



**COLORADO**  
Department of Transportation

# I-25/88TH AVENUE TRANSIT & SAFETY ANALYSIS

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Executive Summary

APRIL 27, 2023





## SECTION 1

# EXECUTIVE SUMMARY

This executive summary highlights the analysis performed to develop transit alternatives to address ongoing safety and operational issues with the existing Regional Transportation District (RTD) Thornton Park-n-Ride and I-25 corridor from 84th to 104th Avenues. This analysis is being performed to address ongoing safety and operational issues at the Thornton Park-n-Ride and suggest infrastructure improvements to the broader Analysis Area to improve safety for the general public.

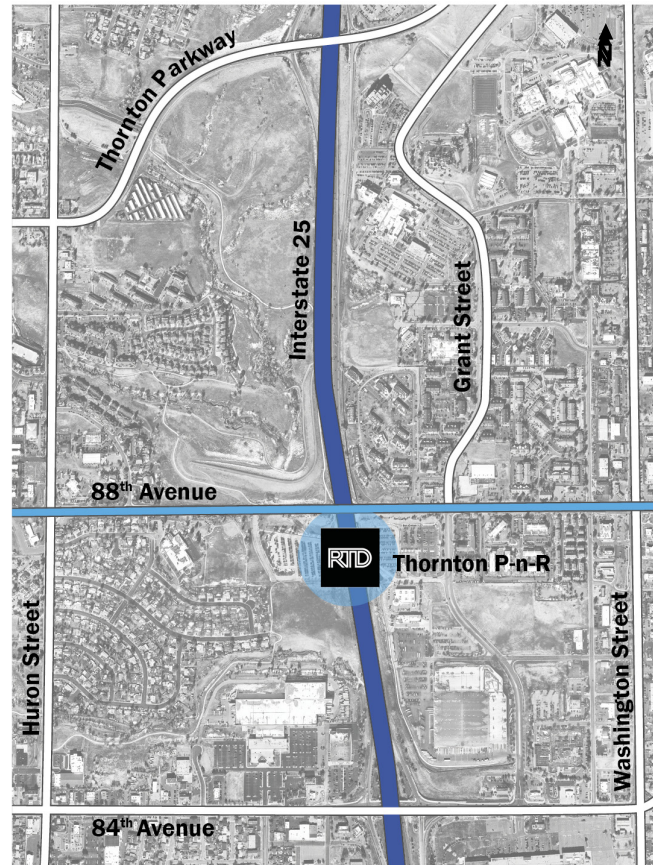
The team developed and subsequently evaluated 17 transit alternatives that addressed safety issues and improved bus operations. A comparative analysis using a benefit-cost approach for each option was used to determine an optimal solution. Each of these alternatives were also evaluated for their respective compatibility with a proposed collector-distributor (C/D) road, climbing/auxiliary lanes, and shoulder improvements as proposed in the *North I-25 (US-36 to 104th Avenue) EA Traffic Validation and Supplemental Options Analysis (White Paper)*.

The team completed a safety analysis of both the transit alternatives as well as the the safety of the proposed collector-distributor (C/D) road, climbing/auxiliary lanes, and shoulder improvements to determine which provided the maximum safety improvement for the analysis area.

The project goals identified in this I-25/88th Avenue Transit and Safety Analysis include:

- Improving transit/traffic operations and safety;
- Improve the existing transit experience at the Thornton Park-n-Ride in addition to a potential pedestrian underpass or overpass;
- Providing the best benefit to transit throughout the Analysis Area;
- Maximizing use of existing infrastructure; and
- Minimizing impacts to residents and neighboring; communities;

As seen in **Figure 1**, the analysis area is focused along the I-25 corridor south of 84th Avenue (Exit 219) to north of Thornton Parkway (Exit 220) and the existing Thornton Park-n-Ride location. This area was expanded to best incorporate and account for required arterial street circulation included in select alternatives.



**FIGURE 1 - PROJECT STUDY AREA**

## Key Project Considerations

Several considerations have informed the alternatives prepared and the evaluation process of this analysis. These considerations are broken down into the safety and transit categories below:

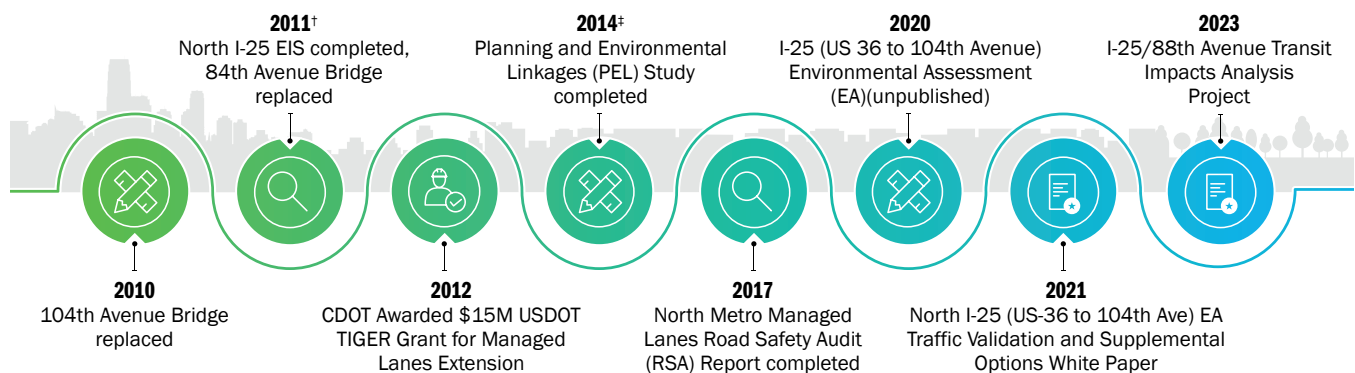
### Safety Considerations

- CDOT and RTD bus incident data shows three crashes in the analysis area directly involving an RTD bus out of more than 1,300 recorded between 2019-2021.
- Buses servicing the Thornton Park-n-Ride cause safety and operational issues when weaving to and from the outer slip ramps to access the I-25 North Express Lanes in both directions, dependent upon time of day.
  - Required lane changes (weaving movements) by RTD buses are nearly impossible to correlate directly to automobile crashes throughout the Analysis Area. They have, however, been anecdotally linked to have caused crashes because of the need for weaving movements across multiple lanes of traffic, roadway grade changes that limit bus acceleration speeds, and the lack of shoulders for emergency access and passing.
  - The operational/congestion issues created by weaving movements were identified within the *North I-25, US 36 to SH 7 Planning and Environmental Linkages Study (PEL)*.

### Transit Considerations

- CDOT's long-term vision is to provide mobility hubs along the I-25 corridor that maximize efficiency and safety for transit.
- COVID-19 and its lasting ridership impacts have disrupted RTD transit operations, including:
  - Temporarily pausing bus route 122X as part of the RTD COVID-19 service changes;
  - 120X ridership has decreased 85% compared to pre-COVID-19 numbers (as measured in 2019)
- The RTD N-Line (*commuter rail*) opened in 2020 and has likely attracted some of the 120X ridership.
  - Parking utilization at the Thornton Park-n-Ride has decreased 91% compared to pre-COVID-19 numbers (as measured in 2019).
- Express lanes into Downtown Denver are operational in the SB direction from 5-11 AM and in the NB direction from noon-3AM daily

The I-25 North Corridor has seen numerous planning, design, and construction projects over the past 13 years, as noted below in **Figure 2**. These projects all served to advance CDOT and stakeholder priorities throughout the corridor to improve traffic efficiency, offer greater mobility choice, repair/replace aging (or otherwise insufficient) infrastructure, and improve safety throughout the transportation network.



**FIGURE 2 - I-25 NORTH PLANNING, DESIGN, AND CONSTRUCTION PROJECTS TIMELINE**

†<https://www.codot.gov/projects/archived-project-sites/north-i-25-eis/Final-EIS>

‡<https://www.codot.gov/projects/studies/study-archives/northI25PEL/north-i-25-us-36-to-sh-7-pel-study>

# Transit Evaluation Process

A three-tiered evaluation process was used to screen transit operational alternatives, as shown in **Figure 3**. The first two levels of screening (Levels I and II) deliberately focused on fatal flaws, transit operational concerns, and capital costs. Safety, operational, and transit efficiency were predominant concerns throughout the evaluation process.

The three levels of evaluation of alternatives included:

## Alternatives Evaluation Level 1 – Fatal Flaws Analysis

The project team developed 17 Level 1 alternatives to address the safety, operational, and capital cost considerations related to transit improvements on I-25 at the NB and SB approaches to the Thornton Park-n-Ride. Their respective compatibility with I-25 supplemental options and fatal flaw determinations also factored into the Level 1 findings. Eight alternatives, including a no-build and center median station at the Thornton Park-n-Ride, advanced to Level 2.

## Alternatives Evaluation Level 2 – Alternatives Refinement

The eight alternatives carried forward into Level 2 were further refined and scored against input from stakeholders including Adams County, City of Northglenn, City of Thornton, and RTD. Design considerations were also incorporated into evaluation efforts including potential Park-n-Ride locations, circulation patterns, as well as current and future land use decisions. Three alternatives which provided the greatest safety, operations, and transit benefits were advanced to Level 3 screening for further consideration.

## Alternatives Evaluation Level 3 – Recommended Alternative Evaluation

The three alternatives carried forward to Level 3 provided a detailed analysis of the most promising transit route pattern(s), physical configuration options, and operational alternatives. Elements of the three alternatives include:

- Alternative 1: Grade Separated Center Bus Station, Bus Ramps to the 88th Avenue Bridge above I-25
- Alternative 2: At-Grade Center Bus Station (as proposed in the PEL)
- Alternative 3: Northbound Only At-Grade Center Bus Station, Southbound Slip Lanes on West Side of I-25

The focus of the Level 3 alternatives evaluation exercise built on the Level 2 evaluation, including factors related to the physical configuration of the proposed options while simultaneously addressing the overall purpose of the analysis. A transit benefit/cost analysis was completed, weighing the transit and safety benefits of each proposed alternative against the capital cost for each alternative. Level 3 evaluation identified the center loading station as the recommended alternative.



**FIGURE 3 - ALTERNATIVES ANALYSIS EVALUATION PROCESS**

# I-25 & 88th Avenue Transit Alternatives Analysis

## Traffic Operations Analysis Methodology

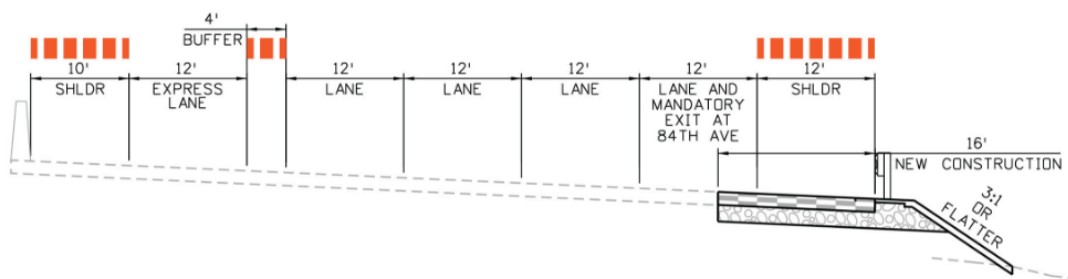
All three transit alternatives that advanced to the Level 3 evaluation process assumed a traffic configuration that was previously analyzed using Transmodeler and documented in the White Paper (2021). The traffic measures of effectiveness (MOEs) evaluated for year 2040 in that study included:

- Vehicle miles traveled (VMT)
- Vehicle hours traveled (VHT)
- Flow rate
- Freeway level of service (LOS)
- Freeway speed
- Average network speed
- Average network delay

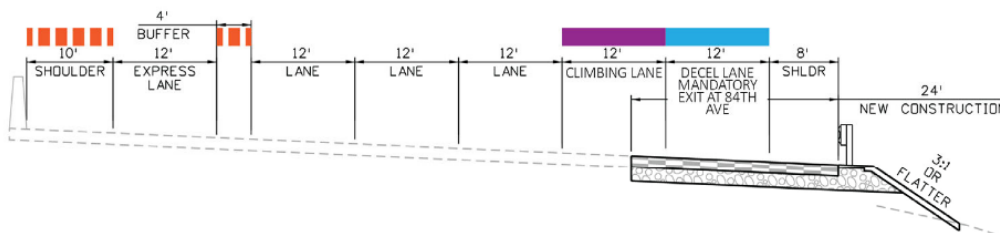
Given there were no additional traffic configuration changes in the three proposed transit alternatives from what was previously modeled, the traffic MOEs previously documented in the White Paper will remain the same. Therefore, there is not expected to be a measurable difference in impact to traffic operations between the three transit alternatives.

## Traffic Safety Methodology

Two analyses of expected traffic safety impacts of various alternatives along I-25 in the analysis area were performed. The first included a safety impact analysis of the improvements proposed in the PEL and Supplemental Options A, D and F. It is assumed that southbound PEL improvements will bring shoulder and buffer widths to standard between 104th and 84th Ave. Northbound improvements proposed in supplemental options A, D, and F are shown in **Figures 4, 5, and 6**. The second included an analysis of safety impacts of each of the three transit alternatives carried through to the Level 3 evaluation. A brief overview of the methodology for each of the two safety analyses is summarized on the following page.

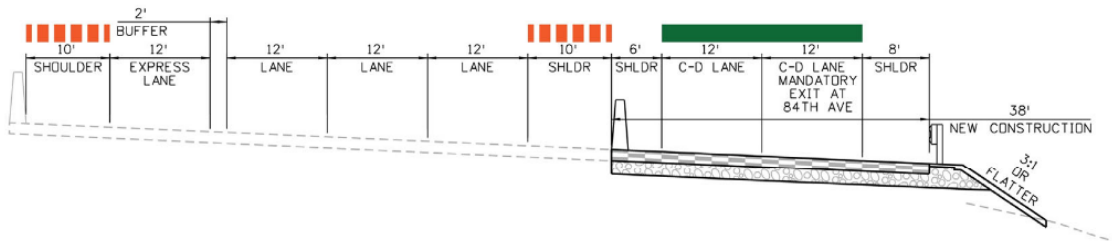


**FIGURE 4 - OPTION A: BRING CORRIDOR TO STANDARD (NB I-25 LOOKING NORTH)**



**FIGURE 5 - OPTION D: ADD RAMP SPACING MODIFICATIONS, ADD DECELERATION LANE FOR EXIT TO 84<sup>TH</sup> AVENUE AND EXTEND CLIMBING LANE TO THORNTON PARKWAY (NB I-25 LOOKING NORTH)**





**FIGURE 6 - OPTION F: ADD RAMP SPACING MODIFICATIONS, ADD CD ROAD BETWEEN 1-270 AND 84<sup>TH</sup> AVENUE AND EXTEND CLIMBING LANE TO THORNTON PARKWAY (NB I-25 LOOKING NORTH)**

### Safety Analysis of I-25 PEL & Supplemental Options

The safety analysis of the improvements proposed in the PEL and Supplemental Options A, D and F was performed using a combination of safety performance functions (SPFs), crash modification factors (CMFs), and anecdotal data from similar configurations along US 36 to estimate approximate reduction in crashes that could be expected in each alternative. The primary design elements that impact safety outcomes in the Analysis Area include:

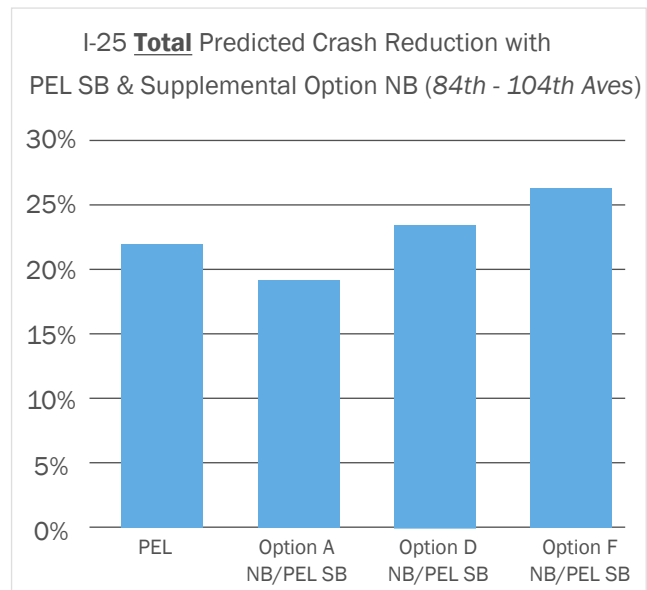
- An additional general-purpose lane in both directions
- Changes to the width of the inside and outside shoulder in both directions
- Additional buffer space between the express lane and adjacent general-purpose lanes in both directions
- A continuous auxiliary lane between 84th Avenue and 104th Avenue in both directions
- Increase ramp spacing distance at the I-270/US 36 interchange (NB direction only)
- A collector-distributor road (C/D road) NB south of 84th Avenue (NB direction only)

Each of these changes was assigned an SPF or CMF based on guidance from the Highway Safety Manual, Crash Modification Clearinghouse, or, in the case of the express lane buffer width (where there is no comparable CMF), a comparative analysis of crash outcomes along US 36 between Denver and Boulder was completed.

SPFs and CMFs were applied to historical crashes over a three-year period (from 2017 to 2019) along four segments of the analysis area. The CMFs were applied by crash type that would be affected by the design change. This analysis resulted in an estimated percent reduction in crashes in each alternative. The analysis was performed assuming existing (2019) traffic volumes.

### Findings

**Figure 7** on the right shows that the design changes included in the PEL Proposed Action and proposed Supplemental Options are estimated to result in approximately a 20% to 25% reduction in crashes along I-25 between mile marker (MM) 217 and MM 221 assuming 2019 traffic volumes. The variation depends on the configuration northbound as all options assumed the PEL Proposed Action would be implemented in the southbound direction. Option A provides the lowest reduction in crashes because it does not include an additional lane or continuous auxiliary lane. The PEL Proposed Action results in a lower reduction in crashes than Supplemental Options D and F primarily because



**FIGURE 7 - I-25 TOTAL PREDICTED CRASH REDUCTION WITH PEL SB & SUPPLEMENTAL OPTION NB (84<sup>TH</sup> - 104<sup>TH</sup> AVES)**

it does not include widening for standard shoulders and buffer space south of 84th Avenue. Option F northbound paired with the PEL Proposed Action southbound performs the best primarily because, unlike Option D, it includes a continuous auxiliary lane north of 84th Avenue and an additional lane north of Thornton Parkway.

**Notes:**

- Crash reduction is based on maintaining 2019 volumes and does not account for potential increased traffic from operational improvements.

**Safety Analysis of I-25 Transit Alternatives**

The primary variation between the three transit alternatives that is likely to impact traffic safety are the relative increase or decrease in potential conflict points between buses and other traffic. The three potential safety impacts identified in the three alternatives evaluated include:

- The frequency and distance that buses would have to weave between the right-most travel lane of I-25 and the inner-left express lane.
- Any new major signalized intersections along the bus route.
- Changes to the number of locations where pedestrians would need to cross a bus lane or street to access the bus platform.

Because these changes do not have associated CMFs and there were too few direct bus incidents in the historical crash data along the corridor to apply a CMF, an alternative approach was developed using a combination of quantitative and qualitative measures that included the following five metrics:

- The distance of the weave per direction (from earliest starting point that a bus could begin the weave to end location where a bus would need to complete the weave)
- The frequency buses must weave (hours per weekday and weekend day) per direction
- The number of signalized crossings along the bus route
- The number of uncontrolled pedestrian/ bicycle crossings along bus route or between the station area and bus platform
- Other qualitative observations related to bus operations

**Findings**

**Figure 8** includes a high-level summary of the safety analysis of the transit alternatives carried through to the Level 3 evaluation process. All three alternatives would eliminate the bus weave in the NB direction and Alternative 1 and 2 would allow for more distance for buses to weave SB between the 120th Avenue on-ramp and the center station at 88th Avenue. Alternative 1 would result in a new signalized crossing at the 88th Avenue Bridge. All three alternatives would eliminate the uncontrolled pedestrian crossing of the busway at 88th Avenue NB, and Alternative 1 and 2 would eliminate all uncontrolled pedestrian crossings in the analysis area. While all alternatives would see safety improvements based on the criteria evaluated, Alternative 2 would result in a marginally higher safety benefit than the other two alternatives.

	Alternative 1	Alternative 2	Alternative 3
Distance of the bus weave	▲▲	▲▲	▲
Hours per day buses weave	▲	▲	▲
Signalized crossings along bus route	▼	—	—
Uncontrolled pedestrian crossing	▲▲	▲▲	▲

**FIGURE 8 - HIGH-LEVEL SUMMARY OF SAFETY ANALYSIS OF TRANSIT ALTERNATIVES**

## Recommended Transit Alternative

Following completion of the Level 3 Alternatives evaluation, the at-grade center median station was selected as the recommended transit alternative, as shown in **Figure 9**, for a variety of reasons. These include:

- CDOT's long-term vision is to provide mobility hubs along the I-25 corridor that maximize efficiency and safety for transit.
- It offers the highest benefit-cost ratio of the three station alternatives considered as part of the Level 3 evaluation.
- It minimizes costs and throwaway waste by retaining the existing Thornton Park-n-Ride parking lots and other existing transit infrastructure.
- The center median station provides the greatest safety benefit by reducing weaving conditions in both directions:
  - NB direction – weaving movements are completely eliminated with no need for slip ramps to access the Thornton Park-n-Ride.
  - SB direction – weaving movements are allowed to take place over a longer 3.5-mile distance between the Wagon Road Park-n-Ride at 120th Avenue and I-25, thereby allowing buses to use the I-25 North Express Lanes to further increase efficiency.

## Conclusion

This analysis has identified a recommended transit solution that not only provides optimal transit operations but also maximizes safety improvements in the corridor. Additionally, this analysis has determined Supplemental Option F provides the maximum safety and operational benefit for the I-25 corridor from US-36 to 104th Avenue.

Next steps include further analysis and refinement of the recommended transit alternative and interstate improvements through preliminary engineering, NEPA Environmental Assessment, and final design through future CDOT procurements.



**FIGURE 9** - SCHEMATIC FOR THE RECOMMENDED ALTERNATIVE