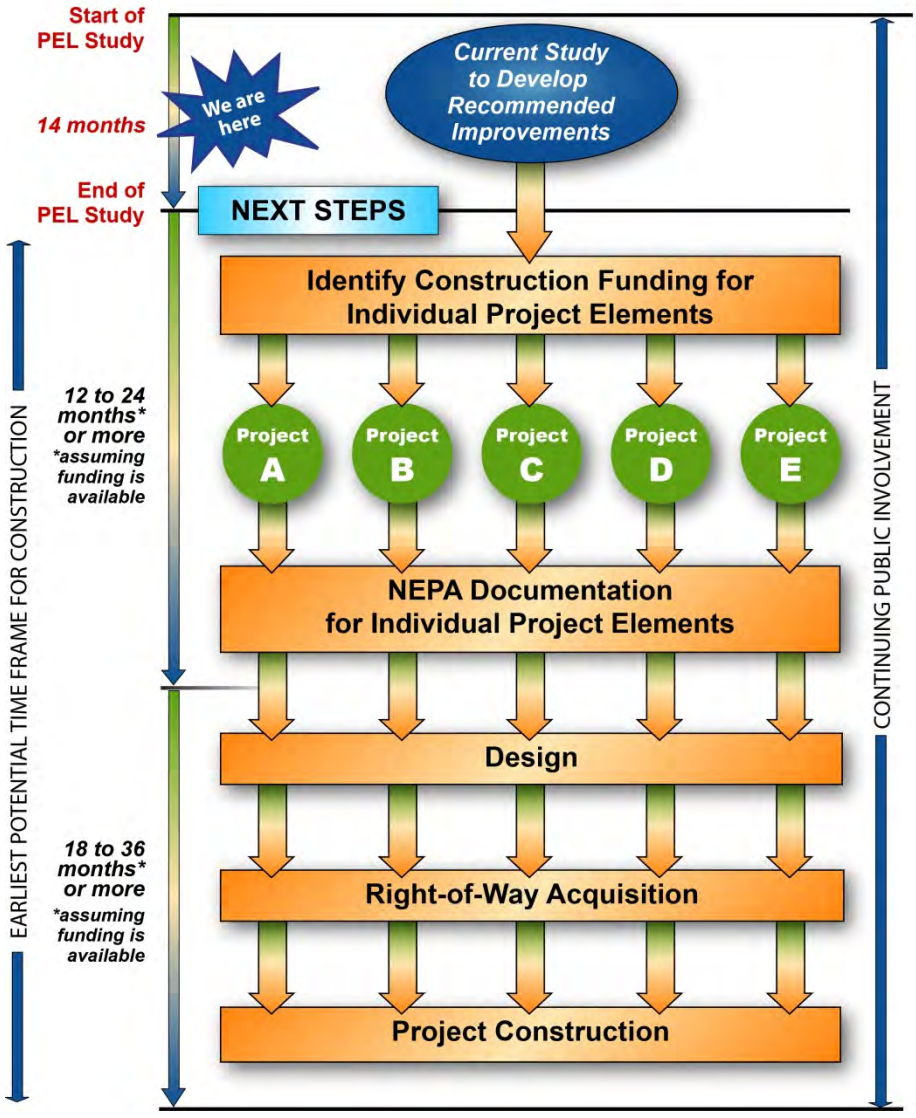
The final PEL study recommendations will include large-scale improvements and/or separate, short-term improvements. Long-term recommendations will likely have short-term project elements identified as phases or stand-alone projects.

Next Steps

Following completion of this Alternatives Development and Analysis Report, review by the Technical Team and resource agencies, and receipt of public input at the second public meeting, a PEL Report will be prepared. This report will document the final interchange improvement recommendations, prioritization of improvements, and funding considerations. The final PEL study recommendations will be presented in a final public project newsletter. Comments received from the final public notice will be documented so that remaining public concerns can be addressed in conjunction with subsequent NEPA process(es).

Individual projects may be initiated as funding becomes available for elements of the recommended alternative. It is anticipated that these improvement projects could move forward with individual NEPA processes, with this PEL Study providing the documentation of the intent to implement the full set of interchange improvements over time, as funding becomes available. **Figure 4** illustrates this overall project process.

Figure 4: Overall Project Process



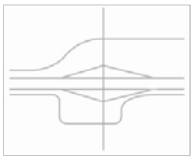
Kipling Street at eastbound I-70 ramps intersection

Level 1 Alternatives Screening

The initial range of improvement options included changes in interchange layout as well as small-scale lane configurations and multimodal-focused enhancements. A variety of alternatives were identified for consideration, focusing on the interchange's largest issues identified in the Purpose and Need, including the close signal spacing along Kipling Street, the weave movement between the ramp and frontage road intersections, the queuing conditions on the Westbound I-70 Off Ramp, and the merging conditions for the Eastbound I-70 On Ramp. Managed lane configurations were not considered because the scope of this study does not incude through lane capacity improvements to I-70 or Kipling Street.

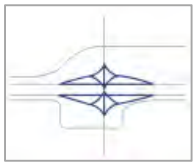
Level 1 Alternatives

Given the interchange setting and the largest needs, the following concepts, in addition to the No Action alternative, were considered as described and illustrated.



No Action

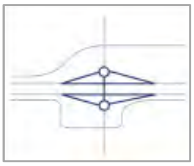
The No Action alternative is included as a baseline for comparison to the action alternatives. Under the No Action alternative, only programmed improvements that are planned and funded by CDOT, the County, or cities would be completed, as described earlier in this report.



Alternative 1 – Single Point Urban Interchange (SPUI)

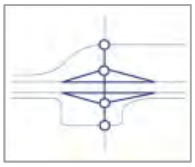
This alternative was considered because it may address issues associated with the close signal spacing on Kipling Street by eliminating one traffic signal. It consists of a new interchange configuration with diamond type ramps that intersect at a single signalized intersection on Kipling Street serving all movements to/from the I-70 ramps and the Kipling Street through movements.

Alternative 2 – Diamond with Roundabouts at Ramps



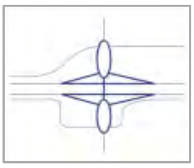
This alternative was considered because it may address the issues associated with the close signal spacing on Kipling Street by eliminating two traffic signals. It consists of a new interchange configuration with diamond type ramps and two multilane roundabouts on Kipling Street at the ramp intersections. The frontage road intersections remain as signalized intersections.

Alternative 3 – Diamond with Roundabouts at Ramps & Frontage Roads



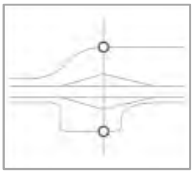
This alternative was considered because it may address issues associated with the close signal spacing on Kipling Street by eliminating four traffic signals. It consists of a new interchange layout with diamond type ramps and a series of four multilane roundabouts on Kipling Street at the ramps and frontage road intersections.

Alternative 4 – Diamond with Six-Leg Roundabout at Ramps & Frontage Rds



This alternative was considered because it may address issues associated with the close signal spacing on Kipling Street by eliminating four traffic signals. It consists of a new interchange layout with diamond type ramps and two multilane roundabouts on Kipling Street providing movements for the ramps and frontage roads.

Alternative 5 – Diamond with Roundabouts at Frontage Roads



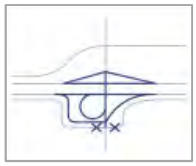
This alternative was considered because it may address the issues associated with the close signal spacing on Kipling Street by eliminating two traffic signals. It consists of a new interchange configuration with diamond type ramps and two multilane roundabouts on Kipling Street at the frontage road intersections. The ramp intersections remain as signalized intersections.

Alternative 6 – Fully Directional

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange configuration with multiple levels of directional ramps and no signals for ramp movements. The frontage road intersections would require some modification.

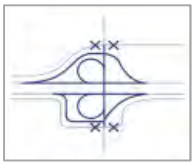
Alternative 7 – Partial Cloverleaf with Loops SW & NE Quadrants

This alternative was considered because it may address the issues associated with the close signal spacing on Kipling Street by eliminating two traffic signals and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange configuration with a loop ramp in the southwest and northeast quadrants providing free-flow operations for the left turn movements from Kipling Street to eastbound and westbound I-70. The frontage road intersections would require some modification.



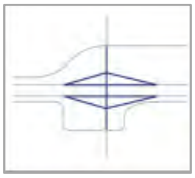
Alternative 8 – Partial Cloverleaf with Loop SW Quadrant

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating one traffic signal. It consists of a new interchange layout with a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70. The South Frontage Road intersection would require some modification.



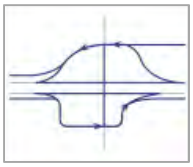
Alternative 9 – Partial Cloverlead with Loops SW & NW Quadrants

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating two traffic signals and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange configuration with a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and a loop ramp in the northwest quadrant providing free-flow operations for the left turn from the westbound off ramp to southbound Kipling Street. The frontage road intersections would require some modification.



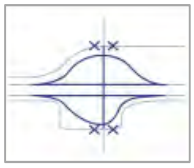
Alternative 10 – Improved Tight Diamond with Lanes on Kipling & Ramps

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp and other congested movements through the interchange. It consists of the current diamond interchange configuration with diamond type ramps and four signalized intersections on Kipling Street with additional turn lanes on the ramps and on Kipling Street through the interchange.



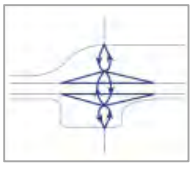
Alternative 11 – Texas Frontage Road Diamond

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating two traffic signals and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange configuration with diamond type ramps and frontage road access provided directly to/from the freeway ramps for full access to Kipling Street.



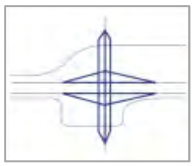
Alternative 12 – Traditional Diamond

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by increasing traffic signal spacing and/or eliminating traffic signals at the frontage roads. It consists of the current diamond interchange configuration with diamond type ramps and two signalized intersections on Kipling Street serving the ramps with increased spacing between the ramp traffic signals. The frontage road intersections would require some modification.



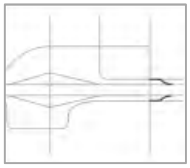
Alternative 13 – Double Crossover Diamond

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp. It consists of a new interchange configuration with diamond type ramps and the Kipling Street movements shifted to the other side of the street under the bridge to allow left turn movements that do not cross traffic.



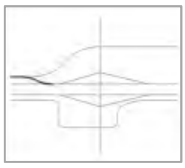
Alternative 14 – Three-Level Diamond

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp and other congested movements through the interchange. It consists of a new interchange layout with diamond ramps and multiple levels to separate the Kipling Street through movements from the ramp and frontage road intersections.



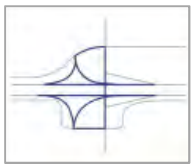
Alternative 15 – Half Diamond to East at Garrison

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp. It consists of the existing diamond interchange with new diamond type ramps added at Garrison Street for Westbound I-70 Off Ramp and Eastbound I-70 On Ramp movements. No other changes are made to the existing interchange.



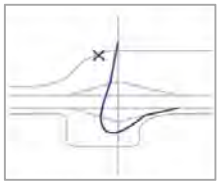
Alternative 16 – New WB Off Ramp West of Kipling

This alternative was considered because it may address the issues associated with the weave movement between the Westbound I-70 Off Ramp and North Frontage Road intersection. It consists of the existing diamond interchange with a new diamond ramp added west of Kipling Street for the Westbound I-70 Off Ramp movement northwest of the interchange. No other changes are made to the existing interchange.



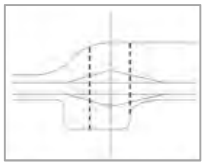
Alternative 17 – Button Hook Ramps

This alternative was considered because it may address the issues associated with the close signal spacing on Kipling Street by eliminating two traffic signals, may address queuing conditions on the Westbound I-70 Off Ramp, and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange layout with the I-70 ramp intersections on the frontage roads and access to Kipling Street via the frontage road traffic signals. The existing ramps on the east side of Kipling Street remain.



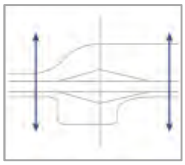
Alternative 18 – SB to EB Flyover Ramp

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp and southbound Kipling Street approaching the interchange. It consists of the existing diamond interchange with diamond type ramps and four signalized intersections on Kipling Street with a flyover ramp serving the heavy movement from southbound Kipling Street to eastbound I-70. No other changes are made to the existing interchange.



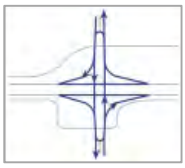
Alternative 19 – Bike Path I-70 Grade Separations at Interchange

This alternative was considered because it provides multimodal connection enhancements. It consists of the existing diamond interchange with grade-separated multiuse path connections at the interchange east and west of Kipling Street. No other changes are made to the existing interchange.



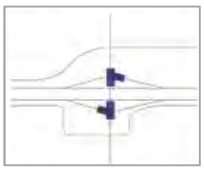
Alternative 20 – Local Road I-70 Grade Separation at Miller & Independence

This alternative was considered because it provides multimodal connection enhancements. It consists of the existing diamond interchange with grade-separated street connections at Miller Street and Independence Street east and west of Kipling Street. No other changes are made to the existing interchange at Kipling Street.



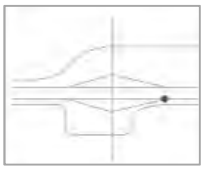
Alternative 21 – Michigan Lefts for Ramps

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp and other congested movements through the interchange. It consists of a new interchange configuration with diamond type ramps and left turns restricted at the ramp intersections, so drivers must turn right then do a U-turn at the frontage road intersection.



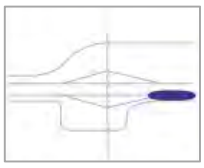
Alternative 22 – Added Turn Lanes for Ramps

This alternative was considered because it may address queuing conditions on the Westbound I-70 Off Ramp and other congested movements through the interchange. It consists of the existing diamond interchange with addedl turn lanes at the ramp intersections. No other changes are made to the existing interchange.



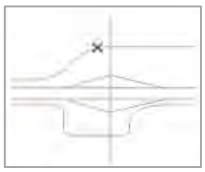
Alternative 23 – Ramp Meter Modifications

This alternative was considered because it may address issues with the merging conditions for the Eastbound I-70 On Ramp. It consists of the existing diamond interchange with changes at the eastbound I-70 ramp meter, consisting of added lanes at the ramp meter. No other changes are made to the existing interchange.



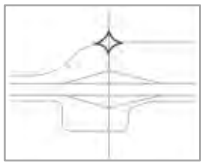
Alternative 24 – EB Ramp Merge Lane Modifications

This alternative was considered because it may address the issues associated with the merging conditions for the Eastbound I-70 On Ramp. It consists of the existing diamond interchange with changes at the eastbound I-70 ramp merge, consisting of a longer merge lane. No other changes are made to the existing interchange.



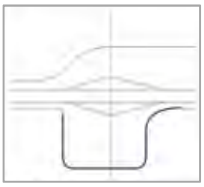
Alternative 25 – Close West Side of 49th Ave

This alternative was considered because it may address issues from the weave movement from the Westbound I-70 Off Ramp to North Frontage Road intersection. It consists of the existing diamond interchange and closing the west side of the North Frontage Road intersection. No other changes are made to the interchange.



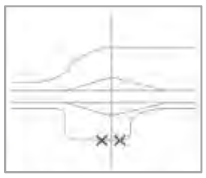
Alternative 26 – Remove 49th Ave Signal

This alternative was considered because it may address issues from the weave movement from the Westbound I-70 Off Ramp to North Frontage Road intersection. It consists of the existing diamond interchange and removing the North Frontage Road traffic signal. Right-in and right-out movements are provided at the intersection. No other changes are made to the existing interchange.



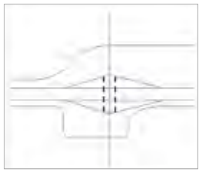
Alternative 27 – Realign South Frontage Road Further South

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street. It consists of the existing diamond interchange and realigning the South Frontage Road further south, at least 600 feet from the eastbound I-70 ramp. No other changes are made to the existing interchange.



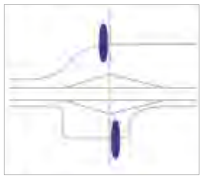
Alternative 28 – Close South Frontage Road at Kipling

This alternative was considered because it may address the issues associated with close signal spacing on Kipling Street by eliminating one traffic signal. It consists of the existing diamond interchange with the South Frontage Road closed at Kipling Street. No other changes are made to the existing interchange.



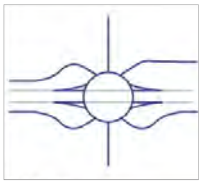
Alternative 29 – Widen/Improve Paths under I-70 Bridge

This alternative was considered because it provides multimodal connection enhancements. It consists of the existing diamond interchange with improved sidewalks under the bridge. No other changes are made to the existing interchange.



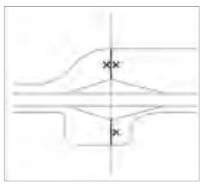
Alternative 30 – Bus Pullouts

This alternative was considered because it provides multimodal connection enhancements. It consists of the existing diamond interchange with bus pullouts provided at the transit stops north and south of the interchange. No other changes are made to the existing interchange.



Alternative 31 – Single Roundabout Interchange

This alternative was considered because it may address queuing conditions on the Westbound I-70 Off Ramp and eliminates the weave movement between the ramp and frontage road intersections. It consists of a new interchange layout with a single roundabout providing one-way movements at the ramps and frontage roads.



Alternative 32 – Close Driveways between Ramps and Frontage Roads

This alternative was considered because it provides multimodal connection enhancements. It consists of the existing diamond interchange with closing the driveways between the ramps and frontage roads north and south of the interchange. No other changes are made to the existing interchange.

Level 1 Screening Evaluation

The wide range of alternatives developed were evaluated against the Level 1 screening criteria to identify fatal flaws related to the project Purpose and Need. Alternatives that received a fatal flaw rating on any of the criteria elements (that is, one or more "No" responses) were eliminated from further consideration as a stand-alone alternative. The Level 1 Screening and Analysis Matrix is shown in **Figure 5** on the following pages. The reasons for elimination related to the Purpose and Need are shown in the summary of results.

Figure 5: Level 1 Screening Matrix

Category	Level 1 Screening Criteria	NA No Action	1 Single Point Urban Interchange (SPUI)	2 Diamond with Roundabouts at Ramps	3 Diamond with Roundabouts at Ramps & Frontage Roads	4 Diamond with Six-Leg Roundabout at Ramps & Frontage Roads	5 Diamond with Roundabouts at Frontage Roads	6 Fully Directional	7 Partial Cloverleaf with Loops SW & NE Quadrants	8 Partial Cloverleaf with Loop SW Quadrant	9 Partial Cloverleaf with Loops SW & NW Quadrants	10 Improved Tight Diamond - Added Lanes on Kipling & Ramps
Traffic Operations	Can the alternative meet current and future traffic demands?	**NO** does not meet current and future traffic demands at the interchange	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
	Does the alternative improve operations by addressing the interaction of the Kipling interchange with the frontage road intersections?	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** operational issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**YES**	**NO** operational issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**YES**	**NO** operational issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain
Safety	Does the alternative improve existing and future No Action conditions that contribute to higher than expected crash rates?	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**YES**	**NO** safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**YES**	**NO** safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain
Multimodal Connections	Can the alternative accommodate bicycle, pedestrian, and transit connections through the interchange?	**NO** No change to inadequate connections through the interchange	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
SUMMARY OF RESULTS		**Carried Forward:** Baseline Comparison	**Carried Forward**	**Eliminated:** Does not meet Purpose and Need because it does not address the operational & safety issues of the weave movement between WB I-70 Off Ramp & N. Frontage Rd	**Carried Forward**	**Carried Forward**	**Eliminated:** Does not meet Purpose and Need because it does not address the operational & safety issues of the weave movement between WB I-70 Off Ramp & N. Frontage Rd	**Carried Forward**	**Carried Forward**	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the weave movement between WB I-70 Off Ramp & N. Frontage Rd	**Carried Forward**	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd
NOTES			Addresses issues associated with the close signal spacing on Kipling by eliminating one signal		Addresses issues associated with the close signal spacing on Kipling by eliminating four signals and addresses safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd	Addresses issues associated with the close signal spacing on Kipling by eliminating four signals and addresses safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd		Addresses the queuing conditions on the WB I-70 Off Ramp and may eliminate the weave movement between WB I-70 Off Ramp and N. Frontage Rd	Addresses issues associated with close signal spacing on Kipling by eliminating two signals and eliminates the weave movement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; Addresses issues associated with close signal spacing on Kipling by eliminating one signal	Addresses issues associated with close signal spacing on Kipling by eliminating two signals and eliminates the weave movement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; May address queuing conditions on the WB I-70 Off Ramp

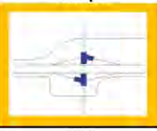
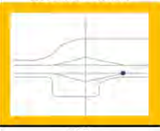
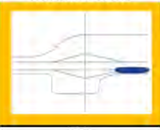
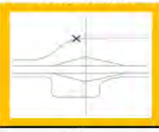
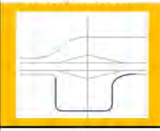
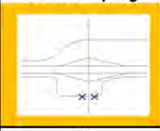
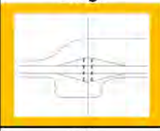
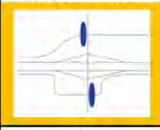
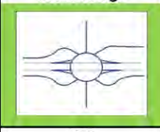
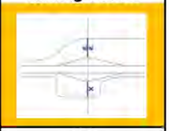
Green = Carried Forward
Yellow = Eliminated as a Stand-Alone Alternative
Red = Eliminated

Figure 5: Level 1 Screening Matrix (continued)

Category	Level 1 Screening Criteria	11 Texas Frontage Road Diamond	12 Traditional Diamond	13 Double Crossover Diamond	14 Three-Level Diamond	15 Half Diamond to East at Garrison	16 New WB Off Ramp West of Kipling	17 Button Hook Ramps	18 SB to EB Flyover Ramp	19 Bike Path I-70 Grade Separations at Interchange	20 Local Road I-70 Grade Separation at Miller and Independence	21 Michigan Lefts for Ramps
Traffic Operations	Can the alternative meet current and future traffic demands?	YES	YES	YES	YES	NO does not meet current and future traffic demands at the interchange	NO does not meet current and future traffic demands at the interchange	YES	YES	NO does not meet current and future traffic demands at the interchange	NO does not meet current and future traffic demands at the interchange	YES
	Does the alternative improve operations by addressing the interaction of the Kipling interchange with the frontage road intersections?	YES	YES	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	YES	NO operational issues from close signal spacing remain	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	YES
Safety	Does the alternative improve existing and future No Action conditions that contribute to higher than expected crash rates?	YES	YES	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	YES	NO safety issues from close signal spacing remain	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	NO safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	YES
Multimodal Connections	Can the alternative accommodate bicycle, pedestrian, and transit connections through the interchange?	YES	YES	YES	YES	NO No change to inadequate connections through the interchange	NO No change with connections through the existing interchange	YES	NO No change with connections through the existing interchange	YES	NO No change with connections through the existing interchange	YES
SUMMARY OF RESULTS		Carried Forward	Carried Forward	Eliminated as a Stand-Alone: Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd	Eliminated: Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd	Eliminated: Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	Eliminated: Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	Carried Forward	Eliminated as a Stand-Alone: Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & does not provide adequate multimodal connections	Eliminated as a Stand-Alone: Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd	Eliminated: Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	Carried Forward
NOTES		Addresses issues associated with close signal spacing on Kipling by eliminating two signals and eliminates the weave movement between WB I-70 Off Ramp and N. Frontage Rd	Addresses issues associated with close signal spacing on Kipling by increasing signal spacing and/or eliminating signals at the frontage road	May be carried forward as an element of another alternative; May address queuing conditions on the WB I-70 Off Ramp	Removing minor amount of through traffic on Kipling does not substantially reduce intersection volumes at the ramps and frontage roads	Removing minor amount of local traffic to/from east of Kipling does not substantially reduce interchange volumes	Removing minor amount of WB I-70 traffic bound for west of Kipling does not substantially reduce interchange volumes	Addresses issues associated with close signal spacing on Kipling by eliminating two signals and eliminates the weave movement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; May address queuing conditions on the WB I-70 Off Ramp	May be carried forward as an element of another alternative; May address multimodal connection enhancements		Addresses issues associated with close signal spacing on Kipling by eliminating two signals and addresses queuing conditions on WB I-70 Off Ramp and other congested movements through the interchange

Green = Carried Forward
Yellow = Eliminated as a Stand-Alone Alternative
Red = Eliminated

Figure 5: Level 1 Screening Matrix (continued)

Category	Level 1 Screening Criteria	22 Added Turn Lanes for Ramps	23 Ramp Meter Modifications	24 EB Ramp Merge Lane Modifications	25 Close West Side of 49th Avenue	26 Remove 49th Avenue Signal (closure or RIRO)	27 Realign South Frontage Road Further South	28 Close South Frontage Road at Kipling	29 Widen/Improve Paths Under I-70 Bridge	30 Bus Pullouts	31 Single Roundabout Interchange	32 Close Driveways Between Ramps and Frontage Roads
												
Traffic Operations	Can the alternative meet current and future traffic demands?	**YES**	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**NO** does not meet current and future traffic demands at the interchange	**YES**	**NO** does not meet current and future traffic demands at the interchange
	Does the alternative improve operations by addressing the interaction of the Kipling interchange with the frontage road intersections?	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**YES**	**NO** operational issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** operational issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** operational issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain
Safety	Does the alternative improve existing and future No Action conditions that contribute to higher than expected crash rates?	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from close signal spacing and queuing condition on WB I-70 Off Ramp remain	**NO** safety issues from close signal spacing and queuing condition on WB I-70 Off Ramp remain	**NO** safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain	**YES**	**NO** safety issues from close signal spacing and weave movement between WB I-70 Off Ramp and N. Frontage Rd remain
Multimodal Connections	Can the alternative accommodate bicycle, pedestrian, and transit connections through the interchange?	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**NO** No change with connections through the existing interchange	**YES**	**YES**	**YES**	**YES**
SUMMARY OF RESULTS		**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the close signal spacing & weave between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address safety issues of close signal spacing & queuing conditions on WB I-70 Off Ramp & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address safety issues of close signal spacing & queuing conditions on WB I-70 Off Ramp & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the weave movement between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address the operational & safety issues of the weave movement between WB I-70 Off Ramp & N. Frontage Rd & does not provide adequate multimodal connections	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd	**Carried Forward**	**Eliminated as a Stand-Alone:** Does not meet Purpose and Need because it does not address operational & safety issues of close signal spacing & weave movement between WB I-70 Off Ramp & N. Frontage Rd
NOTES		May be carried forward as an element of another alternative; May address queuing conditions on the WB I-70 Off Ramp	May be carried forward as an element of another alternative; May address merging conditions on the EB I-70 On Ramp	May be carried forward as an element of another alternative; May address merging conditions on the EB I-70 On Ramp	May be carried forward as an element of another alternative; May address issues with weave movement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; May address issues with weave movement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; May address issues with close signal spacing on Kipling	May be carried forward as an element of another alternative; May address issues with close signal spacing on Kipling	May be carried forward as an element of another alternative; May address multimodal connection enhancements	May be carried forward as an element of another alternative; May address multimodal connection enhancements	Address queuing conditions on the WB I-70 Off Ramp and eliminates the weave mvoement between WB I-70 Off Ramp and N. Frontage Rd	May be carried forward as an element of another alternative; May address multimodal connection enhancements

Green = Carried Forward
Yellow = Eliminated as a Stand-Alone Alternative
Red = Eliminated

Intentionally blank page.

Level 1 Screening Results

Project Purpose and Need:

- Meet current and future traffic demands
- Improve operational efficiency of the interchange
- Improve traveler safety through the interchange
- Accommodate multimodal connections

Six alternatives were eliminated from further consideration because they do not meet the project Purpose and Need for reasons stated in Figure 5 in the "summary of Results" row. These are illustrated in **Figure 6**.

It was determined that some small-scale alternatives eliminated as a stand-alone alternative could be included as elements of larger-scale alternatives in Level 2 screening. The 15 alternatives eliminated from consideration as stand-alone alternatives are shown in **Figure 7**. These relatively small-scale improvements may provide benefit as elements of large-scale improvements in Level 2 screening.

The 12 alternatives carried forward for consideration in Level 2 screening (including the No Action alternative) are shown in **Figure 8**.

Figure 6: Alternatives Eliminated from Further Consideration

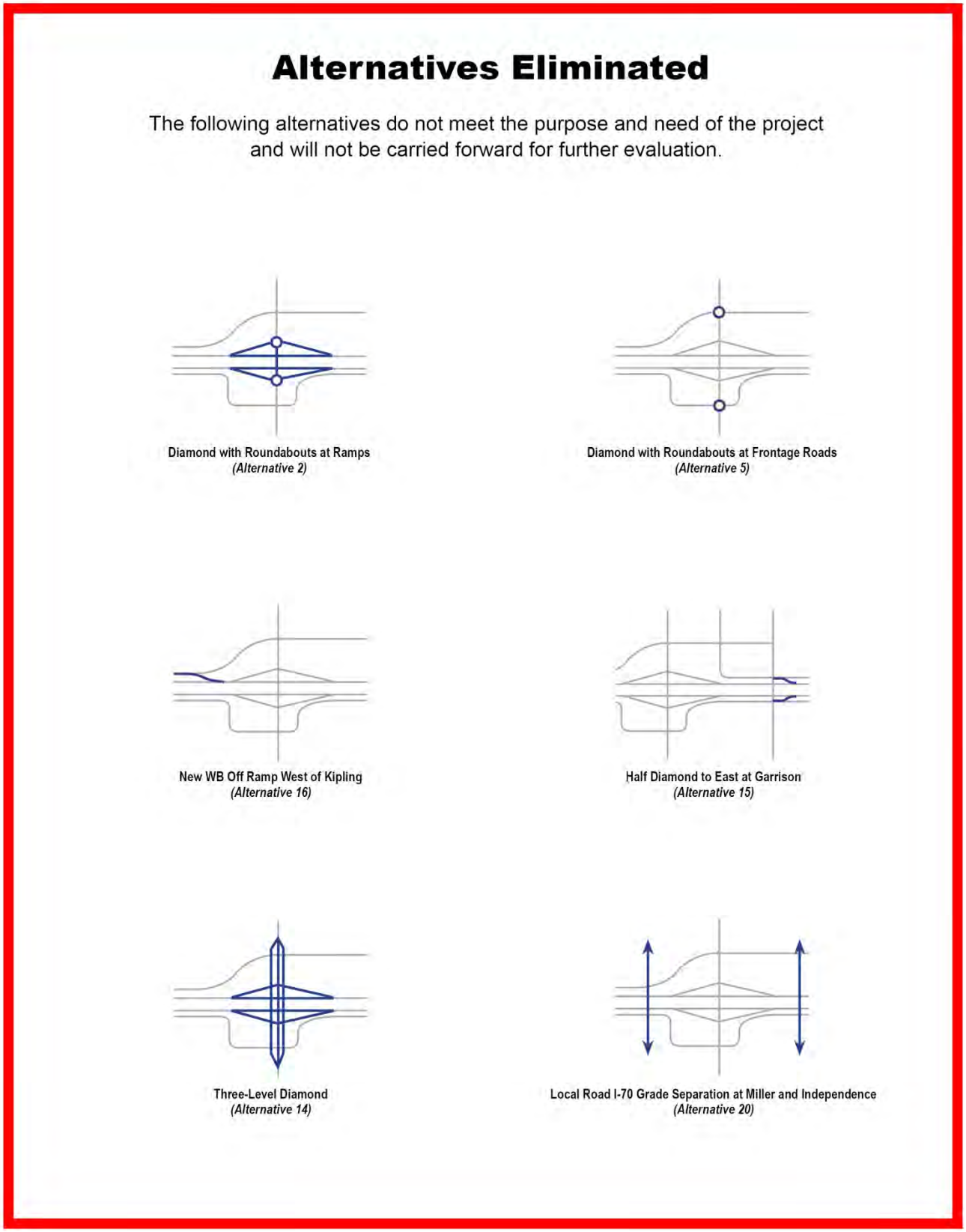


Figure 7: Alternatives Eliminated as a Stand-Alone Alternative

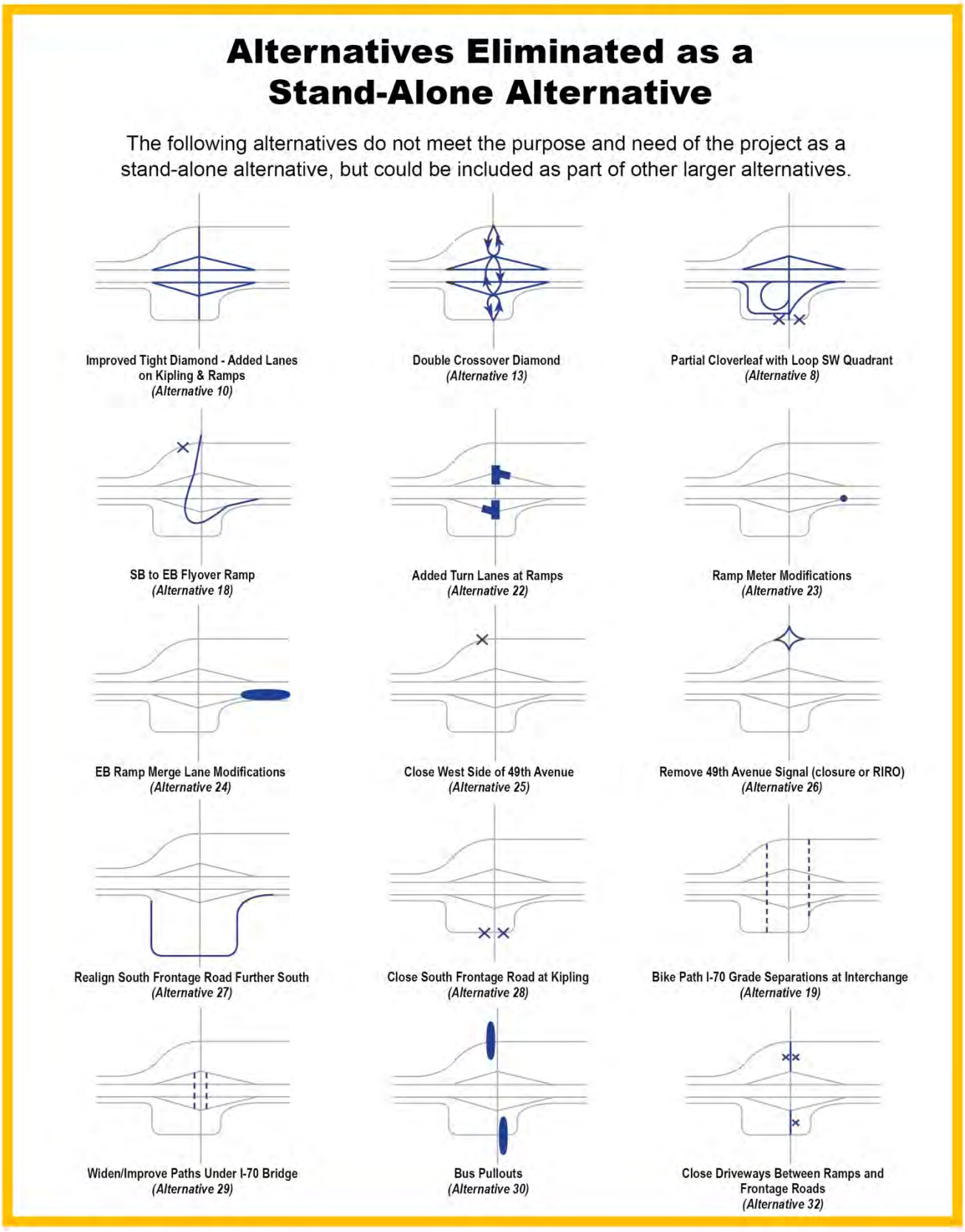
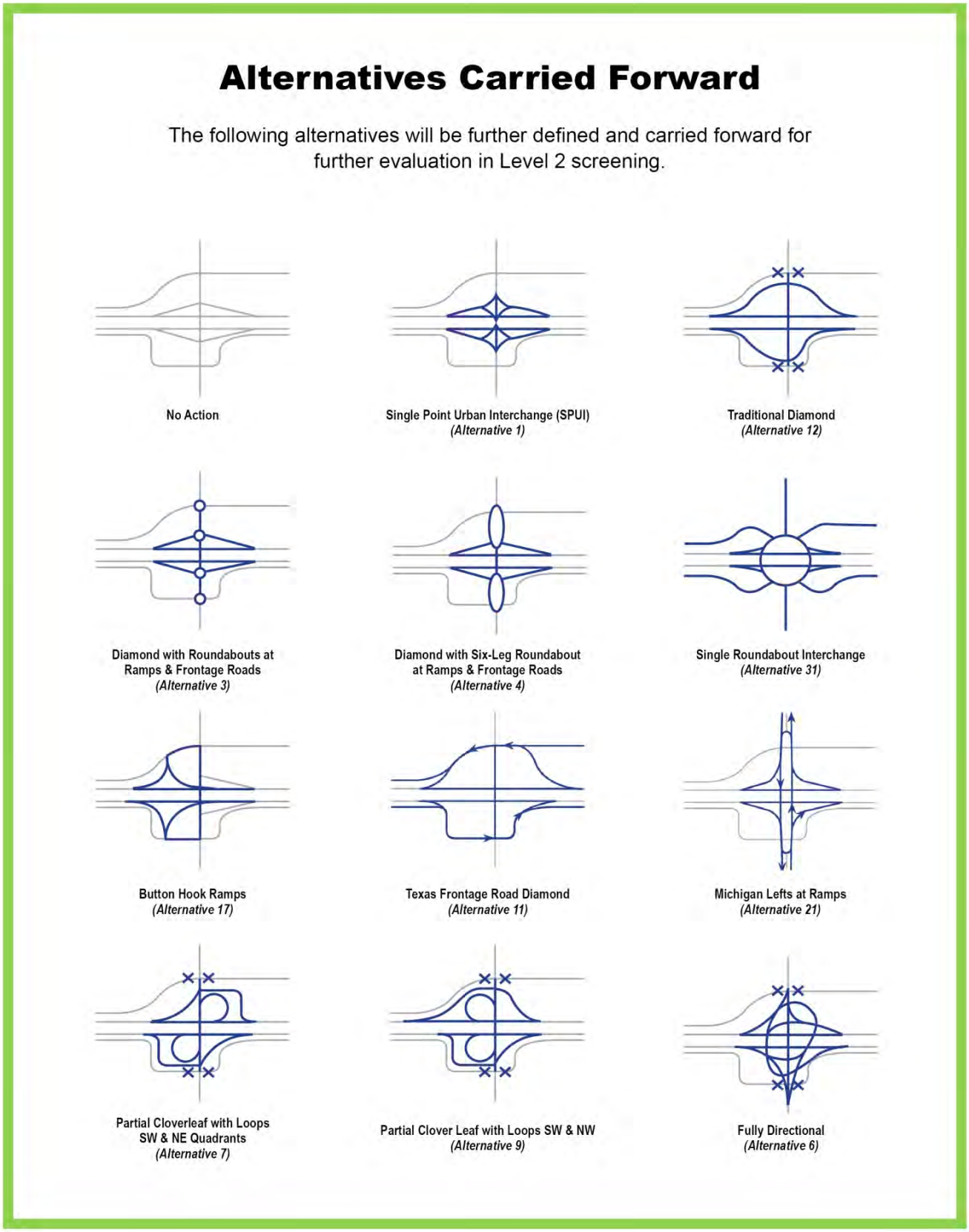
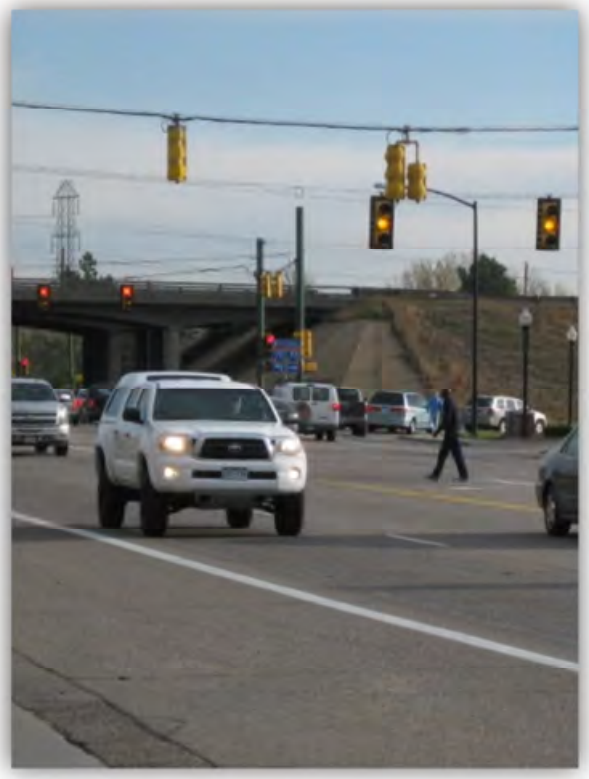


Figure 8: Alternatives Carried Forward





Kipling Street and South Frontage Road intersection

Level 2 Alternatives Screening

Alternatives from the Level 1 screening that were recommended for further evaluation were refined to add more definition of the proposed improvements, to better understand the operations and costs of the alternatives, and to provide information for further assessment in the Level 2 evaluation. The purpose of the Level 2 evaluation was to complete additional and more detailed analysis to determine whether or not each alternative meets the Purpose and Need, compare how well each alternative would perform, and identify what impacts each alternative would have.

Level 2 Alternatives

In addition to the 12 interchange configuration alternatives carried forward from Level 1 screening, the following four alternatives were added for consideration in the Level 2 screening based on public and Technical Team input for combining elements of other alternatives. With these additional alternatives, 16 alternatives (including the No Action alternative) were considered in the Level 2 screening.

Alternative 33 – Loop SW Quadrant & Improved WB Ramps

Alternative 33 is a combination of Level 1 Alternatives 8 and 11.

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating one traffic signal and eliminate the weave movement between the ramp and frontage road intersections. It consists of a new interchange layout with a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and diamond type ramps with frontage road access directly to/from the freeway ramps on the north side of the interchange.

This alternative combines the benefits of eliminating the weave movement within the smaller footprint of the Texas Frontage Road configuration on the north side of

the interchange with the safety and capacity benefits of the southwest quadrant loop ramp for the southbound Kipling Street to eastbound I-70 left turn movement.

Alternative 34 – Improved Tight Diamond with SB to EB Flyover

Alternative 34 is a combination of Level 1 Alternatives 10, 18, and 11.

This alternative was considered because it may address the queuing conditions on the Westbound I-70 Off Ramp, southbound Kipling Street approaching the interchange, and other congested movements through the interchange by providing capacity through both ramp intersections. It consists of the current diamond interchange configuration with diamond type ramps with additional turn lanes on the ramps and Kipling Street through the interchange and a flyover ramp serving the heavy movement from southbound Kipling Street to eastbound I-70.

This alternative combines the capacity benefits of the southbound Kipling Street flyover ramp with added turn lane capacity at both ramp intersections.

Alternative 35 – Double Crossover Diamond Interchange

Alternative 35 is a combination of Level 1 Alternatives 13, 26, and 28.

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating two traffic signals and the queuing conditions on the Westbound I-70 Off Ramp and other congested movements through the interchange. It consists of a new interchange configuration with diamond type ramps and the Kipling Street movements shifted to the other side of the street under the bridge to allow left turn movements that do not cross traffic, plus the removal of the frontage road traffic signals with right-in and right-out movements only at those intersections.

This alternative fixes the capacity limitations of the previously-considered double crossover diamond layout by removing the adjacent frontage road traffic signals.

Alternative 36 – Button Hook Ramps South & Improved WB Ramps

Alternative 36 is a combination of Level 1 Alternatives 11 and 17.

This alternative was considered because it may address issues associated with close signal spacing on Kipling Street by eliminating two traffic signals and eliminate the weave movement between the ramp and frontage road intersections. It consists of a new interchange configuration with the eastbound I-70 ramp terminal intersection on the South Frontage Road and diamond type ramps with frontage road access directly to/from the freeway ramps on the north side of the interchange.

This alternative combines the benefits of eliminating the weave movement within the relatively small footprint of the Texas Frontage Road ramp configuration on the north side of the interchange with the capacity and direct access benefits of the button hook ramps on the south side of the interchange.

Alternative Conceptual Layout

The Level 2 alternative concepts were developed at a conceptual design level of detail using the applicable CDOT and Wheat Ridge design standards. The design parameters followed for the conceptual design of the alternative interchange improvements are listed in **Appendix A**.

In order to fairly compare the impacts of alternatives through the Level 2 screening process, key design elements were assumed as part of the conceptual layout for all alternatives.

Shared use path – A hard surface path for pedestrians and bicyclists that is at least eight feet wide and is physically separated from motor vehicle traffic.

In order to accommodate multimodal connections, a bi-directional shared use path is assumed to run on both sides of Kipling Street in all alternatives, consistent with local agency planning. This path is eight feet wide, following the CDOT minimum standard width. The opportunity to reduce the width of the shared use path to a sidewalk on one side of Kipling Street to mitigate property impacts may be considered during the future NEPA process(es).

In order to accommodate multimodal connections, an on-street bicycle lane is assumed on Kipling Street in all alternatives, consistent with the *Jefferson County Bicycle Plan*. The bike lanes are six feet wide, following the CDOT recommended width. A decision to not include on-street bike lanes along Kipling Street to mitigate property impacts may be considered during the future NEPA clearance process(es).

The scope of this project does not include additional through lane capacity on I-70 or Kipling Street. Various alternatives include additional lanes through the interchange and/or at intersections, but all of the alternatives assume there is no widening of I-70 or Kipling Street outside of the interchange area included in the project. The bridge structure and ramps will be designed to tie-in to the potential future widening of I-70. It is assumed that the ramp meter for the Eastbound I-70 On Ramp would remain with all alternatives.

Level 2 Performance Measures

The following evaluation criteria and performance measures were developed to compare how each alternative meets the Purpose and Need and goals of the project. The measures are a mix of qualitative and quantitative assessments, based on the criteria and the data available at this stage of development.

The color ratings shown with the performance measures are related to the colors provided in the Level 2 Screening Matrix in **Appendix B**. The ratings were used as a visual indication of the comparative characteristics of a criterion between alternatives, but not used as an indication of a decision (i.e., an alternative with many "red" ratings was not automatically rendered unreasonable). The quantitative and qualitative ratings were based on industry standards or on a relative scale developed in coordination with the project Technical Team.

Optimize operations and reduce congestion

Intersection peak hour Level of Service and delay (2035 overall intersection)

- Overall intersection Level of Service (LOS) and delay (seconds/vehicle) for the ramp and frontage road intersections for the AM and PM peak hour.
- Analyzed with Synchro 8 (Build 802, Revision 685) and reported as Highway Capacity Manual (HCM) 2010 results. (Ramp merge/diverge areas not included in analysis until Level 3 evaluation, using VISSIM software.)
- Rating:
    - Black = LOS D or better
    - Red = LOS E or F

Peak hour queue lengths approaching interchange

- Queue lengths (feet) approaching the interchange for southbound Kipling Street, northbound Kipling Street, and Westbound I-70 Off Ramp for the AM and PM peak hour.
- For southbound and northbound Kipling Street, queue length reported as back-up from the first ramp intersection encountered. For southbound Kipling Street, the queue length is reported from the Westbound I-70 Off Ramp intersection. For northbound Kipling Street, the queue length is reported from the Eastbound I-70 Off Ramp intersection.
- If the reported queue backs up through the upstream intersection (i.e., the frontage road intersection), the queue from that intersection is added to provide the full queue drivers encounter approaching the interchange.
- Analyzed with Synchro 8 (Build 802, Revision 685).
- Acceptable queue for alternatives assumed to be 600 feet, which represents distance between signals.
- Rating:
    - Red = Queue longer than No Action or 600 feet, whichever is greater

Volume-to-Capacity ratio

- Overall intersection Volume-to-Capacity ratio for the ramp and frontage road intersections for the AM and PM peak hour.
- Analyzed with Synchro 8 (Build 802, Revision 685).
- Rating:
    - Red = V/C at 1.00 or more

Perceived driver expectancy measured on a scale of easy, moderate, difficult

- Driver perception of difficulty to navigate the interchange area, including movements between Kipling Street, the I-70 ramps, and frontage roads.
- Rating:
    - Easy (Green) = typical configuration and directional turn movements
    - Moderate (Black) = some out-of-direction turn movements, but typical configuration
    - Difficult (Red) = unusual configuration; unexpected decision points; unusual out-of-direction turn movements (i.e., must turn left to go right)

Improve traveler safety

Expected change in number of crashes within the interchange area

- Rating:
    - Decrease (Green) = expected from reduced congestion (based on operations evaluation results) and less conflict points
    - Minimal change (Black) = expected from small decrease in congestion (based on operations evaluation results) or reduction offset by geometric concern

- Increase (Red) = expected from additional congestion (based on operations evaluation results) and no change in number of conflict points

Reduction in multimodal conflict points at ramps and frontage roads

- Vehicular conflict points counted at frontage road and ramp intersections based on intersection typical of 32 points for a four-way intersection and eight points for roundabout.
- Number of pedestrian and bicycle crossings evaluated qualitatively.
- Differentiating characteristics of pedestrian and bicycle conflict points noted as crossings of high-volume and high-speed right turns.
- Rating:
  - Green = Reduction from No Action greater than 50%
  - Black = Reduction from No Action of 10-50%
  - Red = Reduction from No Action less than 10%

Accommodate multimodal connections

Missing sidewalk or path links/out-of-direction travel

- Out-of-direction travel (i.e., must cross street or turn to go straight) for pedestrians and/or bicycles based on alternative conceptual layout.
- Noted if bicyclists in bike lane on Kipling Street must transition to/from shared use path, based on alternative conceptual layout.
- Rating:
  - Green = Little or no out-of-direction travel for pedestrian and bicyclists through the interchange
  - Black = Some out-of-direction travel for pedestrians
  - Red = Substantial out-of-direction travel for pedestrians and/or bicycles; No bike lanes on Kipling Street

Accommodation of transit connections (e.g. bus pull-outs, transit stop connections)

- Transit stops may require relocation or may be able to remain in current location based on alternative conceptual layout.
- Noted impacts to signalized Kipling Street pedestrian crossing for transit users to access transit stop.
- Rating:
  - Green = Transit stops are able to remain in current location
  - Black = Transit stops require relocation; Limited connections for transit users to access transit stop

User perception of comfort and safety of pedestrian and bicycle movements (easy, moderate, difficult)

- Configurations that meet drivers' expectations for encountering pedestrians or bicyclists (e.g., roadside area for pedestrians, striped bike lanes) feel safer to negotiate.

- Shorter crossing paths (fewer lanes, smaller corner radii) are more comfortable for pedestrians and bicyclists to cross.
- High-volume, high-speed movements that are not comfortable for pedestrians and bicyclists to cross.
- Transitions between a bike lane and a shared use path are not comfortable for bicyclists traveling along the bike lane or pedestrians on the shared use path.
- Large intersection footprints or complicated routing for the bicycle lane and/or shared use path is intimidating for pedestrians and bicyclists to travel through the interchange.
- Rating:
    - Easy (Green) = Alternative generally feels comfortable for pedestrians and bicycle movements
    - Moderate (Black) = One key characteristic makes the alternative feel uncomfortable or intimidating
    - Difficult (Red) = Several characteristics make the alternative feel uncomfortable or intimidating

Avoid and minimize environmental impacts

Potentially impacted noise receptors

- Potential noise receptors impacted with alternative conceptual layout, based on changes in elevation (such as new elevated ramps) or roadways/ramps moving closer to potential noise receptors.
- Potential noise receptors as identified in the Environmental Scan Report.
- Rating:
    - Green = Minor or moderate decrease from reduced congestion and no discernable change in footprint based on alternative conceptual layout
    - Black = Slight increase or reduction from change in congestion
    - Red = Minor or moderate increase from elevated ramps or roadways moving closer to potential noise receptors based on alternative conceptual layout

Potentially impacted hazardous material sites

- Properties with potential hazardous material sites impacted with partial or full takes from the alternative conceptual layout.
- Rating:
    - Green = Four or less sites impacted
    - Black = Five to six sites impacted
    - Red = Seven or more sites impacted

Potentially impacted parks and recreation areas

- Noted potential impact to the Kipling Trail (west side of Kipling Street, north of 50th Avenue) and/or Fruitdale Park (southwest of interchange) as community resources based on alternative conceptual layout.

- Rating:
  - Green = No impact expected
  - Black = Slight, potentially avoidable impact expected
  - Red = Minor or major impact expected

Avoid and minimize community impacts

Right-of-way required

- Number and acres of properties with full acquisition of property expected to be required based on alternative conceptual layout.
- Number and acres of properties with partial acquisition of property expected to be required based on alternative conceptual layout.
- Rating:
  - Green = No full acquisitions expected
  - Black = Four or less full acquisitions expected
  - Red = Five or more full acquisitions expected

Number of property accesses impacted (existing and potential future accesses)

- Number of property accesses (driveways) that are expected to be closed or changed to limited movements based on alternative conceptual layout.
- Rating:
  - Green = Six or less accesses expected to be impacted
  - Black = Seven to 12 accesses expected to be impacted
  - Red = 13 or more accesses expected to be impacted

Number of buildings impacted (commercial, residential)

- Number of buildings that are expected to be directly impacted (i.e., demolished) based on alternative conceptual layout.
- Commercial versus residential buildings noted.
- Rating:
  - Green = Two or less buildings expected to be directly impacted
  - Black = Three to five buildings expected to be directly impacted
  - Red = Six or more buildings expected to be directly impacted

Business property impacts for partial acquisitions (e.g. parking, landscaping)

- Noted type and level of impact for properties expected to be partial takes based on alternative conceptual layout.
- Type of impacts considered potential changes to parking, landscaping, and internal site circulation.
- Rating:
  - Green = Minor impacts to properties
  - Black = Moderate and minor impacts in several quadrants or major impacts limited to one quadrant

- Red = Major impacts to properties in all quadrants of the interchange

Increase in traffic traveling through neighborhoods

- Traffic that may cut-through neighborhood to avoid the interchange if there is increased congestion.
- With closure or limited turns at a frontage road intersection, traffic will need to divert to other streets to access Kipling Street. The street for the potential traffic diversion is based on the alternative conceptual layout.
- Rating:
  - Green = No increase expected
  - Black = Potential increase based on possible increase in congestion
  - Red = Potential increase based on change to frontage road intersection movements

Perceived difficulty to access area businesses measured on a scale of easy, moderate, and difficult

- Focused on circulation to access businesses located off Kipling Street and along I-70 in quadrants of the interchange.
- Rating:
  - Easy (Green) = typical configuration and full access to frontage roads
  - Moderate (Black) = limited access to frontage roads; full access, but unusual configuration
  - Difficult (Red) = out-of-direction turn movements to get to frontage roads

Consistency with established local plans and visions

- Local plans include interchange improvements.
- Full access to frontage roads provides flexibility for local area businesses and land use plans.
- Roundabouts are not consistent with plans for Kipling as a major arterial.
- Fully directional interchange not consistent with arterial-to-freeway interchange.
- Rating:
  - Green = Consistent
  - Red = Not consistent

Maximize Constructability

Conceptual-level probable construction costs on a scale of low, moderate, high, very high

- General evaluation based on amount and size of structures and overall footprint of alternative conceptual layout.

- I-70 bridge replacement and associated profile change and ramp reconstruction is common to all alternatives, so it was not considered in comparison of general cost evaluation.
- Rating:
    - Low (Green) = Typical construction and minimal ROW costs
    - Moderate (Black) = Typical construction with moderate ROW costs
    - High (Red) = Substantial construction with moderate ROW costs
    - Very high (Red) = Substantial construction with substantial ROW costs

Ease and cost of maintenance measured on a scale of easy, moderate, difficult

- Evaluation based on amount of infrastructure to maintain (including structures, traffic signals, and increased lane-miles) and accessibility to perform maintenance.
- Rating:
    - Easy (Green) = Reduced infrastructure and relatively easy maintenance access
    - Moderate (Black) = Typical increase in infrastructure with some access constraints
    - Difficult (Red) = Increase in specialized infrastructure with tight access constraints

Constructability measured on a scale of easy, moderate, and difficult

- Considered general construction complexity, utility impacts, difficulty from contractor perspective (e.g., staging area, length of construction).
- I-70 bridge replacement and associated profile change and ramp reconstruction is common to all alternatives, so it was not considered in comparison of general constructability evaluation.
- Rating:
    - Easy (Green) = Typical construction mostly outside of existing roadway area
    - Moderate (Black) = Moderate construction within tight area
    - Difficult (Red) = Major construction complexity and staging area issues within tight area

Assessment of impacts of construction phasing based on roadway/lane closures and local access impacts on a scale of easy, moderate, and difficult

- Considered potential for required lane closures, general duration of construction, and traveling public impacts.
- Rating:
    - Easy (Green) = Minor impacts to traveling public with most construction outside of roadway
    - Moderate (Black) = Moderate impacts to traveling public with lane closures and full night closures
    - Difficult (Red) = Major impacts to traveling public expected due to phasing and duration

Ability to construct in phased projects measured on a scale of easy, moderate, difficult

- Considered if the function of the alternative be implemented in usable pieces.
- Considered if phases could be built initially with narrow lanes or deferred turn lanes.
- Rating:
  - Easy (Green) = Opportunity for areas (ramps, quadrants, or halves) to be implemented separately
  - Moderate (Black) = Requires all Kipling Street construction at once; bridge replacement may be deferred
  - Difficult (Red) = Usable elements cannot be implemented in pieces (all construction at one time)

Level 2 Screening Results

Project Purpose and Need:
- Meet current and future traffic demands
- Improve operational efficiency of the interchange
- Improve traveler safety through the interchange;
- Accommodate multimodal connections

The purpose of the Level 2 evaluation was to complete additional and more detailed analysis to determine whether or not each alternative meets the Purpose and Need, compare how well each alternative would perform, and identify what impacts each alternative would have based on the goals and objectives for the project. The detailed Level 2 Screening Matrix providing results of the analysis of the alternatives is in **Appendix B**.

The following pages describe each alternative, the results of the evaluation criteria, and a conclusion for whether or not to carry forward the alternative into the subsequent NEPA process(es). An alternative was not carried forward if the evaluation showed the alternative does not meet the project Purpose and Need or the alternative is unreasonable due to impacts and infeasibility.

Carried Forward

In the Level 2 screening, 11 alternatives were not carried forward for further consideration. Five alternatives (including the No Action alternative) were carried forward for further consideration. The four action alternatives meet the project Purpose and Need and goals while minimizing impacts to natural and community resources.

The action alternatives carried forward from Level 2 screening were:

- Alternative 1 – Single Point Urban Interchange (SPUI)
- Alternative 7 – Partial Cloverleaf with Loops SW & NE Quadrants
- Alternative 12 – Traditional Diamond
- Alternative 17 – Button Hook Ramps

No Action

Under the No Action alternative, shown in **Figure 9**, the proposed improvements would not take place. Only programmed transportation improvements with committed funding sources would be completed, including:

- Kipling Shared Use Path, 32nd Ave to 44th Avenue – new shared use path on east side of Kipling Street
- Kipling Trail, 58th Avenue to Ridge Road – new detached shared use path on west side of Kipling Street
- Ridge Rd Bike/Pedestrian Improvements – improved bicycle/pedestrian connection to Gold Line station
- RTD Gold Line Commuter Rail – commuter rail with station at Kipling Street and Ridge Road
- Van Bibber Trail Underpass – new underpass of Kipling Street at 56th Place

Operations and Safety

- Peak hour delay increase experienced at ramp and frontage road intersections.
- Southbound Kipling Street peak hour queues leading to the interchange back up past 50th Avenue.
- Peak hour queues on the Westbound I-70 Off Ramp extend back to the mainline freeway.
- Increase in crashes expected due to additional congestion as traffic volumes increase.

Multimodal Connections

- Only narrow sidewalk provided directly through the interchange and no bicycle lanes on Kipling Street.

Environmental and Community Impacts

- Limited property impacts.
- Minimal environmental impacts expected but with increase in noise and degraded air quality from congestion.
- Increased congestion along Kipling Street may increase traffic traveling through the adjacent neighborhoods.

Constructability

- No construction or right-of-way cost.

Evaluation

Under the No Action alternative, interchange operations will continue to degrade due to increases in traffic volumes beyond the capacity of the interchange. Traffic delay will increase and occur for longer periods throughout the day and an increase in crashes is expected due to the additional congestion. Vehicular queues on the Westbound I-70 Off Ramp will extend beyond the end of the ramp and impact the safety and operations of the mainline freeway and the adjacent interchange at Wadsworth Boulevard.

The high traffic volumes and deficient pedestrian and bicycle facilities will continue to contribute to safety concerns for pedestrians and bicyclists traveling through the interchange. Safe and efficient pedestrian and bicycle connections will become more critical with the opening of the Gold Line commuter station and increased frequencies and ridership for the bus route along Kipling Street.

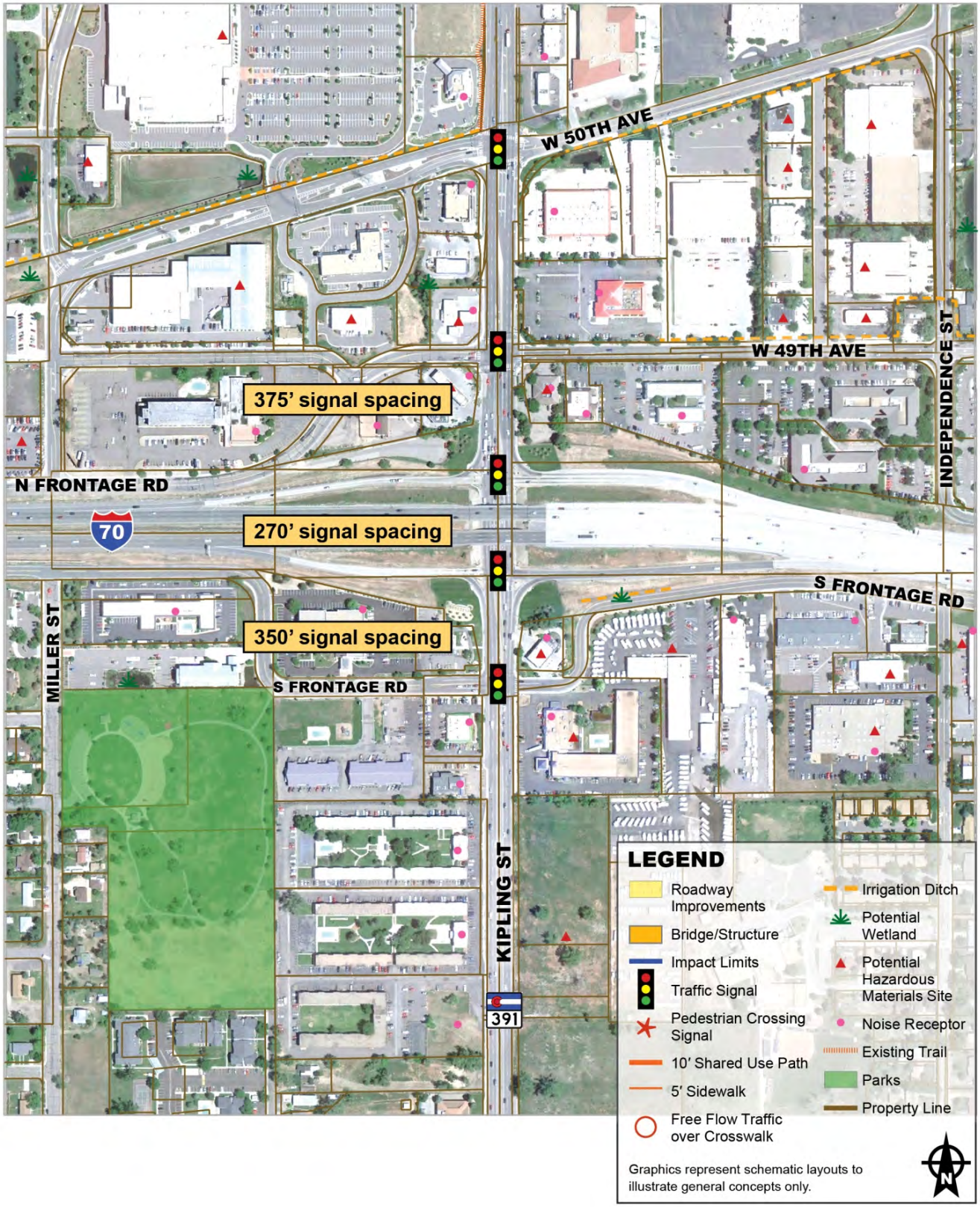
Critical Considerations

The No Action alternative does not meet the Purpose and Need, but is included as a baseline against which to compare impacts of action alternatives. This is important context information in determining the relative magnitude and intensity of the impacts of action alternatives.

Conclusion: **CARRIED FORWARD**

Use as a baseline for comparison

Figure 9: No Action



Single Point Urban Interchange (SPUI)
Alternative I

This interchange consists of a single signalized intersection on Kipling Street serving all movements to/from the I-70 ramps and the Kipling Street through movements.

The alternative, shown in **Figure 10**, provides a compact layout, eliminates one signal on Kipling Street, and increases signal spacing on Kipling Street.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 30% from the No Action alternative in the PM peak hour.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 75%.
- Greater intersection spacing and directional interchange layout is easy for drivers to negotiate.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- The large single intersection may be intimidating for bicyclists and pedestrians traveling north-south to negotiate.

Environmental and Community Impacts

- Interchange estimated to directly impact five commercial properties with partial acquisition (total = 0.2 acres).
- No increase in traffic traveling through the surrounding neighborhoods expected.

Constructability

- Clear-span bridge for I-70 over Kipling Street is required, which creates difficult traffic impacts during construction and limited opportunities to construct in phases.
- Typical construction costs expected with minimal right-of-way costs.

Evaluation

This alternative improves vehicular operations by reducing the overall intersection delay at the Westbound I-70 Off Ramp by 30% in the peak hours. The Westbound I-70 Off Ramp queues are reduced by almost 75% in the peak hours. The increased signal spacing and additional lanes on Kipling Street reduces congestion. The reduced congestion provides safety benefits. Because the SPUI is a typical layout and the frontage road traffic signals remain north and south of the interchange, it would be relatively easy for drivers unfamiliar with the area to access the surrounding businesses, such as the gas stations, hotels, and fast food restaurants, even with the driveways closed immediately adjacent to the ramps.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. Because there are traffic signals at north and south frontage roads, pedestrians and bicyclists are able to cross Kipling Street at both locations and across the north or south leg of each intersection.

The interchange is estimated to directly impact five commercial properties with partial acquisitions totaling less than one acre. The traffic signals serving the frontage road access north and south of the interchange remain in the current location without restrictions to turn movements, so the location of the current access to surrounding residential areas and businesses is unchanged. The likelihood for drivers to use the adjacent local streets to avoid Kipling Street would be reduced due to the improved operations on the major arterial.

The single signalized intersection at the interchange requires a clear-span bridge for I-70 over Kipling Street because there cannot be a bridge pier in the intersection. The construction of the clear-span bridge would have substantial impacts to traffic on I-70 and Kipling Street. Because the configuration of the ramps

requires the new bridge, the ultimate interchange must be constructed as one project with a relatively large funding source. There are limited opportunities to construct the interchange in separate, smaller-scale projects.

Critical Considerations

With a single signalized intersection on Kipling Street for the I-70 ramps and increased signal spacing, this interchange configuration improves vehicular operations at the interchange. Due to the typical layout and the frontage road traffic signals north and south of the interchange, it would be relatively easy for trucks and drivers unfamiliar with the area to access the surrounding businesses. With the capacity improvements and remaining frontage road access, the overall operation of the interchange is improved and the reduced congestion and increased signal spacing also provides safety benefits.

There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street. Signalized pedestrian and bicyclist crossings of Kipling Street are also accommodated at the frontage road traffic signals north and south of the interchange, which will facilitate pedestrian connections to the transit stops at those intersections.

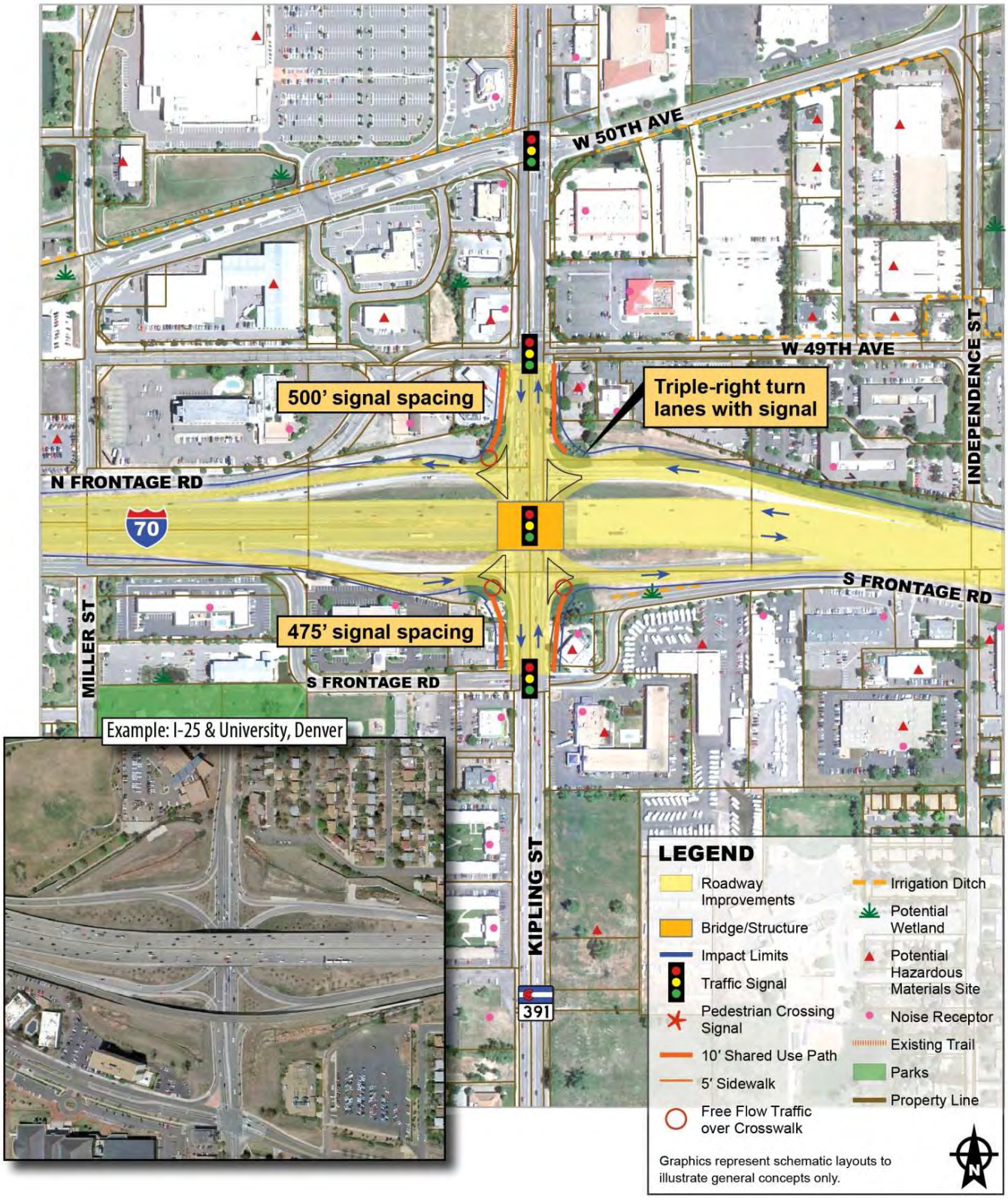
The traffic signals serving the frontage road access north and south of the interchange remain in the current location without restrictions to turn movements, so the location of the current access to surrounding residential areas and businesses is unchanged. This is a benefit to the operational efficiency of the interchange and minimizes local business and resident impacts.

There are moderate construction impacts to traffic on I-70 and Kipling Street due to the construction requirements of the clear-span bridge. The configuration of the ramps and the single signalized intersection reduces the ability to construct the interchange with separate, smaller-scale projects. This means the project funding will need to be constructed as one project with a relatively large funding source.

Because this alternative meets the Purpose and Need by improving the interchange operational efficiency with reduced delay, improving traveler safety with reduced congestion and queues and increased signal spacing, and accommodating direct multimodal connections through the interchange while minimizing impacts to properties and local business access, this alternative was carried forward for further consideration.

Conclusion: **CARRIED FORWARD**

Figure 10: Alternative 1 - Single Point Urban Interchange (SPUI)



Diamond with Roundabout at Ramps & Frontage Road
Alternative 3

This interchange consists of a series of four roundabouts on Kipling Street at the ramps and frontage road intersections. Signalized pedestrian crossings are provided at multilane roundabout approaches.

The alternative, shown in **Figure 11**, eliminates four traffic signals on Kipling Street and reduces traffic speeds on Kipling Street.

Operations and Safety

- Peak hour delay increase experienced at ramp and frontage road intersections.
- Southbound and northbound Kipling Street peak hour queues leading to the interchange substantially increased.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 45% from the No Action alternative.
- Movements through closely-spaced multilane roundabouts may be difficult for drivers to understand.

Multimodal Connections

- Due to roundabout spacing, no pedestrian crossing of Kipling Street provided at the ramp intersections.
- Bicycle lanes transition to/from shared use path through the interchange area.
- Transit stops must move north and south of roundabouts.

Environmental and Community Impacts

- Interchange estimated to directly impact 14 commercial properties with three full and 11 partial acquisitions (total = 2.6 acres).
- Increased congestion during peak hours may increase traffic traveling through the surrounding neighborhoods.

Constructability

- Difficult to maintain traffic on Kipling Street with roundabout construction and limited opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

With this alternative, the delay experienced at the ramp and frontage road intersections increases with the westbound I-70 ramp intersection operating with unacceptable delay at LOS F during the AM peak hour and the eastbound I-70 ramp intersection operating with unacceptable delay at LOF F during the PM peak hour. The roundabout intersections at the ramp terminals do not meet the future traffic demands with volume-to-capacity ratios over 1.0 during the peak hours. Although the vehicular queues along the Westbound I-70 Off Ramp are reduced, substantially longer queues extend along southbound and northbound Kipling Street leading to the interchange, creating additional safety issues due to increased congestion.

There have been substantial concerns expressed for the operational and safety issues that would be introduced with unfamiliar drivers negotiating closely-spaced, multilane roundabout intersections on a major regional arterial to access area businesses.

Because of the high traffic volumes and multiple lanes through the roundabouts, the bicycle lanes are transitioned to/from the shared use path. Signalized pedestrian crossings are provided at multilane roundabout approaches, but there are no pedestrian crossings of Kipling Street except north of the North Frontage Road and south of the South Frontage Road roundabouts due to the close roundabout spacing.

This creates a potential multimodal safety concern if pedestrians and bicyclists attempt to cross Kipling Street at a mid-block location.

The interchange is estimated to directly impact 14 commercial properties with three full and 11 partial acquisitions (total = 2.6 acres). There would also be impacts to surrounding businesses due driveway closures on the legs of the roundabouts and the added difficulty for drivers unfamiliar with the area to negotiate the closely-spaced roundabouts to access the frontage roads. For drivers familiar with the area, there would be an increased likelihood to use the adjacent local streets during peak hours to avoid Kipling Street due to the degraded operations and increased congestion on the major arterial.

The interchange would be moderately difficult to construct because most construction would occur in the area of the existing ramps and frontage roads and would impact existing traffic. To avoid the mixture of traffic signals and roundabouts within the short distance along Kipling Street, the roundabouts would need to be constructed as one project with a relatively large funding source. The roundabouts along Kipling Street may be constructed as a separate project prior to the replacement of the I-70 bridge.

Critical Considerations

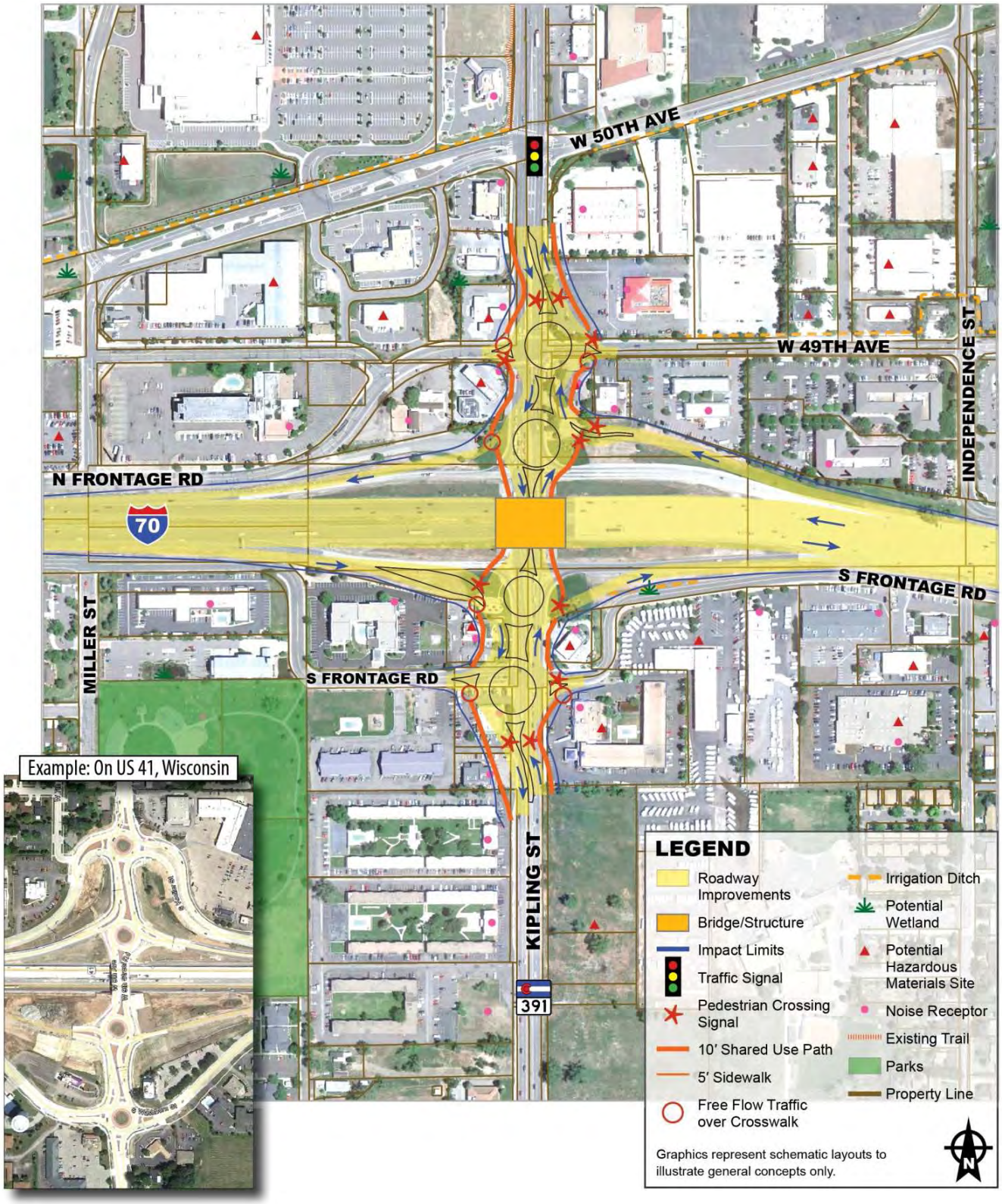
The peak hour traffic operations at the ramps and frontage road intersections are degraded because the roundabouts cannot meet the future traffic demands. There are added safety issues due to the increase in congestion and queues along Kipling Street. There are additional safety and operational concerns with the difficulty for trucks and unfamiliar drivers to negotiate the closely-spaced multilane roundabouts to access area businesses.

There is no pedestrian crossing of Kipling Street between ramp and frontage road roundabouts, which presents a multimodal safety concern.

This alternative does not meet the Purpose and Need because it does not meet future traffic demand, does not improve the operational efficiency or traveler safety through the interchange, and does not accommodate multimodal connections through the interchange. Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 11: Alternative 3 - Diamond with Roundabout at Ramps & Frontage Road



Diamond with Six-Leg Roundabout at Ramps & Frontage Roads
Alternative 4

This interchange consists of two roundabouts on Kipling Street providing movements at the ramps and frontage road intersections. Signalized pedestrian crossings are provided at the roundabout approaches.

The alternative, shown in **Figure 12**, eliminates four traffic signals on Kipling Street and reduces traffic speeds on Kipling Street.

Operations and Safety

- Peak hour delay increase experienced at ramp and frontage road intersections.
- Southbound and northbound Kipling Street and Westbound I-70 Off Ramp peak hour queues leading to the interchange substantially increased.
- Movements through closely-spaced multilane roundabouts may be difficult for drivers to understand.

Multimodal Connections

- Due to roundabout spacing, no pedestrian crossing of Kipling Street provided at the ramp intersections.
- Bicycle lanes transition to/from shared use path through the interchange area.
- Transit stops must move north and south of roundabouts.

Environmental and Community Impacts

- Interchange estimated to directly impact 11 commercial properties with three full and eight partial acquisitions (total = 2.5 acres).
- Increased congestion during peak hours may increase traffic traveling through the surrounding neighborhoods.

Constructability

- Difficult to maintain traffic on Kipling Street with roundabout construction and limited opportunities for to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

With this alternative, the delay experienced at the ramp and frontage road intersections increases with both I-70 ramp intersections operating with unacceptable delay at LOS F during both peak hours. The roundabout intersections at the ramp terminals do not meet the future traffic demands with volume-to-capacity ratios over 1.0 during the peak hours. The vehicular queues along the Westbound I-70 Off Ramp and southbound and northbound Kipling Street approaches leading to the interchange are substantially increased, creating additional safety issues due to increased congestion.

There have been substantial concerns expressed for the operational and safety issues that would be introduced with unfamiliar drivers negotiating closely-spaced, multilane roundabout intersections on a major regional arterial to access area businesses.

Because of the high traffic volumes, multiple lanes, and large configuration of the six-leg roundabouts, the bicycle lanes are transitioned to/from the shared use path. Signalized pedestrian crossings are provided at multilane roundabout approaches, but there are no pedestrian crossings of Kipling Street except north of the North Frontage Road and south of the South Frontage Road. This creates a potential multimodal safety concern if pedestrians and bicyclists attempt to cross Kipling Street within the large roundabout areas.

The interchange is estimated to directly impact 11 commercial properties with three full and eight partial acquisitions (total = 2.5 acres). There would also be impacts to surrounding businesses due to driveway

closures on the legs of the roundabouts and the added difficulty for drivers unfamiliar with the area to negotiate the six-leg roundabouts to access the frontage roads. For drivers familiar with the area, there would be an increased likelihood to use the adjacent local streets during peak hours to avoid Kipling Street due to the degraded operations and increased congestion on the major arterial.

The interchange would be moderately difficult to construct because most construction would occur in the area of the existing ramps and frontage roads and would impact existing traffic. To avoid the mixture of traffic signals and roundabouts within the short distance along Kipling Street, the roundabouts would need to be constructed as one project with a relatively large funding source. The roundabouts along Kipling Street may be constructed as a separate project prior to the replacement of the I-70 bridge.

Critical Considerations

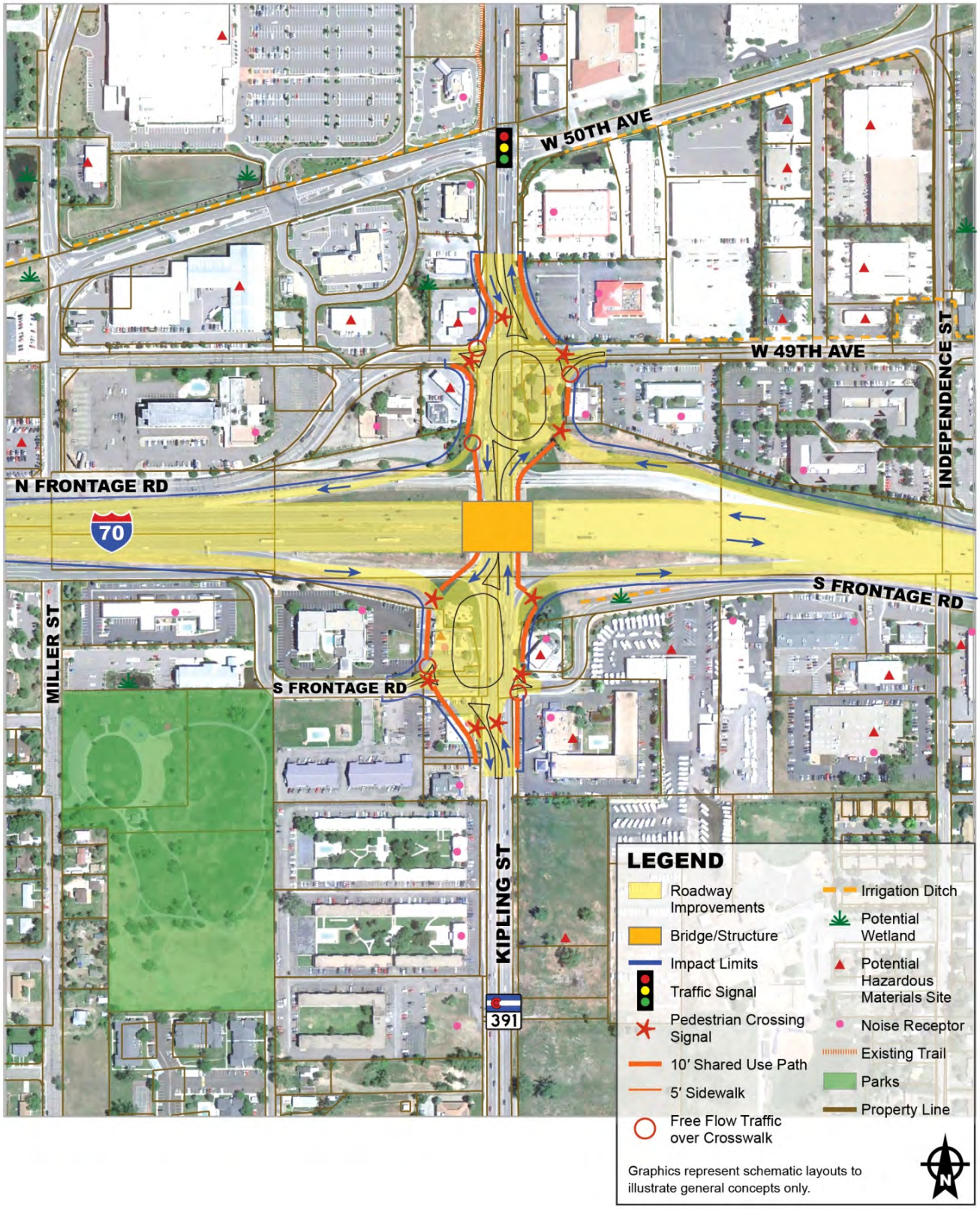
The peak hour traffic operations at the ramps and frontage road intersections are degraded because the roundabouts cannot meet the future traffic demands. There are added safety issues due to the increase in congestion and queues along the Westbound I-70 Off Ramp and Kipling Street. There are additional safety and operational concerns with the difficulty for trucks and unfamiliar drivers to negotiate the six-leg multilane roundabouts to access area businesses.

There is no pedestrian crossing of Kipling Street between ramp and frontage road roundabouts, which presents a multimodal safety concern.

This alternative does not meet the Purpose and Need because it does not meet future traffic demand, does not improve the operational efficiency or traveler safety through the interchange, and does not accommodate multimodal connections through the interchange. Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 12: Alternative 4 - Diamond with Six-Leg Roundabout at Ramps & Frontage Roads



Fully Directional Interchange
Alternative 6

This interchange consists of four levels of directional ramps with no signals for ramp movements. The frontage road traffic signals remain open under flyover ramps without access between the ramps and frontage roads.

The alternative, shown in **Figure 13**, maximizes the interchange vehicular traffic capacity.

Operations and Safety

- Southbound and northbound Kipling Street peak hour queues leading to the interchange are reduced up to 70% from the No Action alternative in the peak hours.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 80% in the PM peak hour.
- Safety concerns with higher speed differential on Kipling Street with directional ramp connections to a lower speed arterial.

Multimodal Connections

- Shared use path provides grade separated crossings through the interchange area, but with some out-of-direction travel required.
- Bicycle lanes cross high-speed ramp movements on and off Kipling Street.

Environmental and Community Impacts

- Interchange estimated to directly impact 38 properties with 13 full and 25 partial acquisitions (total = 18.2 acres).
- Limited access between ramps and frontage roads negatively impacts access to area businesses and may increase traffic traveling through the surrounding neighborhoods.

Constructability

- Relatively difficult to construct with multiple flyover ramps.
- Ramps have opportunity to be constructed and opened in separate projects.
- Substantial construction expected with substantial right-of-way costs.

Evaluation

This alternative has capacity benefits by reducing the southbound and northbound queues on Kipling Street approaching the interchange up to 70% in the peak hours. The Westbound I-70 Off Ramp movements are free-flow directional ramps leading to downstream signals, so the peak hour queues on the ramp are reduced by more than 80%.

The directional ramp connections to Kipling Street introduce a safety concern with high-speed freeway traffic merging with the lower speed arterial. There are also safety concerns where the bicycle lanes on Kipling Street would cross the high-speed ramp movements on and off Kipling Street.

There are grade separations for the shared use path to cross the directional interchange ramps, which creates out-of-direction travel for pedestrians through the interchange.

The interchange is estimated to directly impact 38 properties with 13 full and 25 partial acquisitions (total = 18.2 acres). Three of the partial acquisitions are residential properties (apartments) and the rest of the acquisitions are commercial properties. Although the frontage road traffic signals remain open under flyover ramps, the access between I-70 and the neighborhoods and businesses surrounding the interchange is limited because the ramps connect with Kipling Street north of 50th Avenue and south of the South Frontage Road. Drivers to/from I-70 would not be able to access the frontage roads or the businesses next

to the interchange without completing U-turn maneuvers or traveling on adjacent local streets, which is a negative impact with added operational and safety issues along Kipling Street and neighborhood streets, particularly with trucks and unfamiliar drivers accessing local businesses from the freeway.

The interchange would be relatively difficult to construct with multiple flyover ramps in a tightly constrained area, but some of the ramp construction would be located where there are currently no roads, meaning fewer traffic impacts during those phases of construction. There are opportunities to construct and open the interchange ramps in separate projects. However, the construction and ROW costs would be relatively substantial for the overall project, as well as for the individual flyover ramp phases.

Critical Considerations

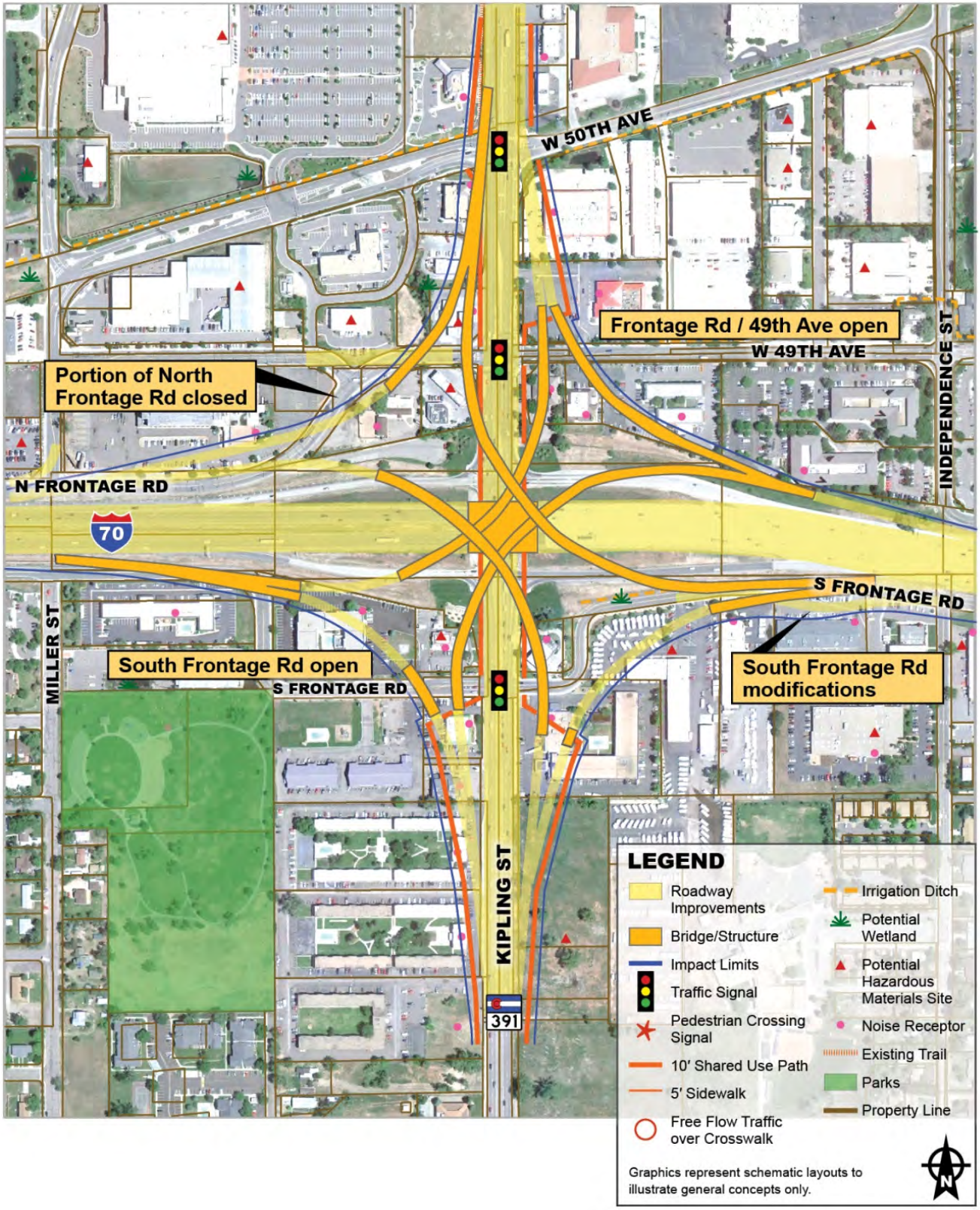
Although there are capacity benefits with the free-flow movements provided by the directional ramps, new safety concerns are introduced with the speed differential of the ramp connections with the arterial traffic and the bicycle lanes on Kipling Street. The shared use path is also located away from Kipling Street at the North Frontage Road and South Frontage Road to utilize grade separations of the ramps.

This alternative negatively impacts the properties surrounding the interchange, directly impacting at least 50% more properties than any other alternative. The physical ROW acreage is similar to other alternatives, but there are other negative impacts to local neighborhoods and businesses next to the interchange because drivers to/from I-70 would not be able to access the frontage roads or the businesses next to the interchange without completing U-turn maneuvers or traveling on adjacent local streets. These traffic movements would introduce operational and safety issues along Kipling Street and neighborhood streets, particularly with trucks and unfamiliar drivers accessing local businesses from the freeway.

This interchange configuration, typically utilized at freeway-to-freeway interchange locations, provides more capacity and higher speeds than needed at this arterial interchange. Other alternatives meet the Purpose and Need while minimizing community impacts. Due to the combination of property impacts with local neighborhood and business impacts, added safety concerns with the speed differential and multimodal conflicts of the directional ramp connections to Kipling Street, and the substantial cost for multiple flyover ramp structures, this alternative is not considered reasonable and was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 13: Alternative 6 - Fully Directional Interchange



Partial Cloverleaf with Loops Southwest & Northeast Quadrants
Alternative 7

This interchange consists of a loop ramp in the southwest and northeast quadrants providing free-flow operations for the left turn movements from Kipling Street to eastbound and westbound I-70. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with location depending on local land use plans.

The alternative, shown in **Figure 14**, eliminates two traffic signals by removing the left turn movements onto the I-70 ramps and increases signal spacing on Kipling Street.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 75% from the No Action alternative in the PM peak hour.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 70%.
- Safety/operational concerns with radius and design speed of the loop ramps with area truck traffic.
- Safety/operational benefit with removal of left turn movements from Kipling Street to eastbound and westbound I-70.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- Shared use path and bicycle lanes cross free-flow loop ramp movements.

Environmental and Community Impacts

- Interchange estimated to directly impact 18 to 20 properties with seven to nine full and 11 partial acquisitions (total = 14.3 to 21.2 acres), depending on the South Frontage Road relocation.
- Potential increase in traffic traveling on Independence Street in northeast quadrant expected due to 49th Avenue closure of direct access to frontage road.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by over 75% during the peak hours. The Westbound I-70 Off Ramp peak hour queues are reduced by almost 70%. There are safety and operational benefits with the removal of the left turn movements from Kipling Street to eastbound and westbound I-70.

There are safety and operational concerns with the radius and design of the loop ramps with the area truck traffic. Even when loop ramps are constructed meeting design standards, large trucks must travel slowly around the ramp which presents speed differential issues with merging freeway movements.

There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street. There are safety concerns with the shared use path and bicycle lanes crossing the free-flow loop ramp movements.

The interchange is estimated to directly impact 18 to 20 properties with seven to nine full and 11 partial acquisitions (total = 14.3 to 21.2 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. The acquisitions for the South Frontage Road include two to four residential properties with the rest of the acquisitions being commercial properties. The direct access to

Kipling Street via the east side of the North Frontage Road is closed, which is a negative impact to the access for area businesses in the northeast quadrant.

The interchange would be relatively easy to construct with the loop ramps located where there are currently no roads, meaning fewer traffic impacts during construction. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

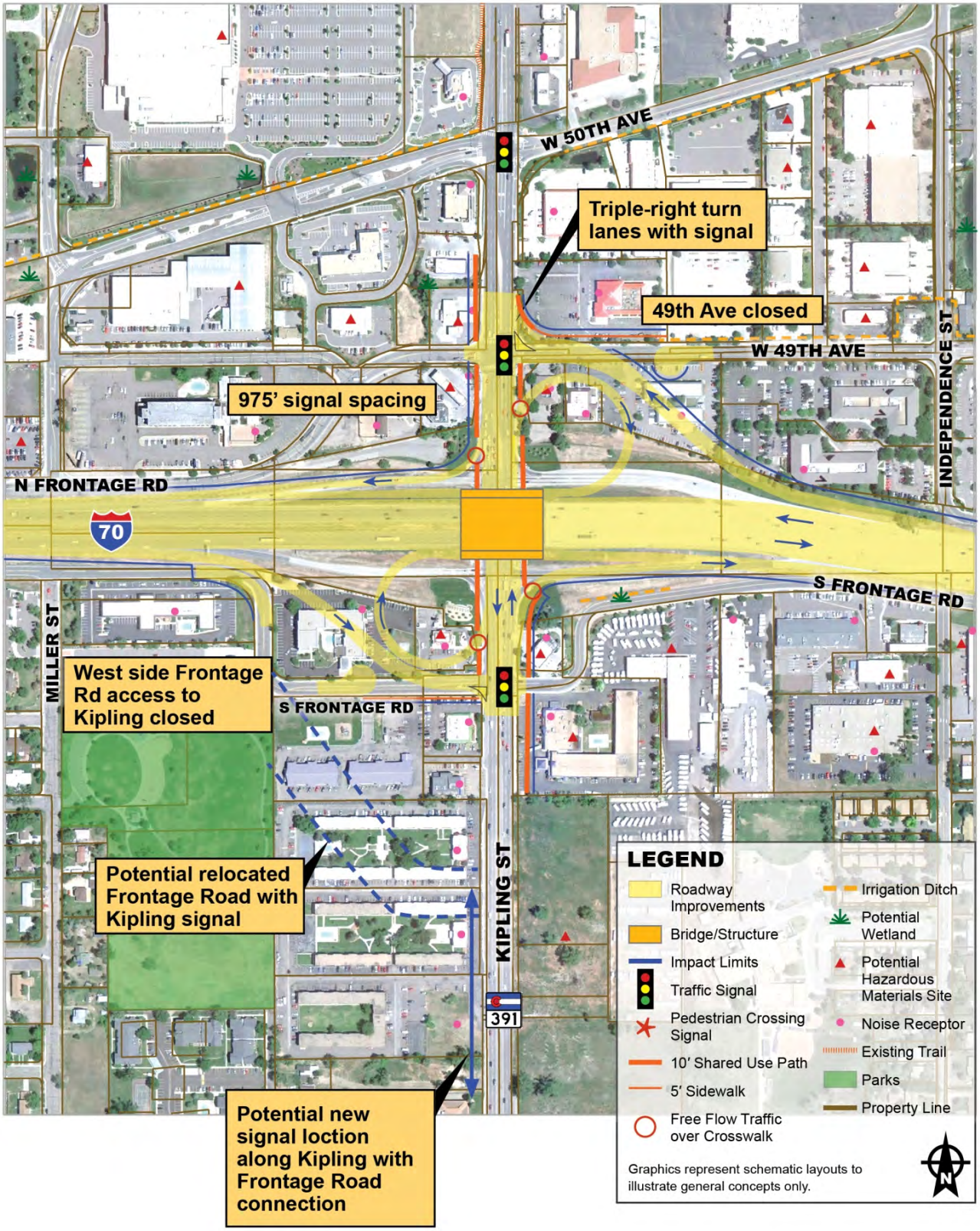
There are operational and safety benefits with the removal of the left turn movements from Kipling Street to eastbound and westbound I-70. There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street, although there are safety concerns with the shared use path and bicycle lanes crossing the free-flow loop ramp movements.

The physical ROW acreage required is similar to other alternatives, but there are larger negative impacts to local residential and business access in the northeast and southwest quadrants because the loop ramps cut off the frontage road access. Some of the property acquisition is for the relocated South Frontage Road, which helps reduce the access impacts to the southwest quadrant of the interchange. However, the South Frontage Road must be relocated farther away from the interchange than with other alternatives due to minimum signal spacing requirements.

Because this alternative meets the Purpose and Need by improving the interchange operational efficiency with reduced delay, improving traveler safety with reduced congestion and queues and increased signal spacing, and accommodating direct multimodal connections through the interchange, this alternative was carried forward for further consideration.

Conclusion: **CARRIED FORWARD**

Figure 14: Alternative 7 - Partial Cloverleaf with Loops Southwest & Northeast Quadrants



Partial Cloverleaf with Loops Southwest & Northwest Quadrants
Alternative 9

This interchange consists of a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and a loop ramp in the northwest quadrant providing free-flow operations for the left turn from the westbound off ramp to southbound Kipling Street. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with the location depending on local land use plans.

The alternative, shown in **Figure 15**, eliminates two traffic signals by eliminating the two heaviest left turn movements in the interchange area and increases signal spacing on Kipling Street.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 70% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by over 50%.
- Westbound I-70 Off Ramps are free-flow movements merging onto Kipling Street without signals.
- Safety/operational concerns with radius and design speed of the loop ramps with area truck traffic.
- Safety/operational benefit with removal of high volume left turn conflicts for Westbound I-70 Off Ramp and Eastbound I-70 On Ramp.
- Safety concerns with loop ramp serving traffic exiting freeway and area of weaving traffic along Kipling Street between the loop ramps.

Multimodal Connections

- Grade separated crossings of loop ramps provided for shared use path with out-of-direction travel required.
- Bicycle lanes transition to/from shared use path on west side of Kipling Street to avoid weaving area.

Environmental and Community Impacts

- Interchange estimated to directly impact 19 to 21 properties with six to eight full and 13 partial acquisitions (total = 12.9 to 19.8 acres), depending on the South Frontage Road relocation.
- Direct access to west side of frontage road in northwest quadrant is closed.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by over 70% in the peak hours. The Westbound I-70 Off Ramp movements are free-flow movements onto Kipling Street without signals, so there is little to no queuing expected on the ramps. The southbound peak hour queues on Kipling Street approaching the interchange are reduced by over 50%. . There are safety and operational benefits with the removal of the high volume left turns for the Westbound I-70 Off Ramp and Eastbound I-70 On Ramp. However, the northbound peak hour queues are about three times longer than the No Action condition

The loop ramp for the westbound I-70 exit ramp introduces a safety concern with high-speed freeway traffic needing to decelerate quickly around a loop ramp. Due to this safety concern, CDOT typically avoids constructing off ramps as loops. There are also safety and operational concerns with the radius and design of the loop ramps with the area truck traffic. Even when the loop ramps are constructed meeting design

standards, large trucks must travel slowly around the ramp which presents speed differential issues with merging and diverging freeway movements.

The free-flow loop ramp movement in the northwest quadrant introduces new safety concerns with the weaving area of traffic along Kipling Street leading to the free-flow loop ramp in the southwest quadrant. Because of this weaving area along Kipling Street, the bicycle lanes are transitioned to/from the shared use path on the west side of Kipling Street to grade separations of the loop ramps, which creates out-of-direction travel for pedestrians and bicyclists through the interchange.

The interchange is estimated to directly impact 19 to 21 properties with six to eight full and 13 partial acquisitions (total = 12.9 to 19.8 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. The acquisitions for the South Frontage Road include two to four residential properties with the rest of the acquisitions being commercial properties. The direct access to Kipling Street via the west side of the North Frontage Road is closed, which is a negative impact to the access for area businesses in the northwest quadrant.

The interchange would be relatively easy to construct with the loop ramps located where there are currently no roads, meaning fewer traffic impacts during construction. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

Although there are operational and safety benefits with the removal of the left turns at the ramp intersections, new operational and safety concerns are introduced with the weaving maneuvers on Kipling Street between the loop ramps and the deceleration needed for the loop ramp serving traffic exiting the freeway.

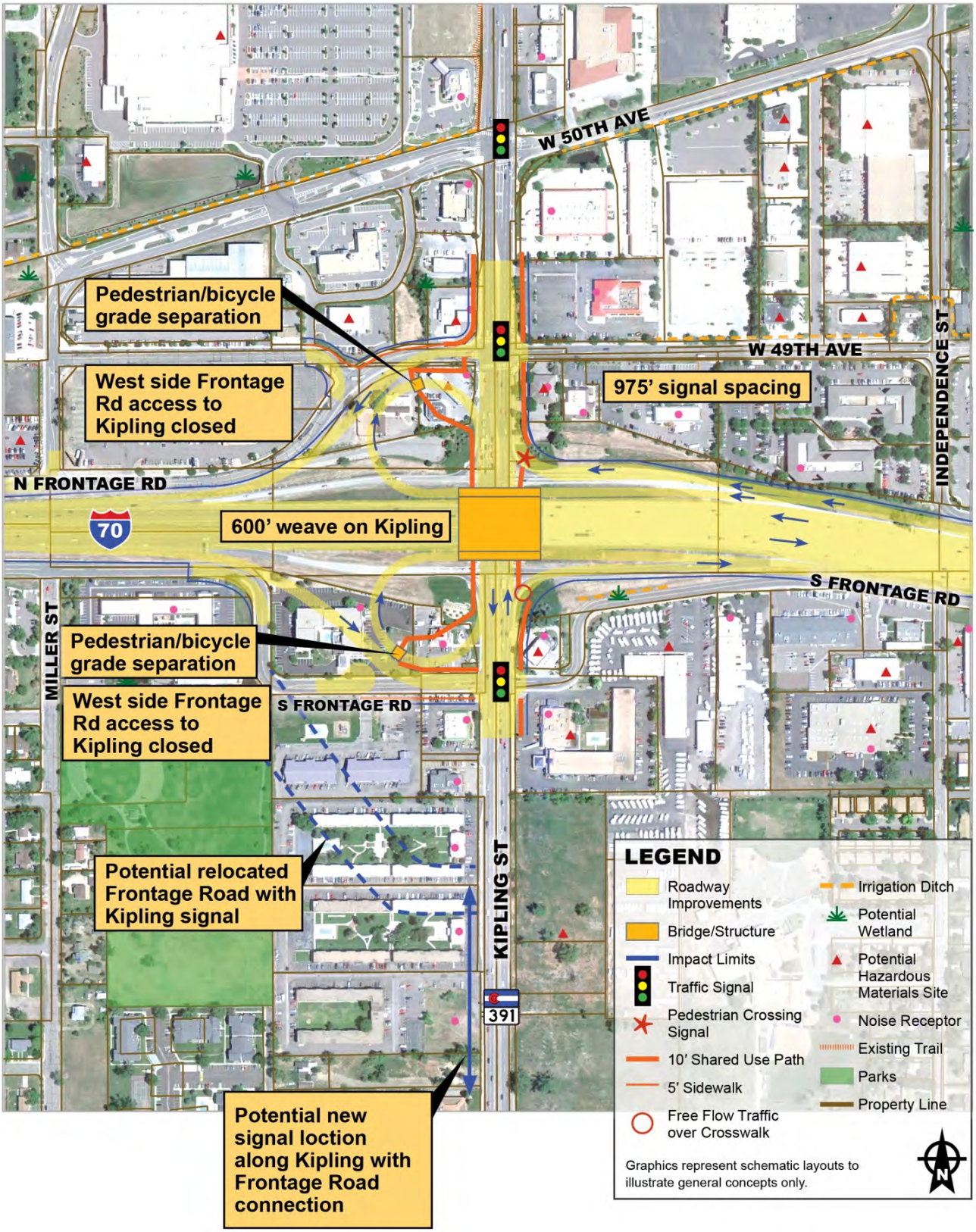
To avoid the weaving area between the loop ramps, the alternative does not accommodate bicycle lanes on the west side of Kipling Street. The shared use path is also located away from Kipling Street to utilize grade separations of the loop ramps. Therefore, the alternative does not accommodate direct multimodal connections.

The physical ROW acreage required is similar to other alternatives, but there are larger negative impacts to local residential and business access on the west side of Kipling Street because the loop ramps cut off the frontage road access to the northwest and southwest quadrants. Some of the property acquisition is for the relocated South Frontage Road, which helps reduce the access impacts to the southwest quadrant of the interchange. However, the South Frontage Road must be relocated farther away from the interchange than with other alternatives due to minimum signal spacing requirements.

Although there are some operational benefits, this alternative does not meet the safety and multimodal elements of the Purpose and Need because it introduces safety concerns with the weaving maneuvers and deceleration issues of the exit loop ramp and does not accommodate direct multimodal connections through the interchange. Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 15: Alternative 9 - Partial Cloverleaf with Loops Southwest & Northwest Quadrants



Texas Frontage Road Diamond
Alternative I1

This interchange consists of a diamond interchange with frontage road access provided directly to/from the freeway ramps. The frontage road intersections from the ramps may be a roundabout (shown in the northwest quadrant), stop-controlled (shown in the southeast quadrant), or merging operations. The frontage road intersections on Kipling Street are unsignalized with limited movements. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with the location depending on local land use plans.

The alternative, shown in **Figure 16**, eliminates two signals on Kipling Street and provides access between I-70 and the frontage roads.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 60% from the No Action alternative in the PM peak hour.
- South Frontage Road experiences increase in delay at unsignalized access.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by about 45%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 70%.
- Safety concerns with speed differential of freeway and local traffic on ramps and difficulty for drivers to negotiate unusual movements through interchange.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- No pedestrian crossing of Kipling Street provided at unsignalized frontage road intersection, so out-of-direction travel required.

Environmental and Community Impacts

- Interchange estimated to directly impact 19 to 26 properties with two to eight full and 17 to 18 partial acquisitions (total = 8.2 to 23.3 acres), depending on South Frontage Road relocation.
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Moderately difficult to construct within tight interchange area with opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs for South Frontage Road relocation.

Evaluation

With this alternative, the overall intersection delay at the Westbound I-70 Off Ramp is reduced by over 50% in the peak hours. The southbound peak hour queues on Kipling Street leading to the interchange are reduced by about 45% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 70%.

With the frontage roads accessing the freeway ramps, there are safety issues created because of the speed differential occurring within a short distance on the ramps between high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp. It would be difficult for trucks and drivers unfamiliar with the area to negotiate the unusual movements between the ramps and the frontage roads, particularly with a roundabout or stop-controlled intersection. Because many of the drivers using this interchange to access the surrounding businesses are not from this area, the unusual configuration would contribute to

safety and operational issues related to drivers traveling slower than the traffic flow or making erratic turn movements.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. However, there is no pedestrian crossing of Kipling Street at the unsignalized frontage road intersection and pedestrians and bicyclists would need to travel out of their way to the north or south to cross at a signal. This out-of-direction travel may encourage pedestrians and bicyclists to attempt to cross Kipling Street at a mid-block location, which is a multimodal safety concern.

The interchange is estimated to directly impact 19 to 26 properties with two to eight full and 17 to 18 partial acquisitions (total = 8.2 to 23.3 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. Most of the acreage and all of the full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The acquisitions for the South Frontage Road include up to four residential properties with the rest of the acquisitions being commercial properties.

The interchange would be moderately difficult to construct because most construction would occur in the area of the existing ramps and frontage roads and impact existing traffic. There are opportunities for construction in phases because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

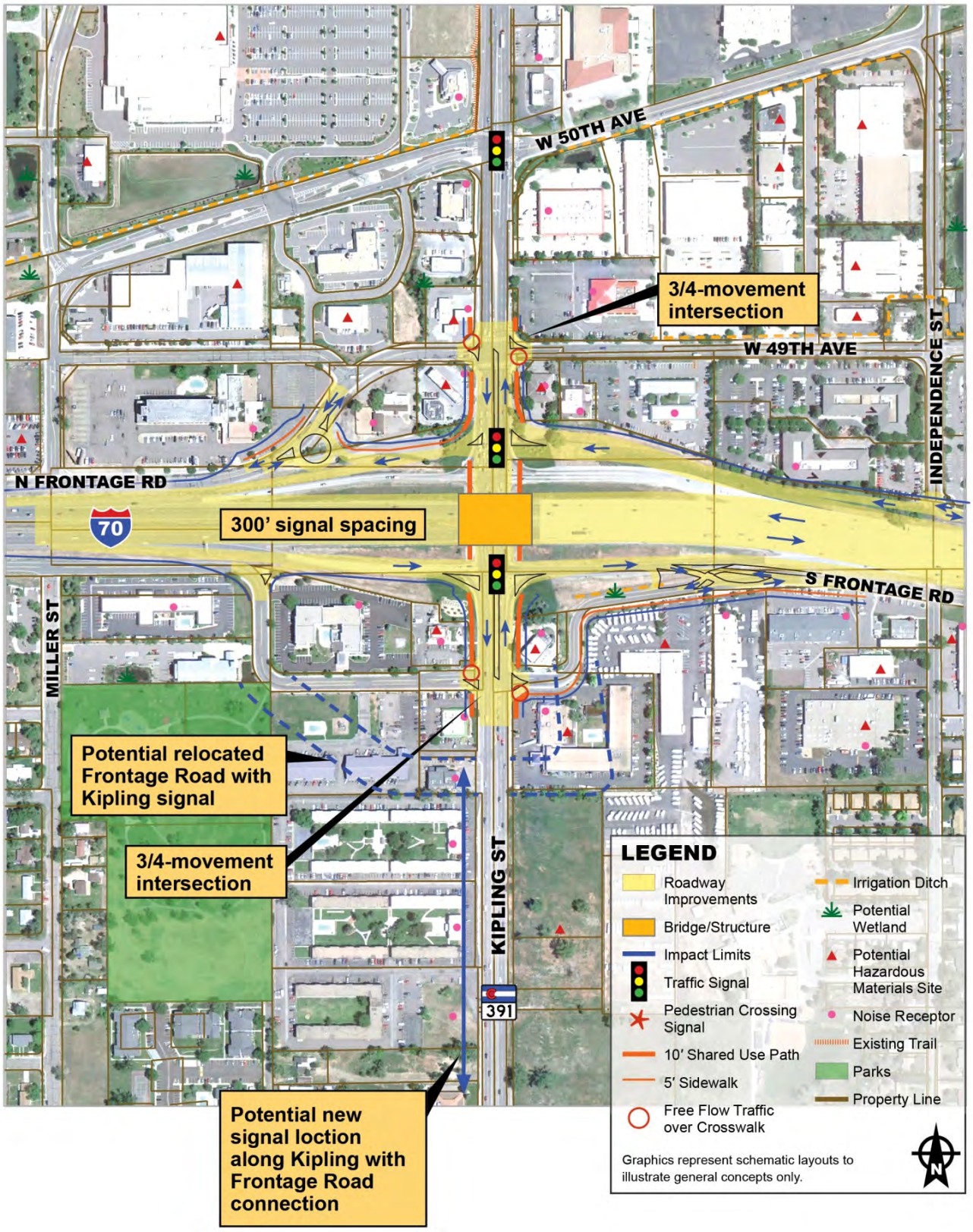
This interchange configuration provides direct access between I-70, Kipling Street, and the frontage roads with improved traffic operations at the ramp traffic signals. However, there have been substantial concerns expressed for the operational and safety issues introduced with the mix of high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp to access the frontage road. Local traffic directly accessing freeway ramps creates operational inefficiencies due to weaving maneuvers, speed differences, and multiple merging and turning conflicts on the ramp. There are additional safety and operational concerns with the difficulty for unfamiliar drivers to negotiate the unusual movements through the interchange to access area businesses.

There is no pedestrian crossing of Kipling Street at the unsignalized frontage road intersection, which presents a multimodal safety concern.

This alternative does not meet the Purpose and Need because it does not improve traveler safety with the combination of multimodal safety concerns and added safety and operational issues related to the local frontage road access to/from the freeway ramps Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 16: Alternative 11 - Texas Frontage Road Diamond



Traditional Diamond
Alternative 12

This interchange consists of two signalized intersections on Kipling Street serving the I-70 ramps with increased spacing between the signals, and the existing frontage road intersections are unsignalized and limited to right-in/right-out movements. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with the location depending on local land use plans.

The alternative, shown in **Figure 17**, eliminates two signals on Kipling Street and increases signal spacing.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 45% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by about 75%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by about 90%.
- Greater intersection spacing and directional interchange layout is easy for drivers to negotiate.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- No pedestrian crossing of Kipling Street provided at unsignalized frontage road intersection, so out-of-direction travel required.

Environmental and Community Impacts

- Interchange estimated to directly impact 20 to 22 properties with five to seven full and 15 partial acquisitions (total = 7.3 to 19.8 acres), depending on the South Frontage Road relocation.
- Potential increase in traffic traveling on Independence Street in northeast quadrant expected due to limitation of left turns at access to frontage road.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs. ($$ - relative moderate costs)

Evaluation

This alternative improves vehicular operations by reducing the overall intersection delay at the Westbound I-70 Off Ramp by 45% in the peak hours. The southbound peak hour queues on Kipling Street leading to the interchange are reduced by about 75% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by about 90%. Because the diamond interchange is a typical layout, it would be relatively easy for drivers unfamiliar with the area to negotiate through the interchange.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. However, there is no pedestrian crossing of Kipling Street at the unsignalized frontage road intersection and pedestrians and bicyclists would need to travel out of their way to the north or south to cross at a signal. This out-of-direction travel may encourage pedestrians and bicyclists to attempt to cross Kipling Street at a mid-block location, which is a multimodal safety concern.

The interchange is estimated to directly impact 20 to 22 properties with five to seven full and 15 partial acquisitions (total = 7.3 to 19.8 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. Most of the acreage and all of the full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The acquisitions for the South Frontage Road include up to four residential properties with the rest of the acquisitions being commercial properties.

The traffic signal at the North Frontage Road would be removed and the intersection would be converted to a right-in right-out operation, which benefits operations and safety along Kipling Street, but would require traffic that would turn left at that intersection to use the 50th Avenue traffic signal. This is a negative impact for businesses along the frontage road.

The interchange would be moderately difficult to construct because most construction would occur in the area of the existing ramps and frontage roads and impact existing traffic. There are opportunities for construction in phases because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

This interchange configuration improves vehicular operations at the interchange and the typical layout makes it relatively easy for drivers unfamiliar with the area to negotiate through the interchange. With the capacity improvements and increased signal spacing, the overall operation of the interchange is improved and the reduced congestion also provides safety benefits.

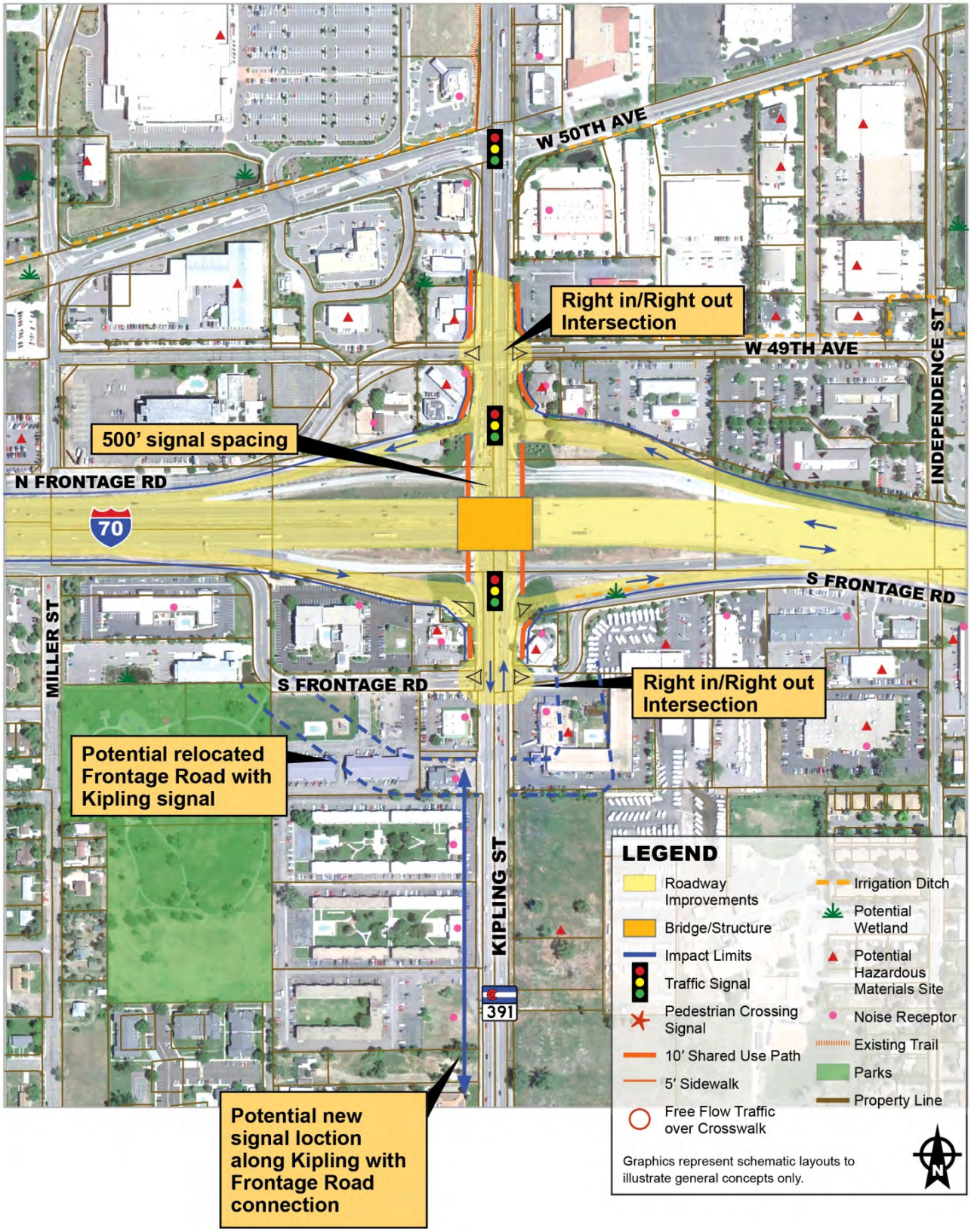
There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street, but there is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection, which presents a multimodal safety concern.

The physical ROW acreage required is similar to other alternatives, but most of the acreage and full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The removal of the traffic signal and conversion to a right-in right-out operation at the North Frontage Road would require traffic that would turn left at that intersection to go to the 50th Avenue traffic signal, which would negatively impact the access for businesses along the frontage road.

Because this alternative meets the Purpose and Need by improving the interchange operational efficiency with reduced delay, improving traveler safety with reduced congestion and queues and increased signal spacing, and accommodating direct multimodal connections through the interchange while minimizing impacts to business access, this alternative was carried forward for further consideration.

Conclusion: **CARRIED FORWARD**

Figure 17: Alternative 12 - Traditional Diamond



Button Hook Ramps
Alternative 17

This interchange consists of a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and a loop ramp in the northwest quadrant providing access from the westbound off ramp to southbound Kipling Street with direct access to the frontage road in the northwest quadrant.

The alternative, shown in **Figure 18**, eliminates two traffic signals on Kipling Street and provides access between I-70 and the frontage roads.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 70% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by 85%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 75%.
- Unusual movements for ramp access to/from Kipling Street are relatively difficult for drivers to negotiate.
- Safety/operational concerns with radius and design speed of the loop ramps with area truck traffic.
- Safety/operational benefit with removal of high volume left turn conflicts for Westbound I-70 Off Ramp and Eastbound I-70 On Ramp.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- Shared use path and bicycle lanes cross free-flow loop ramp movements.

Environmental and Community Impacts

- Interchange estimated to directly impact 18 commercial properties with four full and 14 partial acquisitions (total = 6.2 acres).
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by over 70% in the peak hours. The southbound peak hour queues on Kipling Street approaching the interchange are reduced by 85% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by 75%. There is safety and operational benefits with the removal of the high volume left turns on Kipling Street for the Westbound I-70 Off Ramp and Eastbound I-70 On Ramp.

It would be difficult for drivers unfamiliar with the area to negotiate the unusual movements to travel between the freeway ramps and Kipling Street via the frontage roads, particularly with a roundabout. Because many of the drivers using this interchange to access the surrounding businesses are not from this area, the unusual configuration would contribute to operational issues along the frontage roads. However, the likelihood for drivers to use the adjacent local streets to avoid Kipling Street would be reduced due to the improved operations on the major arterial.

The loop ramp for the westbound I-70 exit ramp introduces a safety concern with high-speed freeway traffic needing to decelerate quickly around a loop ramp. Due to this safety concern, CDOT typically avoids constructing off ramps as loops. There are also safety and operational concerns with the radius and design

of the loop ramps and frontage road intersections with the area truck traffic. Even when the loop ramps are constructed meeting design standards, large trucks must travel slowly around the ramp which presents speed differential issues with merging and diverging freeway movements.

There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street. Because there are traffic signals at north and south frontage roads, pedestrians and bicyclists are able to cross Kipling Street at both locations and across the north or south leg of each intersection. However, there are safety concerns with the shared use path and bicycle lanes crossing the free-flow loop ramp movements.

The interchange is estimated to directly impact 18 commercial properties with four full and 14 partial acquisitions (total = 6.2 acres). The ramp configuration provides direct access between I-70 and the north and south frontage roads, providing access benefits to the surrounding businesses and neighborhoods.

The interchange would be relatively easy to construct with the loop ramps located where there are currently no roads, meaning fewer traffic impacts during construction. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

This interchange configuration provides direct access between I-70, Kipling Street, and the frontage roads with improved traffic operations along Kipling Street. There are added operational concerns with the difficulty for unfamiliar drivers to negotiate the unusual movements to travel between the freeway ramps and Kipling Street via the frontage roads, particularly with a roundabout.

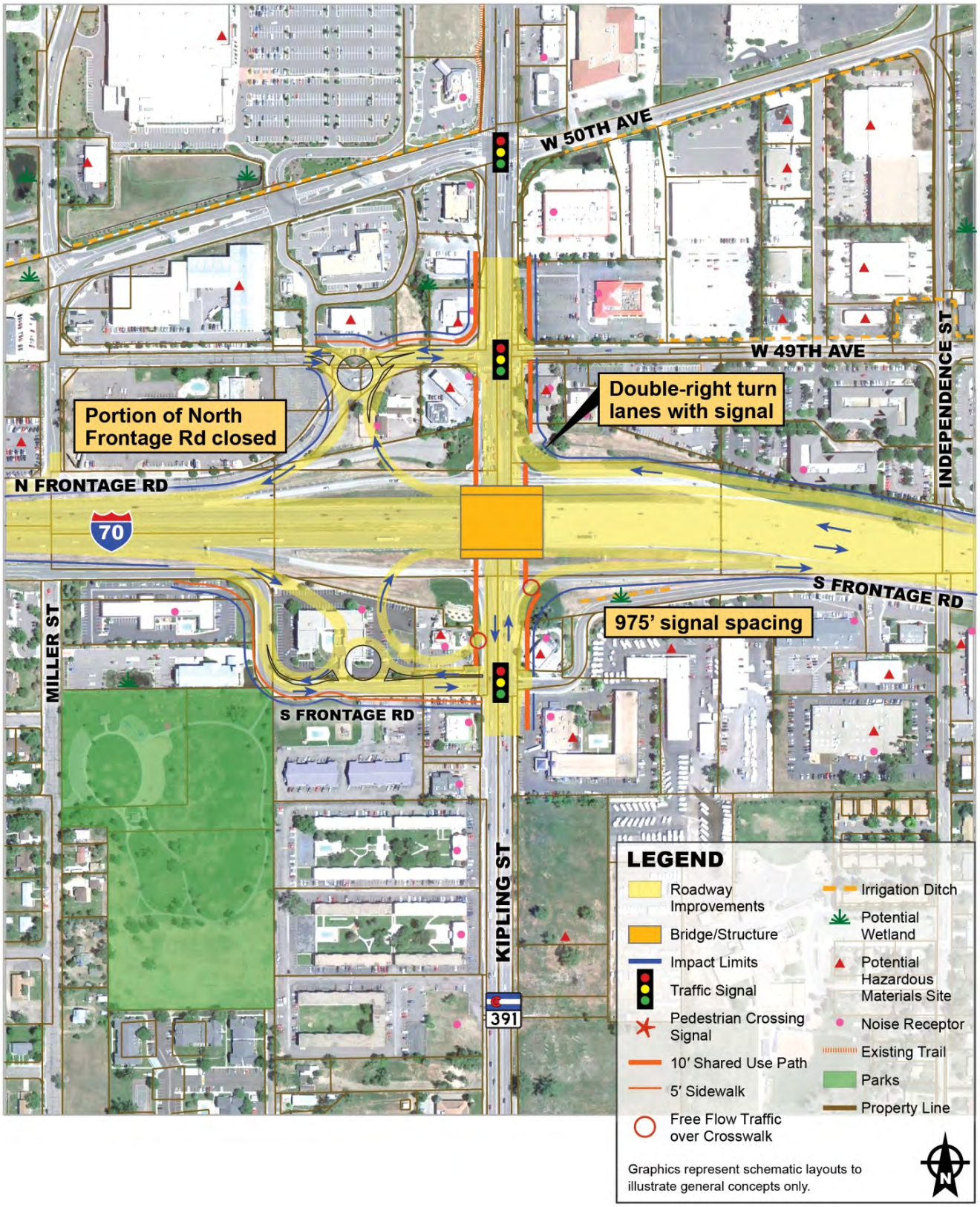
There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street. Signalized pedestrian and bicyclist crossings of Kipling Street are also accommodated at the frontage road traffic signals north and south of the interchange, which will facilitate pedestrian connections to the transit stops at those intersections.

The physical ROW acreage required is similar to other alternatives and the ramp configuration provides direct access between I-70 and the north and south frontage roads, which is a benefit to the operational efficiency of the interchange and minimizes local business and resident impacts.

Because this alternative meets the Purpose and Need by improving the interchange operational efficiency with reduced delay, improving traveler safety with reduced congestion and queues and increased signal spacing, and accommodating direct multimodal connections through the interchange while minimizing impacts to local business access, this alternative was carried forward for further consideration.

Conclusion: **CARRIED FORWARD**

Figure 18: Alternative 17 - Button Hook Ramps



Michigan Lefts for Ramps
Alternative 21

This interchange consists of a diamond interchange with left turns restricted at the ramp intersections, so drivers must turn right then do a U-turn at the frontage road intersection.

The alternative, shown in **Figure 19**, eliminates two traffic signals on Kipling Street.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 35% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange increase.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 50%.
- Unusual turn movements for ramp access to Kipling Street are relatively difficult for drivers to negotiate.

Multimodal Connections

- Grade separated crossing of multilane ramp provided for shared use path, but with some out-of-direction travel required.
- Unusual configuration and vehicular movements contributes to multimodal safety issues and may be intimidating for bicyclists and pedestrians to negotiate.

Environmental and Community Impacts

- Interchange estimated to directly impact ten commercial properties with three full and seven partial acquisitions (total = 2.6 acres).
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Difficult to maintain traffic on Kipling Street with construction with opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

With this alternative, the overall intersection delay at the Westbound I-70 Off Ramp is reduced by 35% in the peak hours. The peak hour queues on the Westbound I-70 Off Ramp are reduced by 50%, but the southbound peak hour queues on Kipling Street leading to the interchange increase. The right turn and U-turn maneuvers required for the left turn movements at the ramp intersections is unusual and would be difficult for drivers unfamiliar with the area to negotiate. There is no freeway interchange with this configuration along I-70 in Colorado or along any freeway in the Denver metropolitan area. Because many of the drivers using this interchange are unfamiliar with the area, this configuration would create additional safety and operational issues related to confused drivers traveling slower than the traffic flow or making erratic turn movements.

The unusual configuration and vehicular movements with wide approaches (such as the four right turn lanes on the Westbound I-70 Off Ramp and two-lane U-turn movements at the frontage roads) contributes to multimodal safety issues and may be intimidating for bicyclists and pedestrians to travel through the interchange because they will be unsure of where to look for vehicle conflicts. Due to the relatively high volumes and speeds of the traffic at the Eastbound I-70 On Ramp, a grade separation is provided across the multilane ramp. Accessing that grade separation creates some out-of-direction travel for pedestrians through the interchange.

The interchange is estimated to directly impact ten commercial properties with three full and seven partial acquisitions (total = 2.6 acres). The traffic signals serving the frontage road access north and south of the interchange remain in the current location without restrictions to turn movements, so the location of the current access to surrounding residential areas and businesses is unchanged. However, the size of the frontage road

intersection is increased and the signal operation is more complex to accommodate the heavy volume of U-turn movements, including trucks.

The interchange would be moderately difficult to construct because most construction would occur in the area of existing ramps and Kipling Street, which would impact existing traffic. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

This interchange configuration provides access between I-70, Kipling Street, and the frontage roads with reduced delay at the ramp traffic signals. However, the southbound peak hour queues on Kipling Street increase and there is safety and operational issues introduced with the unusual turning maneuvers for the heavy volume ramp movements, particularly with the delivery trucks and unfamiliar drivers that frequently utilize the interchange to access area businesses.

The unusual configuration and vehicular movements with wide approaches (such as the four right turn lanes on the Westbound I-70 Off Ramp and two-lane U-turn movements at the frontage roads) contributes to multimodal safety issues. The shared use path is located away from Kipling Street to utilize a grade separation of the on ramp, so a direct connection is not provided along Kipling Street.

This alternative does not meet the Purpose and Need because it does not improve operational efficiency and traveler safety with the combination of multimodal safety concerns and added safety and operational issues related to the unusual vehicular movements. It also does not accommodate direct multimodal connections through the interchange. Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 19: Alternative 21 - Michigan Lefts for Ramps

Single Roundabout Interchange
Alternative 31

This interchange consists of a single large roundabout on Kipling Street providing one-way movements at the ramps and frontage road intersections.

The alternative, shown in **Figure 20**, provides access between I-70, Kipling Street, and the frontage roads with a one-way circle.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 25% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange increase.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 60%.
- Unusual series of closely-spaced signals along one-way circle creates new short weaving and lane-changing distances and may be difficult for drivers to understand.

Multimodal Connections

- Out-of direction travel required for pedestrians and bicyclists on shared use path due to large circular layout.
- Bicycle lanes transition to/from shared use path through the interchange area.

Environmental and Community Impacts

- Interchange estimated to directly impact 16 commercial properties with six full and ten partial acquisitions (total = 4.8 acres).
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Difficult to construct with long duration for multiple structures and limited opportunities to construct in phases.
- Substantial construction costs expected with moderate right-of-way costs.

Evaluation

With this alternative, the overall intersection delay at the Westbound I-70 Off Ramp is reduced by 25% in the peak hours. The peak hour queues on the Westbound I-70 Off Ramp are reduced by 60%, but the southbound peak hour queues on Kipling Street leading to the interchange increase. The series of closely-spaced signals along a one-way circle is unusual and would be difficult for trucks and drivers unfamiliar with the area to negotiate. . There is no freeway interchange with this configuration along I-70 in Colorado or along any freeway in the Denver metropolitan area. Because many of the drivers using this interchange are unfamiliar with the area, this configuration would create additional safety and operational issues related to confused drivers traveling slower than the traffic flow or making erratic turn movements.

Because of the high traffic volumes, multiple lanes, and closely-spaced signal configuration, the bicycle lanes are transitioned to/from the shared use path. Pedestrians would need to cross Kipling Street at the signals to travel through the interchange inside of the large roundabout, which creates out-of-direction travel, particularly for bicyclists transitioning from the on-street bicycle lanes.

The interchange is estimated to directly impact 16 commercial properties with six full and ten partial acquisitions (total = 4.8 acres). There are no turn restrictions for the frontage roads north and south of the interchange, but complexity of accessing area neighborhoods and businesses is increased with the series of closely-spaced traffic signals. This is a negative impact to access for area businesses.

The interchange would be moderately difficult to construct because there are multiple freeway bridge structures, which would take a relatively long time to construct and would impact existing I-70 traffic. The one-way configuration is dependent on the new I-70 bridge structures, so the interchange would need to be constructed as one project with a relatively large funding source. Due to the multiple freeway bridge structures, the construction costs would be relatively substantial.

Critical Considerations

There are operational benefits at the individual traffic signals with the one-way circular operation. However, the southbound peak hour queues on Kipling Street increase and new safety and operational issues are introduced related to unfamiliar drivers traveling slower than the traffic flow or making erratic turn movements.

This alternative does not accommodate the bicycle lane along Kipling Street. The shared use path is located inside the large roundabout, which creates out-of-direction travel.

This alternative does not meet the Purpose and Need because it does not improve operational efficiency and traveler safety with the combination of safety and operational issues introduced with the complexity of the closely-spaced traffic signals. It also does not accommodate direct multimodal connections, Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 20: Alternative 31 - Single Roundabout Interchange

Loop Southwest Quadrant & Improved Westbound Ramps
Alternative 33

This interchange consists of a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and diamond ramps north of I-70 with frontage road access provided directly to/from the freeway ramps. The existing North Frontage Road intersection is unsignalized with limited movements. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with the location depending on local land use plans.

The alternative, shown in **Figure 21**, eliminates two traffic signals on Kipling Street, increases signal spacing, and provides access between I-70 and the frontage roads north of I-70.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 55% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by 40%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 75%.
- Safety concerns with speed differential of freeway and local traffic on ramps and difficulty for drivers to negotiate unusual movements on north side of interchange.
- Safety/operational concerns with radius and design speed of the loop ramp with area truck traffic.
- Safety/operational benefit with removal of high volume left turn conflicts for Eastbound I-70 On Ramp.

Multimodal Connections

- No pedestrian crossing of Kipling Street provided at unsignalized north frontage road intersection, so out-of-direction travel required.
- Bicycle lanes are provided along Kipling Street directly through the interchange.

Environmental and Community Impacts

- Interchange estimated to directly impact 18 to 21 properties with three to four to six full and 14 to 15 partial acquisitions (total = 11.2 to 18.2 acres), depending on the South Frontage Road relocation.
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by 55% during the peak hours. The southbound peak hour queues on Kipling Street leading to the interchange are reduced by 40% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 75%. There are safety and operational benefits with the removal of the left turn movements from Kipling Street to eastbound I-70.

With the North Frontage Road accessing the westbound I-70 ramps, there is safety issues created because of the speed differential occurring within a short distance on the ramps between high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp. It would be difficult for trucks and drivers unfamiliar with the area to negotiate the unusual movements between the ramps and the frontage roads, particularly with a roundabout or stop-controlled intersection. Because many of the drivers using this interchange to access the businesses north of I-70 are not from this area, the unusual configuration would contribute to safety and operational issues related to drivers traveling slower than the traffic flow or making erratic turn movements.

There are also safety and operational concerns with the radius and design of the loop ramp in the southwest quadrant with the area truck traffic. Even when loop ramps are constructed meeting design standards, large trucks must travel slowly around the ramp which presents speed differential issues with merging freeway movements.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. However, there is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection and pedestrians and bicyclists would need to travel out of their way to the north or south to cross at a signal. This out-of-direction travel may encourage pedestrians and bicyclists to attempt to cross Kipling Street at a mid-block location, which is a multimodal safety concern. There are also safety concerns with the shared use path and bicycle lanes crossing the free-flow loop ramp movements.

The interchange is estimated to directly impact 18 to 21 properties with three to four to six full and 14 to 15 partial acquisitions (total = 11.2 to 18.2 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. The acquisitions for the South Frontage Road include two to four residential properties with the rest of the acquisitions being commercial properties.

The interchange would be relatively easy to construct with most of the ramps located where there are currently no roads, meaning fewer traffic impacts during construction. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

This interchange configuration improves traffic operations at the ramp traffic signals. However, there have been substantial concerns expressed for the operational and safety issues introduced with the mix of high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp to access the North Frontage Road. Local traffic directly accessing freeway ramps creates operational inefficiencies due to weaving maneuvers, speed differences, and multiple merging and turning conflicts on the ramp. There are additional safety and operational concerns with the difficulty for unfamiliar drivers to negotiate the unusual movements to access area businesses on the north side of the interchange.

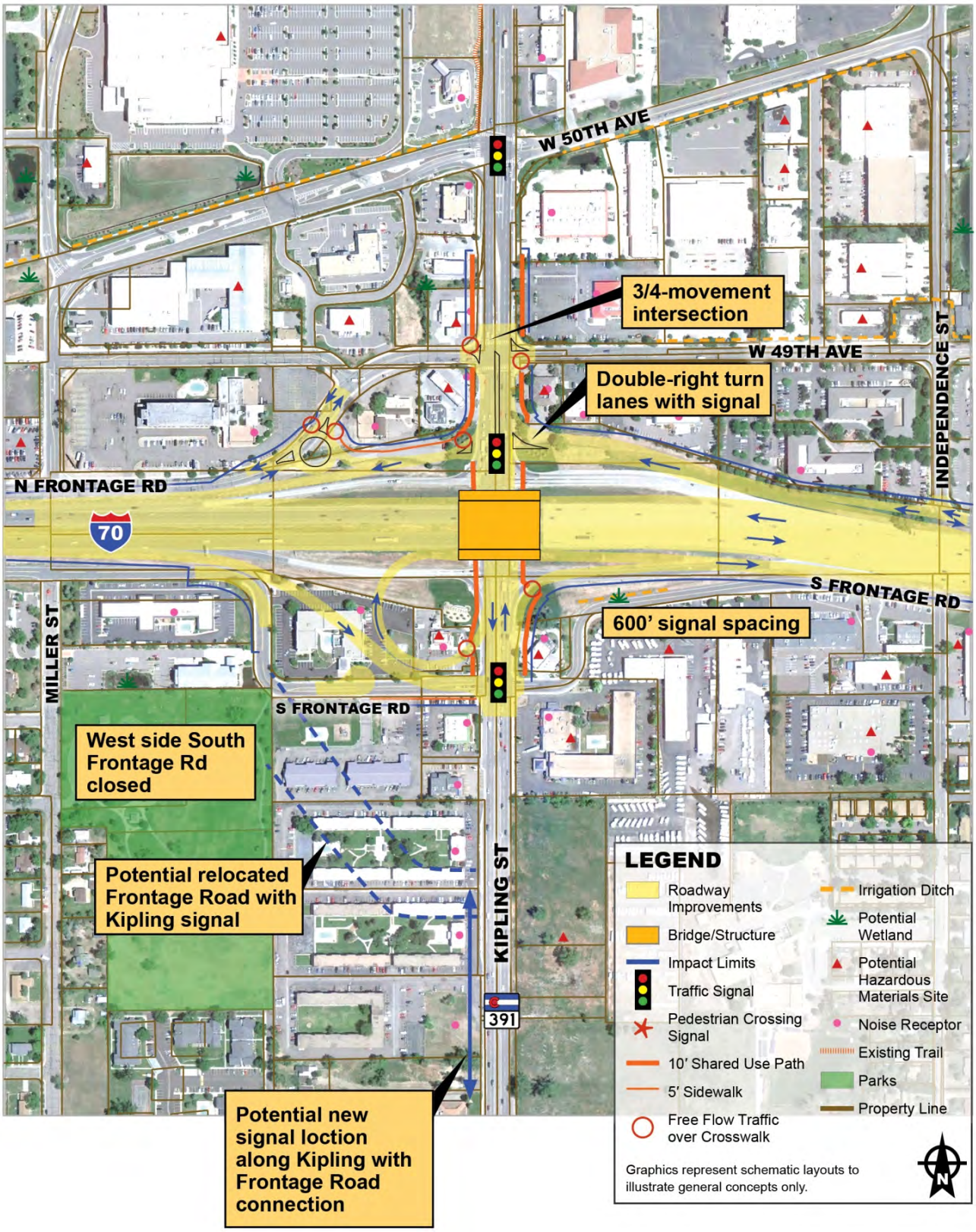
There is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection, which presents a multimodal safety concern.

The physical ROW acreage required is similar to other alternatives, but there are larger negative impacts to local residential and business access in the southwest quadrant because the loop ramp cuts off the frontage road access in its current location. Some of the property acquisition is for the relocated South Frontage Road, which helps reduce the access impacts to the southwest quadrant of the interchange. However, the South Frontage Road must be relocated farther away from the interchange than with other alternatives due to minimum signal spacing requirements.

This alternative does not meet the Purpose and Need because it does not improve traveler safety with the combination of multimodal safety concerns and added safety and operational issues related to the North Frontage Road access to/from the westbound I-70 ramps Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 21: Alternative 33 - Southwest Quadrant & Improved Westbound Ramps



Improved Tight Diamond with Southbound to Eastbound Flyover
Alternative 34

This interchange consists of current configuration with two tightly-spaced signalized intersections on Kipling Street serving the I-70 ramps and a flyover ramp serving the heavy movement from southbound Kipling Street to eastbound I-70.

The alternative, shown in **Figure 22**, provides a free-flow movement for the heavy southbound to eastbound movement through the interchange.

Operations and Safety

- Peak hour delays at the North Frontage Road and Kipling Street intersection increase with over double the overall intersection delay during the PM peak hour.
- Westbound I-70 Off Ramp delay reduced by 70% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by about 80%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by about 70%.
- Operational and safety concerns with the early decision point located between the closely-spaced intersections.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- Pedestrians and bicyclists cross ramp intersections at signals.

Environmental and Community Impacts

- Interchange estimated to directly impact seven commercial properties with seven partial acquisitions (total = 0.7 acres).
- Moderate access impacts due to flyover ramp.
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Relatively difficult to construct with flyover ramp.
- Opportunity for flyover ramp to be constructed prior to other interchange phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by about 70% in the peak hours. The southbound peak hour queues on Kipling Street approaching the interchange are reduced by about 80% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by about 70%. However, capacity issues at the North Frontage Road intersection remain with a volume-to-capacity ratio at 1.0 and with over double the overall intersection delay during the PM peak hour.

Although the flyover ramp provides free-flow access to eastbound I-70 for southbound Kipling Street traffic north of the interchange area, the southbound left turn at the eastbound I-70 ramps intersection cannot be removed in order to accommodate local traffic. The safety and operational benefit of the flyover ramp is limited because the operational and safety issues related to the closely-spaced traffic signals remain. These remaining issues include inadequate distance to achieve signal progression and short space for weaving and lane-changing maneuvers, which contributes to rear-end and sideswipe crashes.

The directional ramp from Kipling Street introduces safety and operational concerns with an early decision point along southbound Kipling Street at the 50th Avenue intersection. The directional ramp within the

close spacing of the North Frontage Road and 50th Avenue traffic signals creates operational issues with unbalanced lane utilization due to high volumes in the right lane leading to the flyover ramp. This additional high-volume maneuver between the intersections will exacerbate the operational and safety issues related to the closely-spaced traffic signals.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. Because there are traffic signals at the north and south frontage roads, pedestrians and bicyclists are able to cross Kipling Street at both locations and across the north and south leg of each intersection.

The interchange is estimated to directly impact seven commercial properties with seven partial acquisitions (total = 0.7 acres). The interchange would be relatively difficult to construct with the flyover ramp in a tightly constrained area. There are opportunities to construct and open the flyover ramp prior to the completing the rest of the interchange.

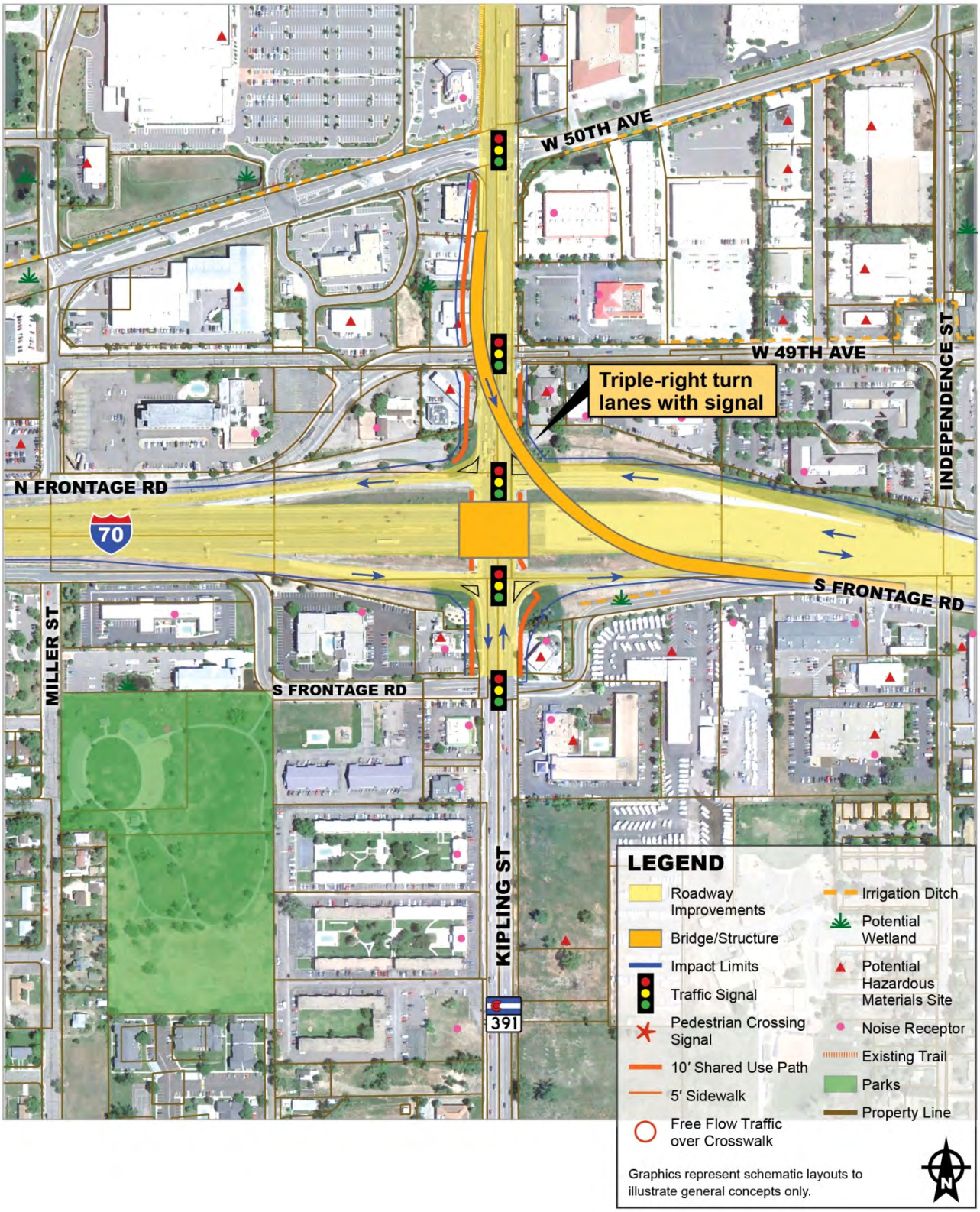
Critical Considerations

Although there are operational benefits with the free-flow movement to eastbound I-70 for southbound Kipling Street traffic north of the interchange area, the safety and operational benefits are limited because the southbound left turn at the eastbound I-70 ramps intersection cannot be removed to accommodate local traffic and the closely-spaced traffic signals at the ramps and frontage roads remain. Operational and safety issues related to the closely-spaced traffic signals remain, including inadequate distance to achieve signal progression and short space for weaving and lane-changing maneuvers, contributing to rear-end and sideswipe crashes. New safety concerns are introduced with the early decision point along southbound Kipling Street at the 50th Avenue intersection with the additional high-volume maneuver exacerbating the operational and safety issues related to the closely-spaced traffic signals.

This alternative does not meet the Purpose and Need because it does not improve the operational efficiency and traveler safety through the interchange due to the combination of added safety and operational concerns with the flyover ramp connection to Kipling Street and the operational issues not resolved because the closely-spaced traffic signals and major movements in the interchange remain. Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 22: Alternative 34 - Improved Tight Diamond with Southbound to Eastbound Flyover



Double Crossover Diamond Interchange
Alternative 35

This interchange consists of a diamond interchange with Kipling Street movements shifted to the other side of the street under the bridge to allow left turn movements that do not cross traffic. The existing frontage road intersections are unsignalized and limited to right-in/right-out movements. The South Frontage Road is relocated with a traffic signal on Kipling Street south of the interchange with the location depending on local land use plans.

The alternative, shown in **Figure 23**, eliminates two signals on Kipling Street and increases signal spacing.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 45% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by about 65%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by about 70%.
- Crossover layout at ramp intersections and unusual turn movements for ramp access to Kipling Street is relatively difficult for drivers to negotiate.

Multimodal Connections

- Shared use path and bicycle lanes are provided directly through the interchange.
- Unusual configuration and vehicular movements creates multimodal safety issues and may be intimidating for bicyclists and pedestrians to negotiate.

Environmental and Community Impacts

- Interchange estimated to directly impact 17 to 21 properties with three to seven full and 14 partial acquisitions (total = 7.3 to 19.8 acres), depending on the South Frontage Road relocation.
- Potential increase in traffic traveling on Independence Street in northeast quadrant expected due to limitation of left turns at access to frontage road.

Constructability

- Difficult to maintain traffic on Kipling Street with construction and limited opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs.

Evaluation

With this alternative, the overall intersection delay at the Westbound I-70 Off Ramp is reduced by 45% in the peak hours. The peak hour queues on the Westbound I-70 Off Ramp are reduced by about 70%. However, capacity issues at the Eastbound I-70 On Ramp intersection remain with a volume-to-capacity ratio at over 1.0 during the AM peak hour.

The crossover layout at the ramp intersections and turn movements are unusual and would be difficult for drivers unfamiliar with the area to negotiate. Because many of the drivers using this interchange are unfamiliar with the area, this configuration would create additional safety and operational issues related to confused drivers traveling slower than the traffic flow or making erratic turn movements.

The unusual configuration and vehicular movements contribute to multimodal safety issues and may be intimidating for bicyclists and pedestrians to travel through the interchange because they will be unsure of where to look for vehicle conflicts. There is also no pedestrian crossing of Kipling Street at the unsignalized frontage road intersections and pedestrians and bicyclists would need to travel out of their way to the north or south

to cross at a signal. This out-of-direction travel may encourage pedestrians and bicyclists to attempt to cross Kipling Street at a mid-block location, which is another multimodal safety concern.

The interchange is estimated to directly impact 17 to 21 properties with three to seven full and 14 partial acquisitions (total = 7.3 to 19.8 acres), depending on where the South Frontage Road is relocated based on the final traffic signal location along Kipling Street. Most of the acreage and all of the full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The acquisitions for the South Frontage Road include up to four residential properties with the rest of the acquisitions being commercial properties.

The traffic signal at the North Frontage Road would be removed and the intersection would be converted to a right-in right-out operation, which benefits operations and safety along Kipling Street, but would require traffic that would turn left at that intersection to use the 50th Avenue traffic signal. This is a negative impact for businesses along the frontage road.

The interchange would be moderately difficult to construct because most construction would occur in the area of existing ramps and Kipling Street, which would impact existing traffic. The crossover layout at the ramp intersections requires the construction to occur as one project without opportunities to construct the interchange in separate, smaller-scale projects.

Critical Considerations

This interchange configuration improves traffic operations, but there are safety and operational issues introduced with the crossover layout at the ramp intersections and unusual turn movements, particularly with the unfamiliar drivers that frequently utilize the interchange to access area businesses.

There are direct multimodal connections through the interchange with on-street bicycle lanes and a shared use path along Kipling Street, but there is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection, which presents a multimodal safety concern. The unusual configuration and vehicular movements also contribute to multimodal safety issues.

The physical ROW acreage required is similar to other alternatives, but most of the acreage and full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The removal of the traffic signal and conversion to a right-in right-out operation at the North Frontage Road would require traffic turning left at that intersection to go to the 50th Avenue traffic signal, which would negatively impact the access for businesses along the frontage road.

This alternative does not meet the Purpose and Need because it does not improve traveler safety with the combination of multimodal safety concerns and added safety and operational issues related to the unusual vehicular movements Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 23: Alternative 35 - Double Crossover Diamond Interchange

Button Hook Ramps South and Improved Westbound Ramps
Alternative 36

This interchange consists of a loop ramp in the southwest quadrant providing free-flow operations for the left turn movement from southbound Kipling Street to eastbound I-70 and diamond ramps north of I-70 with frontage road access provided directly to/from the freeway ramps. The existing North Frontage Road intersection is unsignalized with limited movements.

The alternative, shown in **Figure 24**, eliminates two traffic signals on Kipling Street, increases signal spacing, and provides access between I-70 and the frontage roads north of I-70.

Operations and Safety

- Westbound I-70 Off Ramp delay reduced by 55% from the No Action alternative in the PM peak hour.
- Southbound Kipling Street peak hour queues leading to the interchange are reduced by 50%.
- Peak hour queues on the Westbound I-70 Off Ramp are reduced by 75%.
- Safety concerns with speed differential of freeway and local traffic on ramps and difficulty for drivers to negotiate unusual movements on north side of interchange.
- Safety/operational concerns with radius and design speed of the loop ramp with area truck traffic.
- Safety/operational benefit with removal of high volume left turn conflicts for Eastbound I-70 On Ramp.

Multimodal Connections

- No pedestrian crossing of Kipling Street provided at unsignalized north frontage road intersection, so out-of-direction travel required.
- Bicycle lanes are provided along Kipling Street directly through the interchange.

Environmental and Community Impacts

- Interchange estimated to directly impact 18 commercial properties with two full and 16 partial acquisitions (total = 4.1 acres).
- No increase in traffic traveling through neighborhoods expected.

Constructability

- Relatively easy to construct with areas outside Kipling Street and opportunities to construct in phases.
- Typical construction costs expected with moderate right-of-way costs. ($$ - relative moderate costs)

Evaluation

This alternative has operational benefits by reducing the overall intersection delay at the Westbound I-70 Off Ramp by 55% during the peak hours. The southbound peak hour queues on Kipling Street leading to the interchange are reduced by 50% and the peak hour queues on the Westbound I-70 Off Ramp are reduced by almost 75%. There are safety and operational benefits with the removal of the left turn movements from Kipling Street to eastbound I-70.

With the North Frontage Road accessing the westbound I-70 ramps, there are safety issues created because of the speed differential occurring within a short distance on the ramps between high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp. It would be difficult for trucks and drivers unfamiliar with the area to negotiate the unusual movements between the ramps and the frontage roads, particularly with a roundabout or stop-controlled intersection. Because many of the drivers using this interchange to access the businesses north of I-70 are not from this area, the unusual configuration would contribute to safety and operational issues related to drivers traveling slower than the traffic flow or making erratic turn movements.

There are also safety and operational concerns with the radius and design of the loop ramp in the southwest quadrant with the area truck traffic. Even when loop ramps are constructed meeting design standards, large trucks must travel slowly around the ramp which presents speed differential issues with merging freeway movements.

The on-street bicycle lanes and shared use path are provided along Kipling Street directly through the interchange. However, there is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection and pedestrians and bicyclists would need to travel out of their way to the north or south to cross at a signal. This out-of-direction travel may encourage pedestrians and bicyclists to attempt to cross Kipling Street at a mid-block location, which is a multimodal safety concern.

The interchange is estimated to directly impact 18 commercial properties with two full and 16 partial acquisitions (total = 4.1 acres). The ramp configuration provides direct access between I-70 and the north and south frontage roads, providing access benefits to the surrounding businesses and neighborhoods.

The interchange would be relatively easy to construct with most of the ramps located where there are currently no roads, meaning fewer traffic impacts during construction. There are opportunities for phased construction because the north side of the interchange could be constructed separately from the south side of the interchange.

Critical Considerations

This interchange configuration improves traffic operations at the ramp traffic signals. However, there have been substantial concerns expressed for the operational and safety issues introduced with the mix of high-speed traffic getting on or off the freeway and local traffic turning on or off the ramp to access the North Frontage Road. Local traffic directly accessing freeway ramps creates operational inefficiencies due to weaving maneuvers, speed differences, and multiple merging and turning conflicts on the ramp. There are additional safety and operational concerns with the difficulty for unfamiliar drivers to negotiate the unusual movements to access area businesses on the north side of the interchange.

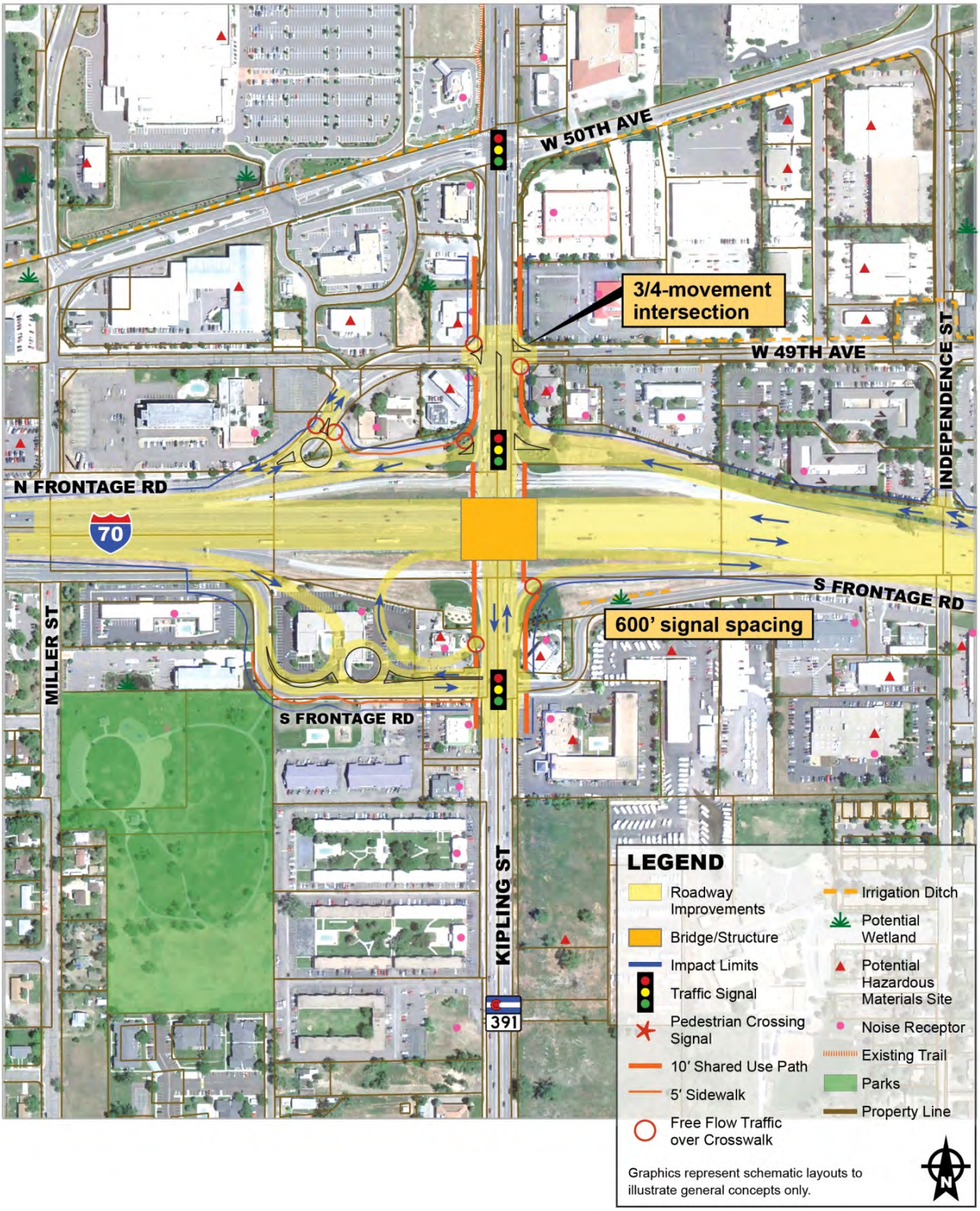
There is no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection, which presents a multimodal safety concern.

The physical ROW acreage required is similar to other alternatives and the ramp configuration provides direct access between I-70 and the north and south frontage roads, which is a benefit to the operational efficiency of the interchange and minimizes local business and resident impacts.

This alternative does not meet the Purpose and Need because it does not improve traveler safety with the combination of multimodal safety concerns and added safety and operational issues related to the North Frontage Road access to/from the westbound I-70 ramps Therefore, this alternative was not carried forward for further consideration.

Conclusion: **NOT CARRIED FORWARD**

Figure 24: Alternative 36 - Button Hook Ramps South and Improved Westbound Ramps



Westbound I-70 approaching Kipling interchange

Level 3 Alternatives Screening

With the Level 3 alternatives evaluation, steps were taken to further narrow the alternative recommendations and to refine the design elements of the alternatives, considering design solutions to minimize costs and community impacts and maximize multimodal benefits. The final results of the study will identify the alternative(s) to carry forward within future NEPA process(es).

Level 3 Alternatives

As described in the previous section of this report, the four action alternatives carried forward from Level 2 screening were:

- Alternative 1 – Single Point Urban Interchange (SPUI)
- Alternative 7 – Partial Cloverleaf with Loops SW & NE Quadrants
- Alternative 12 – Traditional Diamond
- Alternative 17 – Button Hook Ramps

The design concepts for the four alternatives are shown in **Figures 25 through 28**.

Meetings with stakeholders and a public open house were held to present the Level 2 evaluation results and recommendations. Comments from the public and stakeholders indicated concurrence with the Level 2 recommendations with the highest level of support for the SPUI and Traditional Diamond alternatives.

Figure 25: Alternative 1 – Single Point Urban Interchange

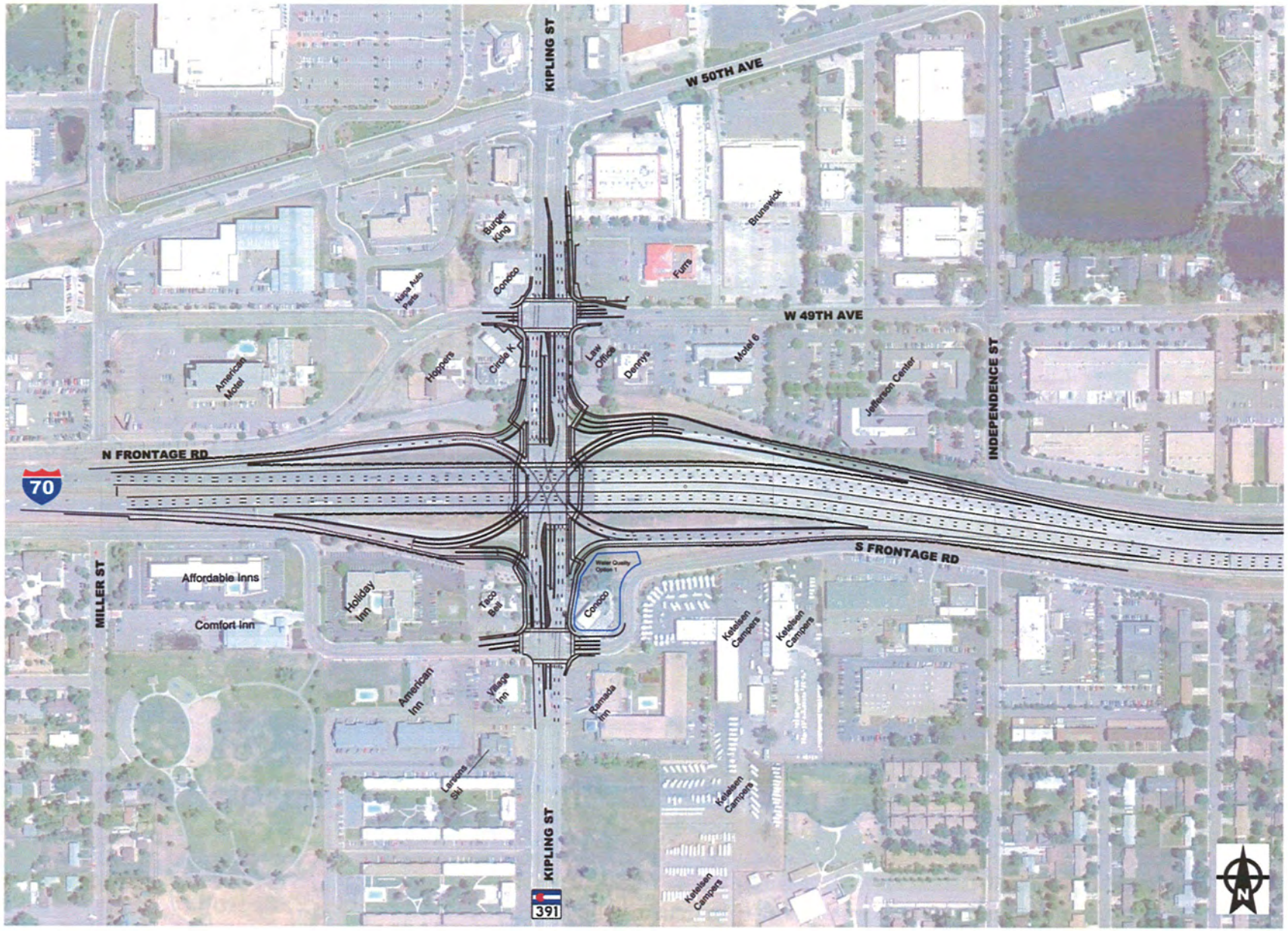


Figure 26: Alternative 7 – Partial Cloverleaf with Loops SW & NE Quadrants

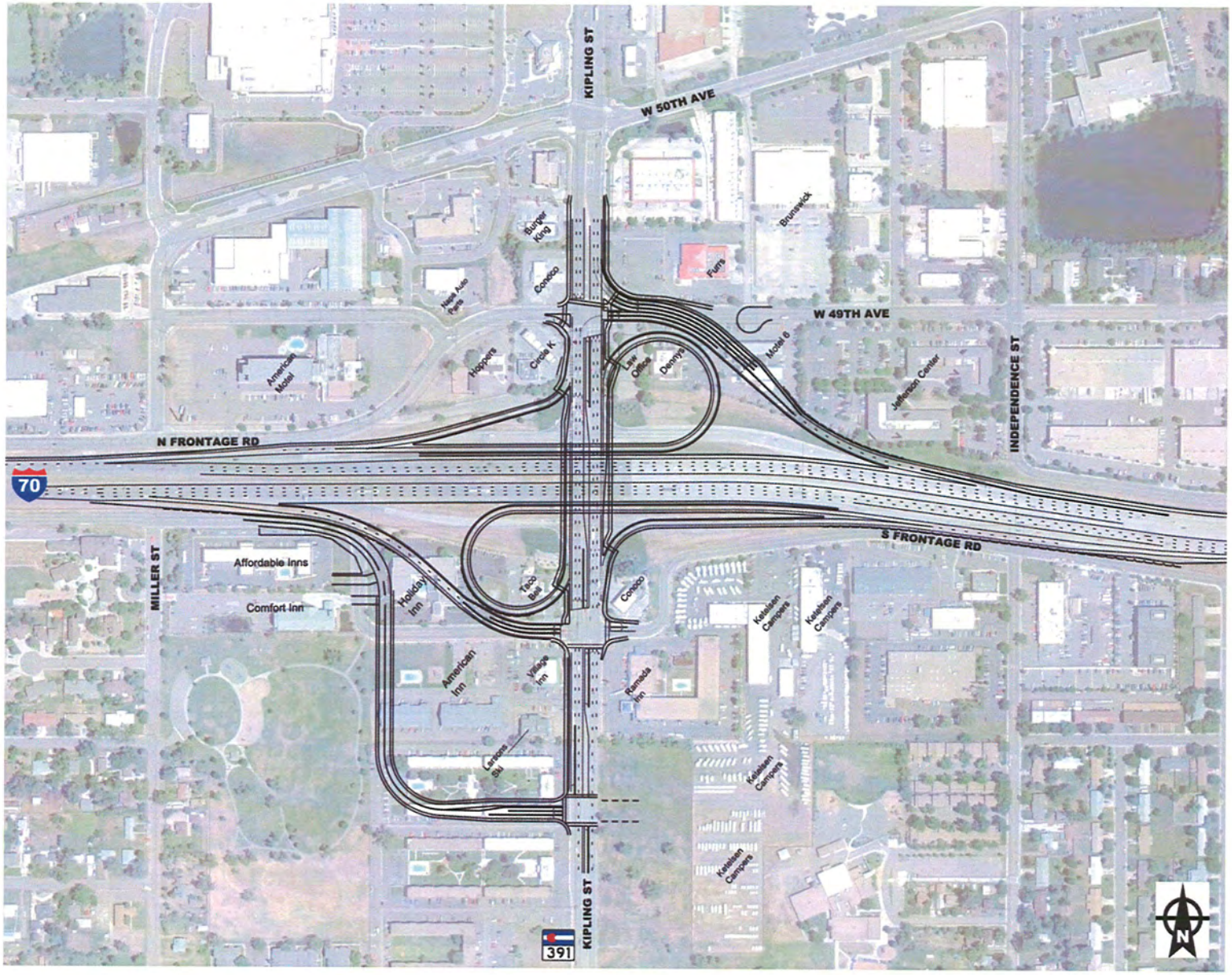


Figure 27: Alternative 12 – Traditional Diamond

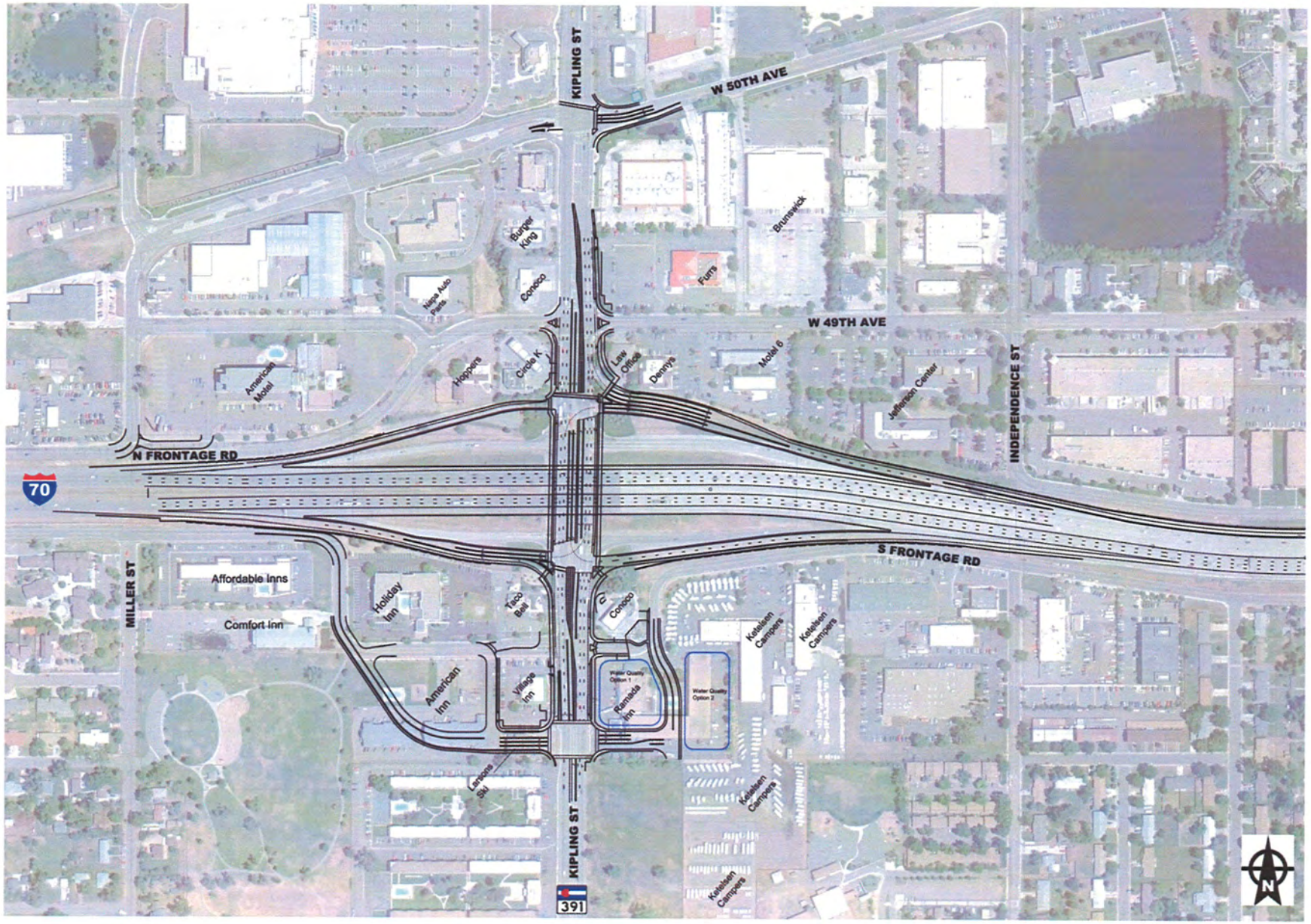
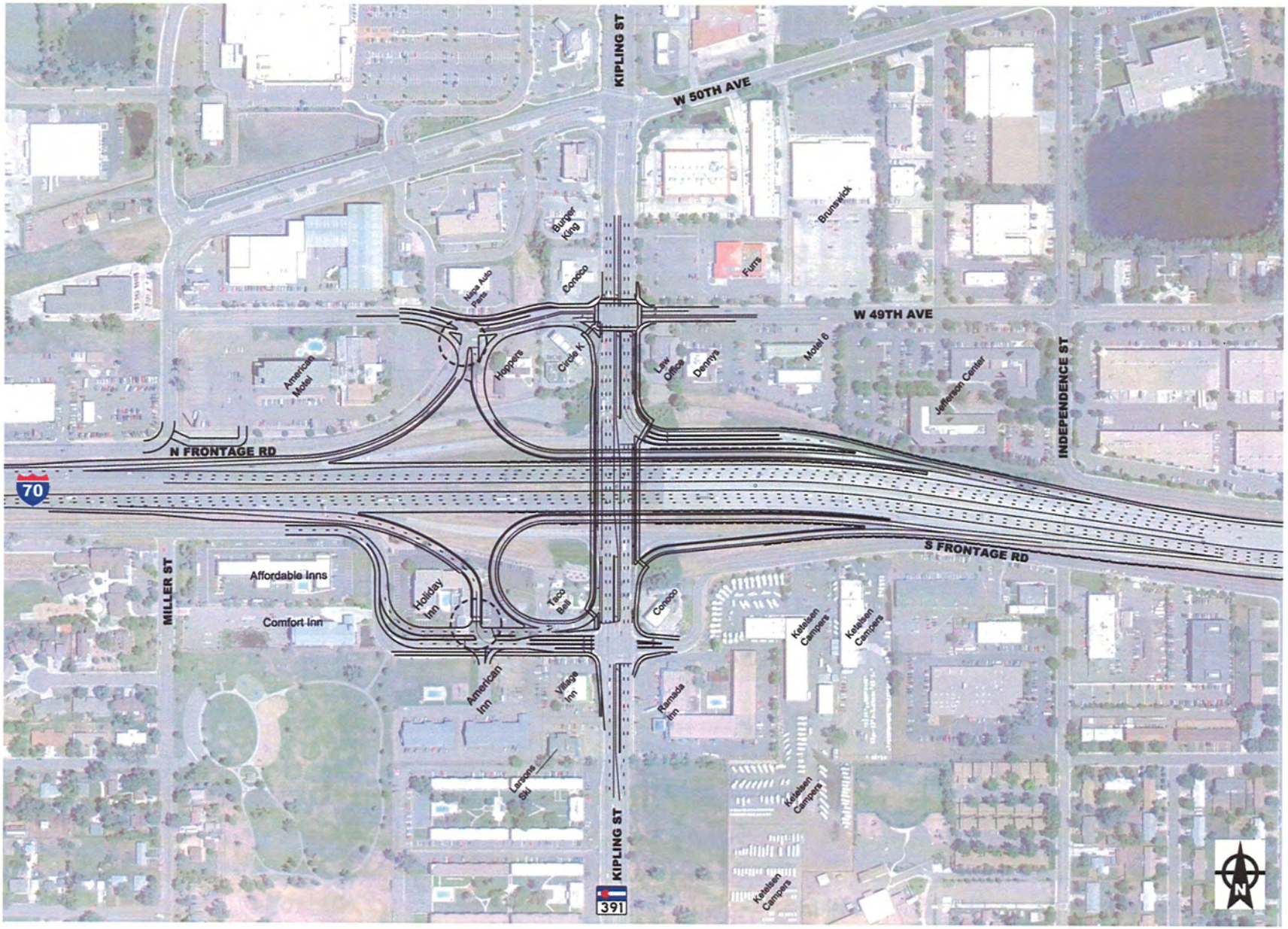


Figure 28: Alternative 17 – Button Hook Ramps



Initial Level 3 Screening

Based on coordination with the Technical Team, local agencies, area stakeholders, and the general public, an additional decision process was conducted at the beginning of the Level 3 evaluation to evaluate if the alternatives should be further narrowed prior to refining the conceptual design and traffic operations analysis for the recommended alternative(s).

Priority Criteria Evaluation

The evaluation criteria for Level 3 were prioritized to include the criteria of most concern from comments received during small group meetings with the Technical Team and area stakeholders, presentations to local agency elected officials, and the open house held with the general public. For this level of screening, the criteria of highest priority for the evaluation of interchange alternatives were developed based on stakeholder input. The criteria are:

- Interchange Capacity
- Driver Expectancy
- Pedestrian and Bicycle Crossings
- Property (ROW) Impacts
- Business Access
- Phased Construction Opportunities
- Project Costs

The four remaining alternatives were compared against these seven priority evaluation criteria using the Level 2 analysis results summarized in the previous chapter and the Level 2 Screening Matrix in Appendix B. The Partial Cloverleaf alternative (Alternative 7) and Button Hook Ramps alternative (Alternative 17) perform poorly compared to the SPUI (Alternative 1) and the Traditional Diamond (Alternative 12) on the majority of these priority criteria, including driver expectancy, pedestrian and bicycle crossings, property impacts, and business access.

Many of the drivers using this interchange are not from this area, so driver expectancy is important to optimize the operational efficiency of the interchange. The Partial Cloverleaf alternative is worse for driver expectancy because the loop ramps require out-of-direction turn movements (i.e., a driver must turn west to access eastbound I-70 via the loop ramp in the southwest quadrant). With drivers unfamiliar to the area, this can lead to sudden lane changes leading to the loop ramps. The Button Hook Ramps alternative is difficult for driver expectancy because it is an unusual interchange configuration and the unusual movements for ramp access to/from Kipling Street via the frontage roads are perceived difficult for drivers to negotiate.

The Partial Cloverleaf and Button Hook Ramps alternatives are worse for pedestrian and bicycle crossings because both configurations include crossings of free-flow loop ramp movements, which are substantially higher speed movements than the free-flow right-right turn movements provided in the SPUI and Traditional Diamond

alternatives. The Traditional Diamond alternative has no pedestrian crossing of Kipling Street at the unsignalized North Frontage Road intersection.

The Partial Cloverleaf and Button Hook Ramps alternatives require more ROW than the SPUI and Traditional Diamond alternatives for the ramp configurations. The physical ROW acreage for the Traditional Diamond alternative is similar, but most of the acreage and full property acquisitions are for the relocated South Frontage Road, which helps reduce the access impacts south of the interchange. The loop ramps of the Partial Cloverleaf alternative require closing the direct frontage road access in the northeast and southwest quadrants, which impacts access to the surrounding businesses worse than the SPUI alternative.

The Button Hook Ramps alternative is worse for area business access than the SPUI and Traditional Diamond alternatives due to the unusual interchange configuration and perceived difficulty for drivers to negotiate through the interchange area via the frontage roads.

Comparatively, the SPUI alternative and Traditional Diamond alternative ranked highest on the majority of the prioritized criteria.

The Partial Cloverleaf alternative would provide the highest interchange capacity of the four remaining alternatives with the loop ramps providing free-flow operations and simplified signal phasing; however, the SPUI and Traditional Diamond alternatives would also provide traffic operational benefits notably better than the typical CDOT operational level of service standards of LOS D or better in urban areas. The Technical Team determined that the small operational benefits of the Partial Cloverleaf alternative over the SPUI and Traditional Diamond alternatives did not outweigh the additional property and business access impacts.

The SPUI alternative provides the least opportunities for phased construction of the ultimate interchange layout because the freeway bridge and ramps must be constructed as one construction project with a relatively large funding source. The SPUI construction cannot be phased with separate construction projects, which would need less funding at one time. However, comments from the public and stakeholders indicated that the substantially lower property impacts of the SPUI (less than 10% of any of the other remaining alternatives) are more important than the desire for major construction to occur earlier (which may be possible with a series of smaller funding sources rather than waiting for a single, large funding source). Also, the SPUI alternative does not preclude short-term improvements that will provide immediate safety and capacity benefits.

Recommended Alternatives

The alternatives were not further narrowed and all four alternatives will be carried forward for further evaluation in future NEPA process(es). However, after a comparison of the four alternatives against the priority criteria, the SPUI and Traditional Diamond alternatives are the recommended alternatives from this PEL study evaluation.

Alternatives Refinement

The SPUI and Traditional Diamond alternatives are being evaluated with additional conceptual design information and traffic operations analysis to further define alternative elements.

Conceptual design details are being evaluated to provide more information on the potential property impacts, including operational challenges with changes in access/driveways. Possible locations for additional infrastructure needs, such as grading, retaining walls, and water quality detention will be identified.

The traffic operations of the two recommended alternatives are being analyzed using VISSIM (Version 5.30-10) traffic simulation software. While the traffic analysis conducted with earlier screening provided comparative information about overall intersection operations and capacity, this analysis will provide additional information on the vehicular interactions and movements through the interchange, as well as the ramp merge and diverge operations on the freeway. The need for additional auxiliary lanes or access restrictions to optimize operations will be identified.

This refinement of the SPUI and Traditional Diamond alternatives will be documented in the final project PEL study report. The final PEL study recommendations will include large-scale improvements and/or separate, short-term improvements. Long-term recommendations will likely have short-term project elements identified as phases of long-term recommendations or stand-alone projects.

Intentionally blank page.

APPENDIX A

Conceptual Design Parameters

Conceptual Design Parameters

Design Element	CDOT/Wheat Ridge Kipling Street (SH 391)	CDOT/FHWA I-70 Mainline	CDOT/FHWA I-70 Ramps
GENERAL			
Functional Classification	Urban Arterial	Interstate	Ramp
Posted Speed Limit / Exit Speed Warning (mph)	45	55	45 / 40
Design Speed	50	60	50 / 45
Loop Ramp			25
Design Vehicle	WB-67	WB-109D	WB-109D
HORIZONTAL ALIGNMENT			
Number of Lanes	4 initial 6 future south of I-70	6 initial 8 future	1 to 2
Horizontal Curve Radius (feet)	1,640	2680 (e=5.4%)	1060 (at 45 mph) 1660 (at 50 mph)
Loop Ramp			167 (at 25mph)
Lane Widths (feet)	12	12	15=1, 12=2
Median Width (feet)	12	N/A	N/A
Min Curb Return Radius (feet)	20	N/A	N/A
Standard Cross Slope	2%	2%	2%
Acceleration Lane Length	550 ft		
Deceleration Lane Length	435 ft		
Accel/Decel Taper Ratio	13.5:1	N/A	N/A
Intersection Minimum Sight Distance (left)	555 ft	N/A	N/A
Intersection Minimum Sight Distance (right)	480 ft	N/A	N/A
Superelevation (e_{max})	6%	8%	6%
Shoulder Widths			
Left Inside (feet) minimum/desirable	N/A	10 / 12	4 / 4
Right Outside (Feet)	N/A	12	8 - 10
VERTICAL ALIGNMENT			
Crest Vertical Curve Rate, Min K	84	151	61 / 84
Sag Vertical Curve Rate, Min K	96	136	79 / 96
Stopping Sight Distance (feet)	425	570	360 / 425
Grade (maximum / minimum)	6% / 1%	4% / 0.5%	Up = 3% / 5% Down = 4% / 6%
Minimum Vertical Clearance at Structures (feet)			
Highways/Streets (feet)		16.5	16.5
Overhead Wires		21.5	21.5
ALTERNATIVE MODES			
Sidewalk Width (feet)	5 - 10	N/A	N/A
On-Street Bike Lanes			
Shared Lane Minimum Width (feet)	14	N/A	N/A
Shoulder Minimum Width (feet)	6	N/A	N/A
Bike Lane Minimum Width (feet)	6	N/A	N/A
Multi-use Path			
Maximum Cross Slope (%)	0.05	N/A	N/A
Design Vehicle	Bicycle	N/A	N/A
Posted Speed (mph)		N/A	N/A
Design Speed (mph)	18	N/A	N/A
Path Width	10 ft	N/A	N/A
Horizontal Minimum Curve Radius (feet)	73	N/A	N/A
Stopping Sight Distance	134	N/A	N/A
Maximum Vertical Grade	0.05	N/A	N/A
Crest Vertical Minimum Curve Length (feet)	180	N/A	N/A
Minimum Vertical Clearance (feet)	10 ft	N/A	N/A
Intersection Minimum Sight Distance (Case B3)	175	N/A	N/A
Intersection Minimum Sight Distance (Case C3)	275 ft	N/A	N/A

APPENDIX B

Level 2 Screening Matrix

I-70 & Kipling Interchange PEL Study
Level 2 Screening Matrix

Category	Level 2 Screening Criteria	Color-Code Legend	NA No Action	1 Single Point Urban Interchange (SPUI)	3 Diamond with Roundabouts at Ramps & Frontage Roads	4 Diamond with Six-Leg Roundabout at Ramps & Frontage Roads	6 Fully Directional Interchange
Optimize operations and reduce congestion	Intersection peak hour Level of Service (LOS) and delay (sec) (AM / PM)	Red = LOS E or F	49th Ave: B (13) / B (17) WB Ramps: D (37) / D (45) EB Ramps: A (9) / A (5) S Frontage: B (10) / B (10)	49th Ave: B (19) / D (38) Ramps: C (26) / C (31) S Frontage: C (22) / C (20)	49th Ave: F (50) / F (70) WB Ramps: F (105) / E (43) EB Ramps: E (49) / F (89) S Frontage: C (15) / C (15)	WB Ramps: F (169) / F (168) EB Ramps: F (51) / F (101)	49th Ave: B (10) / B (17) S Frontage: B (10) / A (9)
	Peak hour queue lengths (ft) approaching interchange (AM / PM)	Red = Queues longer than No Action or 600 feet, whichever is greater	SB Kipling: 492/340 NB Kipling: 86/218 WB Exit Ramp: 682/1312	SB Kipling: 136/527 NB Kipling: 346/94 WB Exit Ramp: 147/356	SB Kipling: 3010/326 NB Kipling: 1358/1241 WB Exit Ramp: 110/718	SB Kipling: 3042/150 NB Kipling: 158/1612 WB Exit Ramp: 2717/4058	SB Kipling: 142 / 154 NB Kipling: 163 / 108 WB Exit Ramp: 192 / 285
	Volume-to-Capacity ratio (overall intersection) (AM / PM)	Red = V/C at 1.00 or more	49th Ave: 0.93/1.00 WB Ramps: 0.95/1.34 EB Ramps: 0.76/0.75 S Frontage: 0.74/0.64	49th Ave: 0.94/0.92 Ramps: 0.66/0.73 S Frontage: 0.61/0.61	49th Ave: 1.08/1.93 WB Ramps: 1.38/1.25 EB Ramps: 1.23/1.56 S Frontage: 0.71/0.71	WB Ramps: 1.65/3.23 EB Ramps: 1.14/1.54	49th Ave: 0.38 / 0.53 S Frontage: 0.32 / 0.36
	Perceived driver expectancy (easy, moderate, difficult)	(see description)	Moderate Close intersection spacing makes maneuvering difficult, but typical interchange layout for urban area	Easy Greater intersection spacing and directional interchange layout	Difficult Movements through multilane roundabouts difficult for drivers to understand	Difficult Movements through multilane roundabouts difficult for drivers to understand	Difficult Out-of-direction movements to access I-70 and ramps from Kipling require unexpected early decision points
Improve traveler safety	Expected change in number of accidents	(see description)	Increase due to additional congestion as traffic volumes increase	Decrease due to reduction in congestion and less conflict points with fewer intersections	Increase/Less Severe with roundabouts compared to signalized intersections, but with increased congestion during peak hours	Increase/Less Severe with roundabouts compared to signalized intersections, but with increased congestion during peak hours	Minimal Change due to reduction in congestion and less conflict points, but higher speed differential on Kipling
	Reduction in multimodal conflict points (ramps and frontage road intersections on Kipling)	Relative Scale: Green = Reduction more than 50% Black = Reduction 10-50% Red = Reduction less than 10%	Vehicular = 90 points	Vehicular = 84 points Pedestrian crossings of high-speed right turns	Vehicular = 28 points	Vehicular = 16 points	Vehicular = 76 points Bicycle lane crosses directional ramps
Accommodate multimodal connections	Missing sidewalk/path links & out-of-direction travel	Green = Direct connections Black = Some out-of-direction travel Red = Substantial out-of-direction travel & no bike lanes	Only narrow sidewalk provided directly through interchange and no bike lanes	Path and bicycle lanes provided directly through interchange	Major out-of-direction travel to cross Kipling. Bicycles in bike lanes must transition to/from shared use path	Major out-of-direction travel to cross Kipling. Bicycles in bike lanes must transition to/from shared use path	Out-of-direction travel for pedestrians to cross under ramps
	Accommodation of transit connections	Green = Transit stops remain in current location Black = Transit stops require relocation or no signal for crossing at stop	No change to transit stops	Accommodates transit stops in current location	Transit stops must move north and south out of roundabouts	Transit stops must move north and south out of roundabouts	Accommodates transit stops in current location, but limits future I-70 transit connection
	User perception of comfort and safety of pedestrian and bicycle movements (easy, moderate, difficult)	(see description)	Difficult Increasingly uncomfortable for pedestrians with increased vehicular congestion and sidewalks under the bridge with limited median refuge areas	Moderate The large center intersection may be intimidating for bicyclists and pedestrians to negotiate.	Moderate Bicyclists must transition to shared use path to travel north/south	Moderate Bicyclists must transition to shared use path to travel north/south	Difficult Many free flow ramp movements for pedestrians and bicycles to negotiate
Avoid and minimize environmental impacts	Potentially impacted noise receptors	Green = Moderate decrease Black = Slight increase or decrease Red = Moderate increase	Moderate noise increase to surrounding homes and hotels from increase in congestion	Slight noise reduction from decrease in congestion	Slight noise increase from increase in congestion	Slight noise increase from increase in congestion	Moderate noise increase from elevated ramps, higher ramp speeds, and ramps closer to homes and hotels
	Potentially impacted hazardous material sites	Relative Scale: Green = 4 or less sites Black = 5-6 sites Red = 7 or more sites	No impacts	4 potential hazardous materials sites	7 potential hazardous materials sites	7 potential hazardous materials sites	10 potential hazardous materials sites
	Potentially impacted parks & recreation areas (Kipling Trail, Fruitdale Park)	Relative Scale: Green = No impact expected Black = Slight impact Red = Minor or major impact	No impacts	No impacts expected	No impacts expected	No impacts expected	Potential minor impact to trail along west side of Kipling north of 50th
Avoid and minimize community impacts	Right-of-Way required	Relative Scale: Green = No full acquisitions Black = 5 or less full acquisitions Red = 6 or more full acquisitions	None	Full = None Partial = 5 properties; 0.2 ac	Full = 3 properties; 1.8 ac Partial = 11 properties; 0.8 ac	Full = 3 properties; 1.8 ac Partial = 8 properties; 0.7 ac	Full = 13 properties; 9.6 ac Partial = 25 properties; 8.6 ac
	Number of property accesses impacted	Relative Scale: Green = 6 or less accesses Black = 7-12 accesses Red = 13 or more accesses	No impacts	3 existing accesses impacted	14 existing accesses impacted	11 existing accesses impacted	36 existing accesses impacted
	Number of buildings impacted	Relative Scale: Green = 2 or less buildings Black = 3-5 buildings Red = 6 or more buildings	No impacts	Commercial = None Residential = None	Commercial = 3 Residential = None	Commercial = 4 Residential = None	Commercial = 31 Residential = None
	Business property impacts for partial acquisitions	Green = Minor impacts Black = Moderate & minor impacts in several quadrants or major impacts in one quadrant Red = Major impacts in all quadrants	No impacts	Minor landscaping impacts in SW and NE quadrants and potential circulation impacts for gas stations	Minor parking and landscaping impacts in all quadrants and circulation impacts for gas stations	Moderate parking and landscaping impacts in all quadrants and circulation impacts for gas stations	Major parking, landscaping, and circulation impacts in all quadrants
	Increase in traffic traveling through neighborhoods	Green = No increase expected Black = Increase due to congestion Red = Increase due to limited frontage road movements	Increased congestion may create neighborhood cut-through	No increase expected	Increased congestion may create neighborhood cut-through	Increased congestion may create neighborhood cut-through	Potential increase due to out-of-direction travel required for access to surrounding area
	Perceived difficulty to access area businesses (easy, moderate, difficult)	(see description)	Moderate Increased congestion creates issues for accessing businesses due to congestion in peak travel hours	Easy Typical urban interchange layout and full access to frontage roads	Difficult Series of multi-lane roundabouts create confusion for turn movements to access frontage roads	Difficult Multi-lane and multi-leg roundabouts create confusion for turn movements to access frontage roads	Difficult Substantial out-of-direction travel required to access frontage roads and adjacent businesses from the freeway
	Consistency with established local plans and visions	Green = Consistent Red = Not consistent	Not Consistent Local plans include interchange improvements	Consistent Typical urban interchange layout and full access to ramps and frontage roads for area business	Not Consistent Roundabouts not consistent with Kipling as six-lane major arterial	Not Consistent Roundabouts not consistent with Kipling as six-lane major arterial	Not Consistent Multi-level interchange and large footprint
Maximize constructability	Conceptual-level probable costs (low, moderate, high, very high)	(see description)	None	$ Low Typical construction and minimal ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$$$ Very High Substantial construction and substantial ROW
	Ease and cost of maintenance (low, moderate, high)	(see description)	Moderate Aging bridge structure and traffic signals with tight access constraints	Moderate Long clear span structure with tight access constraints	Low Typical structure and no traffic signals	Low Typical structure and no traffic signals	High Increase in structures and length of ramps with tight access constraints
	Constructability (easy, moderate, difficult)	(see description)	N/A	Difficult due to building clear-span bridge over Kipling adjacent to existing I-70 bridges	Difficult due to constructing roundabout geometric changes while maintaining multi-lane Kipling traffic	Difficult due to constructing roundabout geometric changes while maintaining multi-lane Kipling traffic	Difficult due to multiple phases to build flyovers and major utility conflicts at 50th
	Assessment of construction phasing impacts (easy, moderate, difficult)	(see description)	N/A	Difficult due to multiple phases and changes to Kipling within existing envelope	Difficult due to number of phases, temporary signals, and changes to Kipling within existing envelope	Difficult due to number of phases, temporary signals, and changes to Kipling within existing envelope	Moderate because most construction is outside of traffic, but with many full closures at night for flyover construction
	Ability to construct in phases (easy, moderate, difficult)	(see description)	N/A	Difficult Usable pieces cannot be implemented in phases	Difficult Usable pieces cannot be implemented in phases	Difficult Usable pieces cannot be implemented in phases	Easy Opportunity for ramps to be constructed and opened separately
SUMMARY OF RESULTS			CARRIED FORWARD further analysis required for comparison	CARRIED FORWARD	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis
NOTES			Poor traffic operations and increasing safety issues due to additional congestion by 2035 No changes to inadequate multimodal connections through the interchange	Improved vehicular operations with minor community and ROW impacts and direct multimodal connections through the interchange area Typical urban interchange layout with no change to current frontage road access Difficult construction impacts and limited opportunities to construct in phases	Does not address operational issues associated with congestion Degraded peak hour traffic operations with perceived driver expectancy issues Multimodal connections are much more out-of-direction and not accommodated as well as other alternatives Difficult construction impacts and limited opportunities to construct in phases	Does not address operational issues associated with congestion Degraded peak hour traffic operations with perceived driver expectancy issues Multimodal connections are much more out-of-direction and not accommodated as well as other alternatives Difficult construction impacts and limited opportunities to construct in phases	Improved vehicular capacity, but does not address safety issues within interchange area due to speed differential on Kipling Major community, ROW, and environmental impacts Multimodal connections are not accommodated safely with bicycle lanes crossing high-speed ramp movements Very high construction cost and increased maintenance
			No Action	Single Point Urban Interchange (SPUI)	Diamond with Roundabouts at Ramps & Frontage Roads	Diamond with Six-Leg Roundabout at Ramps & Frontage Roads	Fully Directional Interchange
			NA	1	3	4	6

Category	Level 2 Screening Criteria	7 Partial Cloverleaf with Loops SW & NE Quadrants	9 Partial Cloverleaf with Loops SW & NW Quadrants	11 Texas Frontage Road Diamond	12 Traditional Diamond Interchange	17 Button Hook Ramps	21 Michigan Lefts for Ramps
Optimize operations and reduce congestion	Intersection peak hour Level of Service (LOS) and delay (sec) (AM / PM)	WB Ramps: B (12) / B (11) EB Ramps: A (7) / B (13)	WB Ramp: A (6) /B (14) EB Ramp: A (5) / C (27)	49th Ave: B (11) / B (12) WB Ramps: B (18) / B (17) EB Ramps: C (20) / B (12) S Frontage: C (21) / E (36)	WB Ramps: A (8) / B (11) EB Ramps: B (10) / A (5)	49th Ave: B (11) / C (25) WB Ramps: A (7) / B (13) S Frontage: B (17) / C (27)	49th Ave W: C (25) / B (17) 49th Ave E: B (20) / C (31) WB Ramps: C (20) / C (29) EB Ramps: B (11) / C (23) S Frontage W: C (32) / F (83) S Frontage E: C (27) / D (38)
	Peak hour queue lengths (ft) approaching interchange (AM / PM)	SB Kipling: 121/382 NB Kipling: 397/598 WB Exit Ramp: 308/419	SB Kipling: 136/149 NB Kipling: 253/598	SB Kipling: 275/306 NB Kipling: 154/239 WB Exit Ramp: 285/423	SB Kipling: 114/266 NB Kipling: 61/138 WB Exit Ramp: 282/93	SB Kipling: 80/154 NB Kipling: 212/263 WB Exit Ramp: 178/329	SB Kipling: 560 / 579 NB Kipling: 235 / 421 WB Exit Ramp: 309 / 635
	Volume-to-Capacity ratio (overall intersection) (AM / PM)	WB Ramps: 0.83/0.84 EB Ramps: 0.71/0.82	EB Ramp: 0.58/0.78	WB Ramps: 0.79/0.77 EB Ramps: 0.86/0.87	WB Ramps: 0.64/0.73 EB Ramps: 0.69/0.68	49th Ave: 0.88/0.78 WB Ramps: 0.53/0.67 S Frontage: 0.67/0.79	49th Ave W: 0.88 / 0.79 49th Ave E: 0.44 / 0.76 WB Ramps: 0.63 / 0.84 EB Ramps: 0.68 / 0.72 S Frontage W: 0.61 / 0.52 S Frontage E: 0.80 / 0.93
	Perceived driver expectancy (easy, moderate, difficult)	Moderate Some out-of-direction movements, but typical interchange layout for urban area	Moderate Some out-of-direction movements, but typical interchange layout for urban area	Difficult Unusual movements with local road access on freeway ramps	Easy Greater intersection spacing and directional interchange layout typical in urban area	Difficult Unusual movements for ramp access to/from Kipling via frontage roads	Difficult Out-of-direction and unusual turn movements to/from freeway
Improve traveler safety	Expected change in number of accidents	Decrease due to reduction in congestion and less conflict points with directional ramps	Minimal Change due to reduction in congestion and conflict points, but weave increases potential for sideswipe accidents and speed differential introduced with loop ramp for exiting traffic	Minimal Change due to reduction in congestion and less conflict points with fewer intersections, but speed differential on ramps with frontage road traffic mix	Decrease due to reduction in congestion and less conflict points with fewer intersections	Decrease due to reduction in congestion and less conflict points with fewer intersections	Minimal Change due to increase in congestion, but less conflict points with fewer intersections
	Reduction in multimodal conflict points (ramps and frontage road intersections on Kipling)	Vehicular = 42 points Pedestrian crossings of high-speed right turns	Vehicular = 43 points Pedestrian and bicycle crossings of high-speed right turns	Vehicular = 59 points	Vehicular = 34 points	Vehicular = 82 points	Vehicular = 27 points
Accommodate multimodal connections	Missing sidewalk/path links & out-of-direction travel	Path and bicycle lanes provided directly through interchange	Major out-of-direction travel for pedestrians to cross loop ramps on west shared use. Bicycles in bike lanes must transition to/from shared use path on west shared use	Major out-of-direction travel for pedestrians crossing Kipling due to no crossings at frontage roads	Path and bicycle lanes provided directly through interchange	Path and bicycle lanes provided directly through interchange	Major out-of-direction travel for pedestrians on east side
	Accommodation of transit connections	Accommodates transit stops in current location	Accommodates transit stops in current location	Accommodates transit stops in current location, but transit users may attempt to cross Kipling at 49th Ave	Transit stops likely require relocation. Transit users may attempt to cross Kipling at 49th Ave	Accommodates transit stops in current location	Transit stops likely require relocation along Kipling
	User perception of comfort and safety of pedestrian and bicycle movements (easy, moderate, difficult)	Moderate Some free flow ramp movements for bicyclists and pedestrians to negotiate	Moderate Bicyclists must transition to shared use path to travel southbound on west shared use of Kipling to avoid weave area	Easy Meets expectancy for drivers and pedestrians/bicyclists crossing at signals with relatively tight intersection layout	Easy Meets expectancy for drivers and pedestrians/bicyclists crossing at signals with relatively tight intersection layout	Moderate Some free flow ramp and secondary roundabout movements for bicyclists and pedestrians to negotiate	Difficult Unusual intersection configuration and vehicular movements may be intimidating for bicyclists in bike lane and pedestrians in crosswalks
Avoid and minimize environmental impacts	Potentially impacted noise receptors	Moderate noise increase from higher speeds and ramps closer to homes and hotels	Moderate noise increase from higher speeds and ramps closer to homes and hotels	Slight noise reduction from decrease in congestion and traffic volumes at frontage road intersections	Slight noise increase from higher speeds and ramps closer to homes and hotels	Moderate noise increase from ramps closer to homes and hotels	Moderate noise increase from ramp movements and volumes at frontage road intersections closer to homes and hotels
	Potentially impacted hazardous material sites	6 potential hazardous materials sites	4 potential hazardous materials sites	3 potential hazardous materials sites	4 potential hazardous materials sites	4 potential hazardous materials sites	5 potential hazardous materials sites
	Potentially impacted parks & recreation areas (Kipling Trail, Fruitdale Park)	Potential minor impact to edge of park with relocation of S Frontage Road	Potential minor impact to edge of park with relocation of S Frontage Road	Potential minor impact to edge of park with relocation of S Frontage Road	Potential minor impact to edge of park with relocation of S Frontage Road	Potential impact to edge of park with roundabout in SW quadrant	No impacts expected
Avoid and minimize community impacts	Right-of-Way required	With S Frontage Rd Moved: Full = 7-9 properties; 13.1-20.0 ac Partial = 11 properties; 1.2 ac	With S Frontage Rd Moved: Full = 6-8 properties; 11.9-18.8 ac Partial = 13 properties; 1.0 ac	With S Frontage Rd Moved: Full = 2-8 properties; 6.5-21.1 ac Partial = 17-18 properties; 1.7-2.2 ac	With S Frontage Rd Moved: Full = 5-7 properties; 6.5-18.0 ac Partial = 15 properties; 0.8-1.8 ac	Full = 4 properties; 5.0 ac Partial = 14 properties; 1.2 ac	Full = 3 properties; 1.7 ac Partial = 7 properties; 0.9 ac
	Number of property accesses impacted	With S Frontage Rd Moved: 19-24 existing accesses impacted	With S Frontage Rd Moved: 19-24 existing accesses impacted	With S Frontage Rd Moved: 13-23 existing accesses impacted	With S Frontage Rd Moved: 14-18 existing accesses impacted	16 existing accesses impacted	11 existing accesses impacted
	Number of buildings impacted	With S Frontage Rd Moved: Commercial = 8-9 Residential = 2-3	With S Frontage Rd Moved: Commercial = 8-9 Residential = 2-3	Commercial = 5 Residential = 0-3	Commercial = 5 Residential = 0-3	Commercial = 7 Residential = None	Commercial = 6 Residential = None
	Business property impacts for partial acquisitions	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor parking and landscaping impacts in NE quadrant with potential circulation impacts for gas stations	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor parking and landscaping impacts with potential circulation impacts for gas stations	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor landscaping impacts in NE quadrant and potential circulation impacts for gas stations	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor landscaping impacts in NE quadrant and potential circulation impacts for gas stations	Moderate parking impacts in the SW and NW quadrants and minor landscaping impacts in the NE and SE quadrants	Moderate parking impacts in SW quadrant and minor landscaping impacts in SW and NE quadrants
	Increase in traffic traveling through neighborhoods	Potential increase on Independence Street due to closure of frontage road access in NE quadrant	Potential increase on Independence Street due to closure of frontage road access in NE quadrant	No increase expected	Potential increase on Independence Street due to closure of north frontage road access	No increase expected	Increased congestion may create neighborhood cut-through
	Perceived difficulty to access area businesses (easy, moderate, difficult)	Moderate Direct access to NW and SE quadrants, but no access to NE quadrant	Moderate Direct access to SE quadrant, but farther travel for access to NW quadrant	Moderate Full access between ramps and frontage road, but unusual configuration may create confusion for directions to businesses	Moderate Typical urban interchange layout, but access for some frontage road movements limited	Moderate Full access between ramps and frontage road, but unusual configuration may create confusion for directions to businesses	Difficult Full access for frontage roads, but out-of-direction and unusual turn movements may create confusion for directions to businesses
	Consistency with established local plans and visions	Consistent Typical urban interchange layout, but limited access to SW quadrant without frontage road relocation	Consistent Typical urban interchange layout, but limited access to SW quadrant without frontage road relocation	Consistent Full access to ramps and frontage roads for area business	Consistent Typical urban interchange layout, but limited frontage road access	Consistent Full access to ramps and frontage roads for area business	Consistent Full access to ramps and frontage roads for area business
Maximize constructability	Conceptual-level probable costs (low, moderate, high, very high)	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW
	Ease and cost of maintenance (low, moderate, high)	Moderate Typical structure and less signals, but increased length of ramps	Moderate Typical structure and less signals, but increased length of ramps	Low Typical structure and less traffic signals	Low Typical structure and less traffic signals	Low Typical structure and less traffic signals	Moderate Typical structure and less signals, but tight access constraints
	Constructability (easy, moderate, difficult)	Easy because most construction is outside of traffic on new alignments with typical structure construction	Easy because most construction is outside of traffic on new alignments with typical structure construction	Moderate because new ramps are close to existing ramps with tight staging area constraints	Easy because most construction is outside of traffic on new alignments with typical structure construction	Easy because most construction is outside of traffic on new alignments with typical structure construction	Difficult due to constructing geometric changes while maintaining multi-lane Kipling traffic
	Assessment of construction phasing impacts (easy, moderate, difficult)	Easy because most changes are outside of Kipling envelope	Easy because most changes are outside of Kipling envelope	Moderate because changes to Kipling within existing cross section and moderate intersection work adjacent to existing intersections	Easy because most new intersections/ramps built away from existing interchange	Easy because most changes are outside of Kipling envelope	Difficult due to number of phases, temporary signals, and changes to Kipling within existing envelope
	Ability to construct in phases (easy, moderate, difficult)	Easy Opportunity for ramps to be constructed and opened separately, but need to consider ultimate replacement of bridge	Easy Opportunity for ramps to be constructed and opened separately, but need to consider ultimate replacement of bridge	Easy Opportunity for each quadrant to be implemented separately	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later
SUMMARY OF RESULTS		CARRIED FORWARD	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis	CARRIED FORWARD	CARRIED FORWARD	NOT CARRIED FORWARD for further analysis
NOTES		Improved vehicular operations and safety with direct multimodal connections through interchange area, although free flow ramp crossings for pedestrians and bicyclists Moderate community and ROW impacts, but limited to two quadrants of the interchange Moderate cost and opportunities to construct in phases	Similar operational benefits and community and ROW impacts to Alternative 7 Weave movements on Kipling does not address safety issues within interchange area Multimodal connections are more out-of-direction and not accommodated as well as other alternatives	Improved vehicular operations less than other alternatives and moderate ROW impacts with S Frontage Rd relocation Major perceived driver expectancy issues and potential safety concerns with local road access on freeway ramps Multimodal connections not accommodated at unsignalized frontage road intersections	Improved vehicular operations and safety with typical urban interchange layout and direct multimodal connections through interchange area Impacts to area business access with change in frontage road access Opportunities to construct in phases, but moderate ROW impacts with S Frontage Rd relocation	Improved vehicular operations with full access between ramps and frontage road Moderate community and ROW impacts, but limited to two quadrants of the interchange Moderate cost and opportunities to construct in phases	Improved vehicular operations less than other alternatives with moderate community impacts Perceived driver expectancy issues with unusual turn movements Multimodal connections are more out-of-direction and not accommodated as well as other alternatives Difficult construction impacts
		Partial Cloverleaf with Loops SW & NE Quadrants	Partial Cloverleaf with Loops SW & NW Quadrants	Texas Frontage Road Diamond	Traditional Diamond Interchange	Button Hook Ramps	Michigan Lefts for Ramps
		7	9	11	12	17	21

Category	Level 2 Screening Criteria	31 Single Roundabout Interchange	33 Loop SW Quadrant & Improved WB Ramps	34 Improved Tight Diamond with SB to EB Flyover	35 Double Crossover Diamond Interchange	36 Button Hook Ramps South & Improved WB Ramps
Optimize operations and reduce congestion	Intersection peak hour Level of Service (LOS) and delay (sec) (AM / PM)	49th Ave W: C (29) / C (34) 49th Ave E: B (16) / C (30) WB Ramps: C (24) / C (33) EB Ramps: B (13) / C (22) S Frontage W: A (9) / A (9) S Frontage E: B (16) / B (17)	49th Ave: A (8) / B (12) WB Ramps: B (17) / C (20) S Frontage: A (5) / B (12)	49th Ave: B(17) / D (40) WB Ramps: C (21) / B (14) EB Ramps: A (1) / A (3) S Frontage: A (9) / B (10)	WB Ramps: B (13) / C (24) EB Ramps: C (23) / C (20)	49th Ave: A (8) / B (12) WB Ramps: B (17) / C (20) S Frontage: B (17) / C (27)
	Peak hour queue lengths (ft) approaching interchange (AM / PM)	SB Kipling: 581 / 483 NB Kipling: 343 / 343 WB Exit Ramp: 274 / 476	SB Kipling: 294/326 NB Kipling: 186/475 WB Exit Ramp: 298/322	SB Kipling: 100/169 NB Kipling: 94/85 WB Exit Ramp: 278/355	SB Kipling: 167 / 326 NB Kipling: 179 / 266 WB Exit Ramp: 155 / 388	SB Kipling: 258/315 NB Kipling: 348/518 WB Exit Ramp: 303/322
	Volume-to-Capacity ratio (overall intersection) (AM / PM)	49th Ave W: 0.99 / 0.96 49th Ave E: 0.70 / 0.96 WB Ramps: 0.53 / 0.79 EB Ramps: 0.66 / 0.69 S Frontage W: 0.67 / 0.64 S Frontage E: 0.78 / 0.90	WB Ramps: 0.81/0.79 S Frontage: 0.70/0.77	49th Ave: 0.86/1.00 WB Ramps: 0.62/0.73 EB Ramps: 0.55/0.59 S Frontage: 0.56/0.60	WB Ramps: 0.67 / 0.74 EB Ramps: 1.10 / 0.93	WB Ramps: 0.80/0.68 S Frontage: 0.60/0.80
	Perceived driver expectancy (easy, moderate, difficult)	Difficult Unusual series of closely-spaced signals with unexpected turn movements required between I-70, Kipling, and frontage roads	Difficult Some out-of-direction movements and unusual movements with local road access on freeway ramps	Moderate One out-of-direction movement for flyover with an unexpected early decision point, but other movements typical in urban area	Difficult Crossover layout unusual for drivers	Difficult Unusual movements with local road access on freeway ramps
Improve traveler safety	Expected change in number of accidents	Minimal Change due to increase in signals, but decrease in left turn conflicts	Minimal Change due to reduction in congestion and less conflict points with fewer intersections, but speed differential on ramps with frontage road traffic mix	Minimal Change due to only small reduction in congestion with no change in number and spacing of traffic signals	Decrease due to reduction in congestion and less conflict points	Minimal Change due to reduction in congestion and less conflict points with fewer intersections, but speed differential on ramps with frontage road traffic mix
	Reduction in multimodal conflict points (ramps and frontage road intersections on Kipling)	Vehicular = 16 points	Vehicular = 65 points Pedestrian crossings of high-speed right turns	Vehicular = 84 points	Vehicular = 22 points Pedestrian crossings of high-speed right turns	Vehicular = 71 points
Accommodate multimodal connections	Missing sidewalk/path links & out-of-direction travel	Major out-of-direction travel for pedestrians and bicyclists due to large circular layout	Minor out-of-direction travel for pedestrians crossing Kipling at 49th Ave	Path and bicycle lanes provided directly through interchange	Out-of-direction travel for pedestrians crossing Kipling at 49th Ave and limited Kipling crossing opportunities at ramps due to crossover movements	Minor out-of-direction travel for pedestrians crossing Kipling at 49th Ave
	Accommodation of transit connections	Transit stops likely require relocation. Transit users need to negotiate large intersections to reach stops	Accommodates transit stops in current location, but transit users may attempt to cross Kipling at 49th Ave	Accommodates transit stops in current location	Transit stops likely require relocation. Transit users may attempt to cross Kipling at 49th Ave	Accommodates transit stops in current location, but transit users may attempt to cross Kipling at 49th Ave
	User perception of comfort and safety of pedestrian and bicycle movements (easy, moderate, difficult)	Difficult Bicyclists must transition to shared use path to travel north/south and complicated routing of pedestrians and bicyclists to middle of circle is challenging	Moderate Some free flow ramp movements for bicyclists and pedestrians to negotiate	Moderate Diamond meets expectancy for drivers and pedestrians/bicyclists, but flyover ramp creates major free flow movement for bicyclists and pedestrians to negotiate	Difficult Unusual intersection configuration and vehicular movements may be intimidating for bicyclists in bike lane and pedestrians in crosswalks	Moderate Some free flow ramp and secondary roundabout movements for bicyclists and pedestrians to negotiate
Avoid and minimize environmental impacts	Potentially impacted noise receptors	Moderate noise increase from Kipling volumes around circle closer to homes and hotels	Slight noise increase in SW quadrant from higher speeds and ramps closer to homes and hotels	Moderate noise increase from elevated ramp and higher ramp speeds	Slight noise reduction from decrease in congestion	Slight noise increase in SW quadrant from ramps closer to homes and hotels
	Potentially impacted hazardous material sites	6 potential hazardous materials sites	3 potential hazardous materials sites	3 potential hazardous materials sites	4 potential hazardous materials sites	3 potential hazardous materials sites
	Potentially impacted parks & recreation areas (Kipling Trail, Fruitdale Park)	No impacts expected	Potential minor impact to edge of park with relocation of S Frontage Road	No impacts expected	Potential minor impact to edge of park with relocation of S Frontage Road	Potential impact to edge of park with roundabout in SW quadrant
Avoid and minimize community impacts	Right-of-Way required	Full = 6 properties; 3.7 ac Partial = 10 properties; 1.1 ac	With S Frontage Rd Moved: Full = 4-6 properties; 10.2-17.1 ac Partial = 14-15 properties; 1.0-1.1 ac	Full = None Partial = 7 properties; 0.7 ac	With S Frontage Rd Moved: Full = 2-7 properties; 6.5-18.0 ac Partial = 14 properties; 0.8-1.8 ac	Full = 2 properties; 3.3 ac Partial = 16 properties; 0.8 ac
	Number of property accesses impacted	14 existing accesses impacted	With S Frontage Rd Moved: 16-22 existing accesses impacted	8 existing accesses impacted	With S Frontage Rd Moved: 13-21 existing accesses impacted	8 existing accesses impacted
	Number of buildings impacted	Commercial = 11 Residential = None	With S Frontage Rd Moved: Commercial = 5 Residential = 2-3	Commercial = 2 Residential = None	Commercial = 5 Residential = 0-3	Commercial = 4 Residential = None
	Business property impacts for partial acquisitions	Moderate parking, landscaping, and circulation impacts in all quadrants	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor landscaping impacts on north side with potential circulation impacts for gas stations	Moderate parking and circulation impacts in NW quadrant and minor landscaping impacts in all quadrants	Potential moderate impacts in SW quadrant with S Frontage Rd moved and minor landscaping impacts in NE quadrant and potential circulation impacts for gas stations	Moderate parking impacts in the SW quadrant and minor landscaping impacts in other quadrants
	Increase in traffic traveling through neighborhoods	No increase expected	No increase expected	No increase expected	Potential increase on Independence Street due to closure of north frontage road access	No increase expected
	Perceived difficulty to access area businesses (easy, moderate, difficult)	Difficult Full access for frontage roads, but out-of-direction and unusual turn movements may create confusion for directions to businesses	Moderate Full access between ramps and frontage road, but unusual configuration may create confusion for directions to businesses	Moderate Typical urban interchange layout and access to frontage roads at tight diamond, but flyover ramp may impact access in NW quadrant	Moderate Unusual crossover layout may create confusion for directions to businesses	Moderate Full access between ramps and frontage road, but unusual configuration may create confusion for directions to businesses
	Consistency with established local plans and visions	Consistent Full access to ramps and frontage roads for area business	Consistent Interchange improvement but limited access to SW quadrant without frontage road relocation	Consistent Full access to ramps and frontage roads for area business	Consistent Interchange improvement but limited access to south quadrants without frontage road relocation	Consistent Full access to ramps and frontage roads for area business
Maximize constructability	Conceptual-level probable costs (low, moderate, high, very high)	$$$ High Substantial construction and moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW	$$ Moderate Typical construction with moderate ROW
	Ease and cost of maintenance (low, moderate, high)	High Increase in structures, signals, and length of Kipling with large open area	Moderate Typical structure and less signals, but increased length of ramps	High Increase in structure and length of ramp with tight access constraints	Moderate Typical structure and less signals, but tight access constraints	Low Typical structure and less traffic signals
	Constructability (easy, moderate, difficult)	Difficult due to constructing new bridges while keeping existing bridges open with temporary ramp alignments	Moderate because new ramps are close to existing ramps with tight staging area constraints	Difficult due to constructing single flyover within tight staging area constraints and maintaining multi-lane Kipling traffic	Moderate due to constructing geometric changes with tight staging area constraints	Moderate because new ramps are close to existing ramps with tight staging area constraints
	Assessment of construction phasing impacts (easy, moderate, difficult)	Difficult due to multiple phases and long duration for I-70 impacts with structures construction	Moderate because changes to Kipling within existing cross section and moderate intersection work adjacent to existing intersections	Moderate because most changes outside/over roadways, but with full closures at night for flyover construction	Difficult due to overall duration and closures required during changeover to crossing traffic on Kipling	Moderate because changes to Kipling within existing cross section and moderate intersection work adjacent to existing intersections
	Ability to construct in phases (easy, moderate, difficult)	Difficult Usable pieces cannot be implemented in phases	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later	Moderate Requires Kipling reconstruction at time of implementation, but bridge work can be implemented later	Easy Opportunity for north and south ramps to be implemented separately with bridge work implemented later
SUMMARY OF RESULTS		NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis	NOT CARRIED FORWARD for further analysis
NOTES		Improved vehicular operations less than other alternatives and major ROW impacts Multimodal connections are not accommodated with out-of-direction travel High construction cost with increased maintenance and limited opportunities to construct in phases	Similar operational benefits and community and ROW impacts to Alternative 17 Major perceived driver expectancy issues and potential safety concerns with local road access on freeway ramps	Improved vehicular operations less than other alternatives with moderate construction cost, increased maintenance, and difficult construction impacts	Improved vehicular operations less than other alternatives and moderate ROW impacts with S Frontage Rd relocation Moderate issues with perceived driver expectancy and area business access due to unusual layout and limited opportunities to construct in phases Multimodal connections not accommodated at unsignalized frontage road intersections	Similar operational benefits and community and ROW impacts to Alternative 17 Major perceived driver expectancy issues and potential safety concerns with local road access on freeway ramps
		Single Roundabout Interchange	Loop SW Quadrant & Improved WB Ramps	Improved Tight Diamond with SB to EB Flyover	Double Crossover Diamond Interchange	Button Hook Ramps South & Improved WB Ramps
		31	33	34	35	36