Memorandum

City of Dallas

DATE February 6, 2025

TO Hon. Chad West
Hon. Jesse Moreno

SUBJECT **Street Design Manual Work Group Report**

Background

On November 14, 2023, Councilmembers Chad West (District 1) and Jesse Moreno (District 2) issued a memorandum to City Manager T.C. Broadnax establishing the Street Design Manual Work Group (the "Work Group"). The memorandum tasked the Work Group with evaluating potential revisions to the City's Street Design Manual to better align with established City policies, including Vision Zero, ForwardDallas, the Comprehensive Environmental and Climate Action Plan (CECAP), the Racial Equity Plan, and the Bike Plan. A copy of that memorandum is attached hereto as Tab A.

The Work Group's responsibilities included engaging with the public, consulting City staff, conducting independent research, and preparing a report containing its findings and recommendations.

Aligning Polcies with Street Design

The City has adopted several forward-thinking policies such as Vision Zero which aim at fostering a culture that moves beyond prioritizing traffic flow to embracing a street system that supports multi-modal transportation and prioritizes safety. The Dallas Complete Street Design Manual highlights this vision, stating, *"complete streets make it easier to cross the street, walk to shops, and bicycle to work. They help buses run on time and make it safer for people to walk to and from train stations."*

Despite these policies, Dallas remains the most dangerous large city in Texas for pedestrian fatalities and severe injuries affecting both pedestrians and vehicle operators.[1]

Traffic Safety in Dallas: A Growing Concern

According to the Vision Zero Dashboard maintained by the City:

- In 2023, Dallas experienced 71 fatal crashes involving pedestrians and 198 crashes resulting in severe pedestrian injuries.

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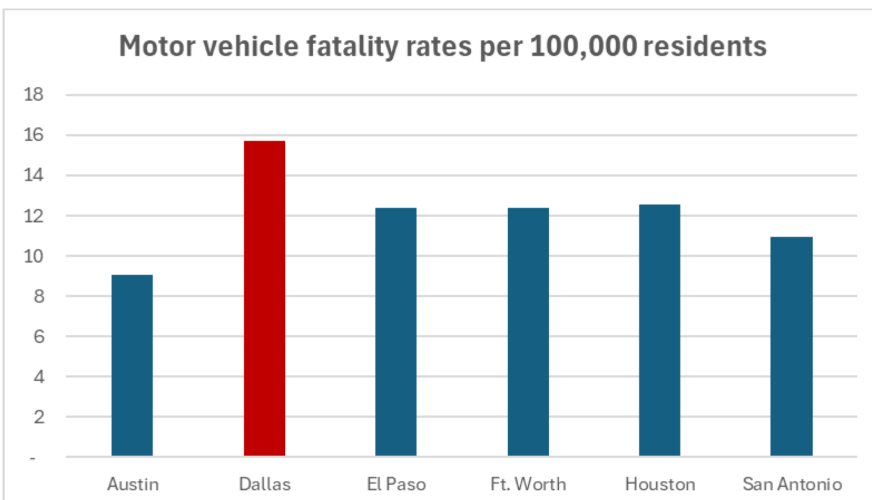
[1] ValuePenguin analysis of NHTSA FARS data in report dated May 1, 2023: https://www.valuepenguin.com/texas-pedestrians-study

- Through October 2024, there were 539 crashes involving pedestrians, with 57 resulting in fatalities (an increase of two from the previous year) and 128 resulting in severe injuries.
- Additionally, for the same period in 2024, there were 22,527 crashes involving motor vehicles, of which 91 were fatal (up by seven from the previous year) and 490 resulted in severe injuries.

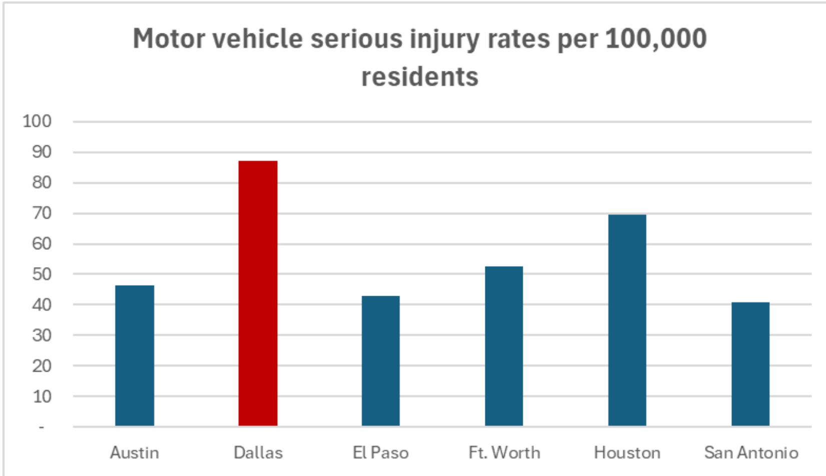
Comparing Dallas to other Large Texas Cities

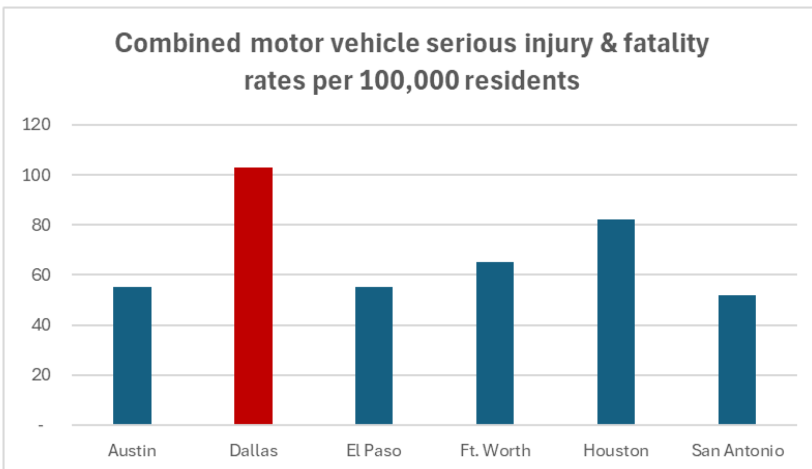
Data from the Texas Department of Transportation underscores the urgency of addressing street safety in Dallas:

- In 2023, traffic crashes in Dallas resulted in 1,339 fatalities and serious injuries.[2]
- On a per capita basis, Dallas residents were killed or seriously injured at a 57% higher rate than the weighted average for Austin, El Paso, Ft. Worth, Houston, and San Antonio.
- This disparity translates into 485 "excess" deaths and serious injuries---a tragic and preventable consequence of poor street design.[3]

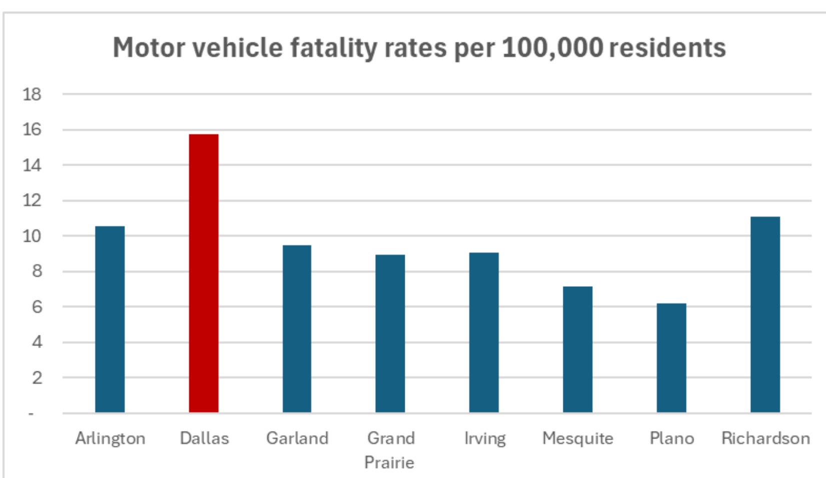


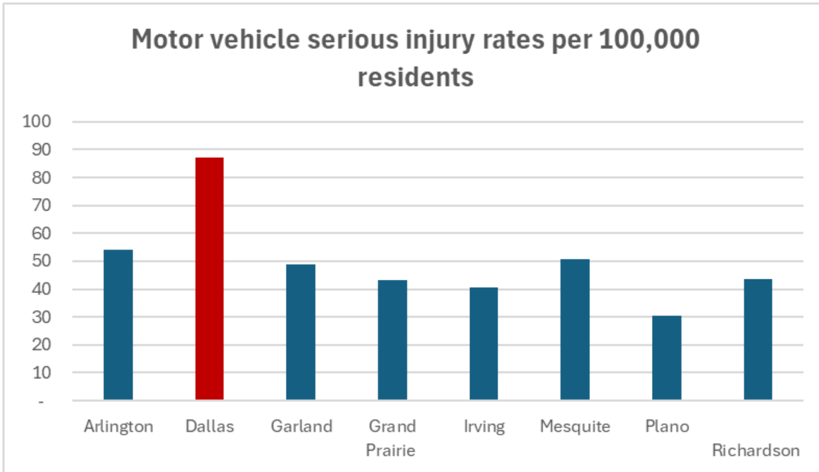
[2] TxDOT's Crash Records Information System: https://www.txdot.gov/content/dam/docs/trf/crash-reports-records/2023/14.pdf We note the discrepancy in numbers between the various sources and attribute that to reporting sources, but all of the sources arrive at similar conclusions: Dallas has higher accident rates than its peer cities.
[3] In contrast, an average of 5 people die in fires in Dallas each year.

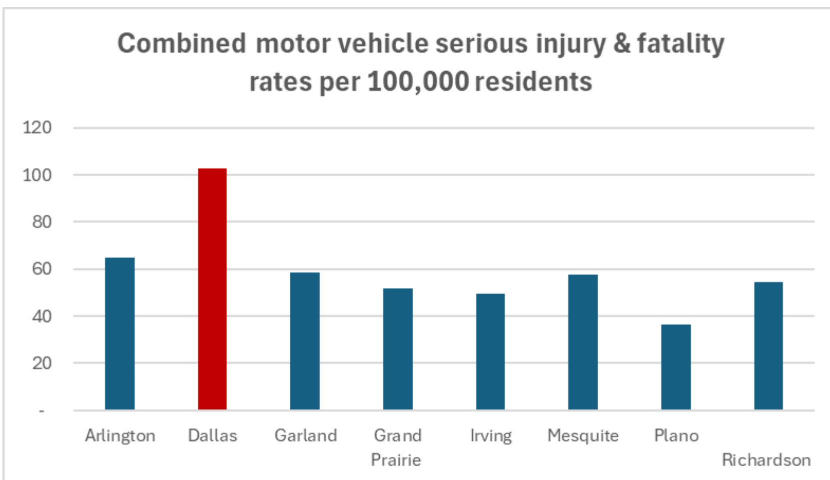




Comparing Dallas to its Suburban Neighbors







Process

The Work Group was chaired by District 14 City Plan Commissioner Melissa Kingston, with the following members:

- Vice Chair Carl Anderson – Larkspur Capital / TREC Representative
- Stephanie Laughlin, P.E. – Jacob & Hefner Associates, Inc. / TREC Representative
- Anthony R. Page – Jaguar Growth Partners / Placemaking Representative

City staff members who routinely participated in Work Group meetings included:

- Robert Perez and Ali Hatefi - Public Works (no longer with the City)
- Ghassan Khankarli - Transportation (currently Director of Transportation and Public Works)

- Executive Deputy Chief Jeff Wallis and Deputy Chief Chris Martinez - Dallas Fire-Rescue (DF&R)

The Work Group also consulted with the Office of the City Auditor and other staff members on various issues as needed.

Meetings and Community Engagement

The Work Group held approximately twelve meetings, both at City Hall and off-site. To ensure transparency and community involvement, the Work Group invited public input through written comments and hosted a public comment session at City Hall in September 2024.

Policies, Plans, and Data Reviewed

In carrying out its tasks, the Work Group reviewed a comprehensive set of City policies, regulations, and procedures, including:

- Street Design Manual, including proposed amendments
- CECAP
- Bike Plan
- Drainage Plan
- Sidewalk Plan
- Racial Equity Plan
- Forward Dallas (2006) and the proposed 2024 revisions (since adopted)
- Vision Zero, including the City's Vision Zero Data dashboard
- Thoroughfare Plan

The Work Group also examined data and best practices from other municipalities that have successfully implemented infrastructure improvements to reduce fatalities and injuries. Additionally, it reviewed programs from agencies or organizations such as the Federal Highway Administration, the American Association of State Highway and Transportation Officials and the National Association of City Transportation Officials that have demonstrated effectiveness in improving traffic safety outcomes.

Findings

I. *Correlation between Policies and Street Design*

- **Inconsistent Policies Across Sources**
  Policies governing City streets are fragmented across multiple sources, often leading to inconsistencies and a lack of understanding by the public, including the development community. For example, the 2019 Street Design Manual includes street sections not found in the 1993 Thoroughfare Plan or the 2016 Complete

Streets Design Manual. This proves difficult during the subdivision plat process when City staff references the outdated street sections of the 1993 Thoroughfare Plan for right-of-way dedications, which demands the property owner give up more land than might be necessary with the new street sections that are outlined in the 2019 Street Design Manual.

- **Design Standards for Emergency Equipment**
  The City continues to design streets to accommodate increasingly large fire and emergency vehicles, which conflicts with other City policies, such as Vision Zero.

    - Other cities are investing in smaller, more agile fire and medical response vehicles that align with urban environments without compromising service. These cities prioritize procuring response equipment that fits the city they envision rather than modifying city streets to accommodate oversized vehicles. See Tab B.

    - DF&R spends significantly less time responding to fires compared to other emergencies. Fire-related fatalities are minimal compared to fatalities on city streets, underscoring the need for equipment investments that support safer street designs.[4] Nationally, only about *"4% of emergency calls have to do with fires,"* according to the National Fire Protection Association.

    - Ironically, the most common type of incident DF&R responds to is motor vehicle accidents.[5]

- **Overlooked Factors in Safer Street Design**
  Critical components of safer street design, such as speed limits/design speeds, lane widths, and curb radii, are frequently overlooked despite being spelled out in City policies.
    - Reducing speed limits from 30 mph to 25 mph shortens stopping distances by 23%, improves driver reaction times, and broadens the driver's cone of vision.[6]
    - Sharper curb radii slow down turning vehicles.
    - Narrower lanes encourage slower driving, reducing crash severity.

[4] Dallas Fire-Rescue Dashboard: https://www.dallasopendata.com/stories/s/Igniting-Insight-with-Data/itzv-guyx/
[5] *Id*.
[6] Federal Highway Administration.

II. *City's Staff's Adherence to and Violations of Policies*

- **Misattributed Policy Violations**
  City staff often attribute non-compliance with policies to DF&R requirements. However, the Work Group found this claim inaccurate. While DF&R prioritizes response times, it has expressed openness to alternative methods that align with public safety goals and a safer built environment.

- **Previous Public Works Leadership**
  Under the leadership of former Director Perez and Assistant Director Hatefi, Public Works exhibited a culture of policy non-compliance. Staff often disregarded policies that did not align with their preferences, leading to frequent violations, slower and costlier project completions, and prioritization of traffic flow over safety. For example, the two-way conversions of Cole Avenue and McKinney Avenue were plagued with delays and policy violations. See Tab C.

- **New Public Works Leadership**
  Under Dr. Ghassan Khankarli, Public Works has demonstrated a far greater willingness to implement best practice infrastructure modifications to ensure a safer public realm. Dr. Khankarli has supported initiatives like two-way conversions, road diets and roundabouts to enhance public safety in areas such as Turtle Creek, Uptown and East Dallas. (e.g., the Cole Avenue/McKinney Avenue two-way conversion, Haskell Avenue/Peak Street two-way conversion, Abrams/Skillman improvements, roundabout study for Fairmont at Turtle Creek, and the Maple Avenue road diet).

- **City Culture and Resistance to Safety**
  Despite shifts in leadership, the City lacks an organizational culture that prioritizes safety above other factors, such as cost, time savings, traffic flow, and innovation.[7] In 2022, Mr. Page, a member of this Work Group, provided a memorandum to then-City Manager T.C. Broadnax outlining similar issues and recommendations to those in this report. There is no evidence that the memorandum was ever considered or implemented. See Tab D.

- **Lack of Accountability**
  There is minimal accountability for staff, consultants, contractors, private developers, or public workers who fail to adhere to City policies. For instance, the McKinney/Cole two-way conversion project, which was initially approved by City Council in November 2016 with Federal and City bond funding approved in 2017, has undergone multiple redesigns, yet the latest 30% plan submittal received by the City in August 2024 from Kimley-Horn and Associates, Inc. still

[7] Dr. Khankarli has recognized that this is an issue, which is a positive first step.

includes numerous policy violations. See Tab E for comments submitted by Uptown Dallas Inc. Although this project remains in the design phase, it illustrates a recurring issue with non-compliance on similar projects.

- **City's Exemption from Its Own Policies**
  Some City staff members erroneously claim that the City is exempt from following its own policies, perpetuating a culture of non-compliance.(e.g., Harwood Park sidewalks).In other instances, City staff members sometimes do not follow or comply with the rules and policies that are required of the private development community. For example, zoning compliance within the public right-of-way for sidewalk, curb ramps and trees and their required placement between the back of curb and the public right-of-way line. It is often the case that when Public Works replaces sidewalks within the City, the new designs do not comply with zoning requirements (sidewalk width and placement) of the areas of replacement. There are examples of Public Works making sidewalk or curb ramp improvements, only for the adjacent site to fall victim to having to either rip out what the City has just replaced or to go through an arduous waiver process to try and fix something that the City created. In some instances, private developers have had to seek a thoroughfare amendment or a zoning change to address the City's non-compliance in order to bring the subject property into compliance

- **Frequent Utility-Related Street Disruptions**
  City streets are frequently torn up for utility replacements and/or repairs due to poor coordination among stakeholders (e.g., among DWU, Public Works, franchise utility providers, and private sector property development). This results in prolonged construction, leaving streets in poor condition and creating temporary obstacles for users. Additionally, when streets are torn up multiple times due to a lack of coordination, it results in a waste of taxpayer resources, the earth's resources, and causes unnecessary emissions into the environment

- **Sidewalk Obstructions**
  Obstacles (e.g., traffic and utility poles, fire hydrants, benches, and trash cans) are often placed on sidewalks unnecessarily, reducing accessibility and limiting pedestrian mobility. These obstacles are often created by Public Works in violation of the City's own policies. See Tab C.

- **Improper Barrier Free Ramp Placement**
  Barrier free ramps are frequently misaligned or obstructed by other infrastructure, limiting accessibility for individuals with mobility challenges. See Tab C.

- **Extended Sidewalk Closures During Construction**
  Construction projects often close sidewalks for extended periods without providing alternative pedestrian pathways or protective scaffolding, compromising safety.

- **Lane Closures Creating Hazards**
  Construction projects are allowed to close street lanes (often multiple) for extended durations, creating hazards for pedestrians, bicyclists, and drivers. For example, the Lincoln Katy Trail project on Carlisle Street, east of Turtle Creek, blocked all but one lane and adjacent sidewalks for well over a year.

Recommendations

1. **Enforce Adherence to Policies**

Require City employees and contractors to comply with all established City policies.

2. **Increase Staff Training**

Provide additional training for inspectors, planners and other staff to ensure familiarity with current policies and procedures, and enforcement of same.

3. **Promote a Culture of Safety**

Foster a City culture that prioritizes safety and adherence to policies. Develop accountability measures to incentivize a safety culture, and employ disciplinary procedures for willful policy violations.

4. **Condition Contractor Payments on Compliance**

Condition contractor payments on adherence to City policies and procedures, including the timely completion of projects with extra scrutiny given to contractor change orders that result in additional time and costs.

5. **Standardize Project Documentation**

Refine and require contractors to use standardized General Notes for all projects, updated to reflect current policies. Ensure that public contracts are reviewed with the same rigor as private projects.

6. **Create a Unified Manual for City Policies**

Consolidate regulations for paving, drainage, parking, and streets into a single, comprehensive manual, organized by subject. Include checklists for submittal requirements and review processes. Update this manual as needed to incorporate relevant content from older documents and avoid cross-referencing outdated materials. For example, professionals currently use this link to find reference materials, manuals, etc.: Land Development engineering forms (dallascityhall.com).

a. Integrate relevant content from the 1993 Drainage Design Manual into the 2019 version.

b. Fold the 1993 Thoroughfare Plan, the 1998 Paving Design Manual and the 2004 Off-Street Parking and Driveways Handbook into the 2019 Street Design Manual.

c. Include specific design standards for DF&R vehicles in the 2019 Street Design Manual consistent with these recommendations.

d. Use the 2021 Department of Public Works Standard Construction Detail, also known as the 251-D, as the sole reference. Incorporate the August 2018 Department of Transportation Traffic Sign Standards into the 251-D standards.

e. Merge the 2016 Complete Streets Manual and Pavement Cut and Repair Standards Manual into the 2019 Street Design Manual and Street Process Manual.

f. Address proposed changes in the 2016 Dallas Complete Street Design Manual in the unified document.

g. Any current or future resources should be provided in a searchable (OCR) format. Formal and informal manual or policy updates should be posted to the engineering forms website, as well as sent to the development community via Planning & Development's listserv.

7. **Update the Street Design Manual**

Incorporate the following updates:

a. Align design speeds with speed limits (25 mph in congested areas, 30-35 mph elsewhere).

b. Limit lane widths to 10 feet for most streets, with 11 feet for outer lanes of multi-lane roads with heavy bus or truck traffic. Consider 9 foot lane widths for most urban settings, with exceptions for heavy bus or truck traffic or as needed to accommodate mass transportation options.

c. Tighten curb radii to the minimum required for the appropriate design vehicle. DF&R has agreed that its vehicles can navigate intersections by deviating from lanes if and when necessary.

d. Establish maximum driveway widths, with any deviations requiring approval by the Director.

e. Require dual, not diagonal, pedestrian and barrier free ramps aligned with crosswalks and sidewalks.

f. Include any specialized emergency response vehicle design standards.

8. **Accelerate Bond Money Spending**

Ensure bond money is spent more promptly to facilitate timely project completion and to avoid potential future reductions in scope due to inflation (ex: Henderson Avenue Complete Streets Project).

9. **Update the Thoroughfare Plan**

Revise the outdated 1993 Thoroughfare Plan to reflect current standards and priorities.

10. **Implement Pre-Project Zoning Review**

Require zoning reviews and approvals before project initiation, including City projects. Develop an internal process to prevent projects from commencing without this step.

11. **Establish an Approval Process for DF&R Design Deviations**

Require written approval from DF&R's Chief of Operations for any deviations from the Street Design Manual requested by DF&R. All other deviations should require approval from the Director of Transportation and Public Works.

12. **Replace Fire Equipment with Urban-Suited Vehicles**

Adopt a policy to phase in smaller, urban-appropriate fire equipment as new purchases are made. See Tab B.

13. **Develop a Utility Coordination Plan**

Create a utility repair and replacement schedule, for a reasonable timeframe (e.g., five years out), requiring approval from all stakeholder departments. Another layer of approval must be done before commencement of any individual project, ensuring proper street restoration post-completion.

14. **Enhance Safety Signage and Markings**

Improve signage and street markings in high pedestrian and multi-modal areas to emphasize safety.

15. **Minimize Sidewalk Obstructions**
Develop processes to ensure sidewalk impediments (e.g., poles, fire hydrants, benches, trash cans) are thoughtfully placed to minimize obstructions. Avoid placing unnecessary obstacles on sidewalks.

16. **Ensure Pedestrian Protection During Construction**
Require construction sites to provide protective scaffolding, canopies, and debris chutes. Maintain safe pedestrian access throughout the construction process.

17. **Enforce Lane Closure Policies**
Enforce the City's lane closure policies for construction projects and increase street lease fees to incentivize shorter street closure durations.

18. **Require City Project Reporting**
Require City staff to submit a quarterly report showing streets and utility project status with a focus on budget vs. actual costs and projected vs. actual schedule.

19. **Continually Review Best Practices**
Continually review regional and national best practices to help ensure the City is always at the forefront of implementing safer streets.

We look forward to the City's consideration and implementation of these measures to promote a safer, more accessible and inclusive Dallas. We appreciate the opportunity to serve and remain available to answer any questions and collaborate with Council and staff to enhance the safety of the City we call home.

Respectfully submitted,

Melissa Kingston,
Work Group Chair
Dallas City Plan Commission
District 14 Representative

Carl Anderson,
Work Group Vice Chair
President Larkspur Capital
TREC Representative

Stephanie Laughlin, P.E.
Jacob & Hefner Associates, Inc.
TREC Representative

Anthony R. Page,
Jaguar Growth Partners
Placemaking Representative

Tab A
Stamped- Street Design Manual Work Group

Memorandum

RECEIVED
2023 NOV 14 PM 3:34
CITY SECRETARY
DALLAS, TEXAS

CITY OF DALLAS

DATE November 14, 2023

TO T.C. Broadnax, City Manager

SUBJECT **Request for Formation of Street Design Manual Work Group to Integrate Recent City Plans**

Mr. Broadnax,

The Dallas City Council voted unanimously in late 2019 to update the City's former Paving Design Manual, incorporating elements of complete streets and modernized paving and design techniques into the Street Design Manual of 2019. Since that time, City Council has adopted several new plans which could have significant impacts on language and goals within the Street Design Manual.

Link to Street Design Manual: https://dallascityhall.com/departments/public-works/DCH%20Documents/Public%20Works/pdf/Street%20Design%20Manual_091219.pdf

We request staff support for facilitation of a small work group charged with advising us and other Councilmembers on possible edits to the Street Design Manual. **The overarching objective of the Street Design Manual Work Group ("Work Group") is to review the Street Design Manual and consider other City of Dallas priorities that have been codified into plans, and advise Council regarding suggested edits to the Street Design Manual to better support such priorities**. To do this, we ask that the Work Group:

- Work alongside City Staff to review all sections of the Street Design Manual, while considering how the following City-adopted policies, among others, are incorporated into the plan:
  - Vision Zero Dallas;
  - Forward Dallas;
  - Comprehensive Environmental & Climate Action Plan (CECAP);
  - Racial Equity Plan; and
  - Dallas Bike Plan
- Provide recommendations to us and other interested Councilmembers on suggested edits, if any, to the Street Design Manual in order to better further goals of other city-adopted plans.

To accomplish these objectives the Work Group shall:

- Meet monthly or as needed, as determined by the chair, with the **first meeting occurring no later than December 31, 2023**;

- Receive primary support from the **Department of Public Works**, with dedicated support from Planning & Urban Design, and support from other departments such as Dallas Police Department, Dallas Fire-Rescue (DFR), the Department of Transportation, and the Office of Environmental Quality, among others, as needed;
- Unless otherwise requested by the Chair, meetings will be closed to the public (as this is advisory only), although the report will be public, of course; and
- **Publish their report within one year of the first meeting of the work group with recommendations on steps forward.**

The Street Design Manual Work Group shall be comprised of:

- Chair – City Plan Commissioner Melissa Kingston
- Vice-Chair – Larkspur Capital President Carl Anderson
- Placemaking Representative – Tony Page
- Texas Real Estate Council Public Policy & Programs Manager – Travis Reynolds
- DFR Deputy Chief Christopher Martinez

Thank you for your support. Please do not hesitate to contact me with any questions.

Chad West, Councilmember
District 1

Jesse Moreno, Councilmember
District 2

cc:

Majed Al-Ghafry, Assistant City Manager
Robert Perez, Assistant City Manager
Andrea Giles, Director of Planning and Urban Design
Dr. Ghassan Khankarli, Director of Transportation
Melissa Kingston, City Plan Commissioner
Carl Anderson, Larkspur Capital President
Tony Page, Placemaking Representative
Travis Reynolds, TREC Public Policy and Programs Manager
Christopher Martinez, DFR Deputy Chief
Tameji R. Berry, Executive Assistant Fire Chief

Tab B
2018 US DOT - Downsizing

Optimizing Large Vehicles for Urban Environments

Downsizing

Jonah Chiarenza
Margo Dawes
Alexander K Epstein, Ph.D.
Donald Fisher, Ph.D.
Katherine Welty

NACTO
Prepared by
U.S.DOT Volpe Center

December 2018

DOT-VNTSC-NACTO-18-01

Prepared for:

National Association of City Transportation Officials (NACTO)
New York, New York

U.S. Department of Transportation
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DOT-VNTSC-NACTO-18-01

Notice

Acknowledgments

The authors thank Kate Fillin-Yeh of the National Association of City Transportation Officials for sponsoring and supporting this work and thank the Vision Zero Large Vehicle Safety Technology Working Group for valuable input. In particular, the authors acknowledge the cities and representatives whose funding and participation on the Working Group made this effort possible:

- **Boston** - Kristopher Carter (Boston Mayor's Office of New Urban Mechanics) and Charlotte Fleetwood (Boston Transportation Department)
- **Chicago** - Mike Amsden, Luann Hamilton, Rosanne Ferruggia Lubeck, David Pertuz, and Sean Wiedel (Chicago Department of Transportation)
- **Los Angeles** - Richard Coulson and Kris Goolsby (Los Angeles Department of General Services) and Nat Gale (Los Angeles Department of Transportation)
- **San Francisco** - John Knox White (San Francisco Municipal Transportation Agency) and Anthony Rivera (San Francisco Fire Department)
- **Seattle** - Christopher Eaves, Jude Willcher, Kristen Simpson (Seattle Department of Transportation)
- **Washington DC** - Stefanie Brody, Stephanie Dock, Laura Richards, and Jonathan Rogers (District Department of Transportation)

The authors also thank Chief Michael Myers of the Portland Fire and Rescue, Vicky Sims and Alina Tuerk Bill of Transport for London, Strempfer of Fleetmasters, Inc., Ritchie Huang of Daimler Truck North America, and Skip Yeakel of Volvo Truck North America for key technical information and discussion.

Additionally, the authors are grateful to David Arthur, Mikio Yanagisawa, Don Fisher, Alisa Fine, and Emily Navarrete of the Volpe Center for technical and editorial review, and to Alex Engel and Celine Schmidt of the National Association of City Transportation Officials for editorial review, report layout, and design.

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Introduction

Large vehicles move goods and services that support thriving, livable communities and urban centers. However, these vehicles are disproportionately responsible for fatalities on U.S. roads. Nationally, large trucks comprise 4% of the U.S. vehicle fleet,[1] yet are involved in 7% of pedestrian fatalities, 11% of bicyclist fatalities,[2] and 12% of car and light-truck occupant fatalities.[3] In 2017, 4,761 people were killed by trucks in the United States.[4] Troublingly, NHTSA's most recent analysis of traffic fatalities shows that, despite a slight decline in overall fatalities in 2017, fatalities involving large trucks increased 9% over 2016 numbers.[5]

When it comes to traffic fatalities, vehicle size matters. Large trucks typically have blind spots that are larger than those of the average car, making it harder for truck drivers to see people or objects directly next to or in front of them.[6] Decreased visibility can also cause drivers to react more slowly to impending collisions. The increased weight of large trucks also means that they stop more slowly than cars and, when they hit people, they do so with increased force. The relationship between vehicle size and increasing pedestrian and cyclist fatalities in the U.S. has also been documented beyond trucks. A recent Detroit Free Press report identified the increasing size of vehicles as the main factor in the U.S. rising fatality rate.[7]

Compounding the higher lethality risk inherent in large trucks, geometric street design choices are commonly constrained by the size and maneuverability of the largest vehicles on the road. The freight and delivery, municipal, construction, transit, and emergency response vehicles used in the U.S. often have wide turning radii and require significant space to maneuver and park. Designing streets around large vehicles increases the likelihood that drivers of smaller vehicles (cars and light-trucks) will travel at unsafe speeds. Although street redesign is widely recognized as a highly effective way to reduce traffic fatalities and injuries, the space needs of large vehicles often deter cities from implementing key safety treatments such as shorter crossing distances, reduced roadway widths and turn radii, pedestrian refuges at intersections, and physically protected lanes for pedestrians and bicyclists. Reducing the size, increasing driver visibility, and improving the maneuverability of large vehicles can give engineers the flexibility to make critical roadway safety improvements that can increase safety outcomes for everyone.

To address these safety challenges in the near-term, municipal and private fleet operators and policy makers can potentially reduce the number of fatalities involving large trucks by redesigning the vehicles themselves in ways that are more compatible with safe, vibrant city streets. Vehicle redesign is a near-term strategy that supports improved street design that can save lives. The spectrum of potential vehicle redesign ranges from minor retrofits that improve driver line-of-sight, to "downsizing," which means replacing aging fleets with newer, more maneuverable, and potentially more efficient vehicles. In addition, numerous technologies exist to improve a driver's ability to operate their vehicles safely, including in complex, multimodal, urban environments. As a significant percentage of trucks and buses in U.S. fleets are owned and operated by public agencies, vehicle redesign offers cities a unique opportunity to support Vision Zero efforts and increase safety on urban streets.

Key Findings

Vehicle downsizing, sometimes referred to as rightsizing, is a policy or practice of preferentially replacing existing vehicles with the smallest appropriate vehicles, potentially offering improved direct vision of other road users, improved maneuverability in urban environments, and reduced conflict with human-scale street geometry.

- **Encouraging or requiring vehicle downsizing can increase safety for pedestrians, cyclists, and drivers.** Smaller vehicles have less mass and, as a result, are less lethal when a crash occurs. Smaller vehicles are also often more maneuverable and have better sightlines, allowing drivers to better avoid crashes in the first place. As a systematic approach, reducing the size of the largest vehicles would allow cities to deploy a wider array of traffic calming techniques in more places, which would reduce the likelihood of speeding and other reckless driving from all drivers, regardless of vehicle type.
- **Accommodating the largest vehicles on the street — often emergency response vehicles or municipal refuse vehicles — prevents cities from redesigning streets for safer speeds and reduced crossing distances.** Even as street designs with narrower lanes, smaller turning radii, and decreased crossing distances are shown to increase street safety, larger vehicles require wider lanes, larger turning radii, and significant space to maneuver and park, preventing street designers from making street improvements that improve safety for everyone.
- **Smaller, more maneuverable emergency response trucks often have similar, or better, capabilities than the most common trucks on the streets in U.S. cities today.** Aerial ladder fire trucks used in major European and Asian cities can reach just as high, despite being only two-thirds as long and having only half of the turn radius as common American models. Some models of pumper fire trucks are up to 30% smaller, and have a turn radius up to 50% less than more typically procured models.
- **More specialized emergency response operations may allow for further improvements in street design, as well as improved emergency response times.** Multiple cities studied use motorcycles and/or bicycles in lieu of or to supplement full-size fire and ambulance trucks for medical calls. Many cities likewise use smaller equipment in selected congested or constrained areas, enabling cities to redesign streets in those areas using best street design practices for safe speeds and improved pedestrian and cyclist visibility.
- **Increased direct vision from the truck cab, a frequent result of vehicle downsizing, also has unique safety benefits.** Findings related to direct vision enhancements include:
    - **Trucks with improved direct vision can markedly decrease operator reaction time — up to 50% faster than through indirect vision (mirrors, backup cameras, etc.) — with minimal additional cost.** When tested in a simulation, more than half of distracted drivers in traditional cabs struck a pedestrian, while only 12% of high-vision cab drivers did. High-vision truck cabs cost 0-5% more than conventional cabs — costs that may be recouped over time with decreased insurance and crash liability claims.
    - **Many design elements that improve driver visibility can be retrofitted onto existing fleets, enhancing safety more rapidly than typical vehicle replacement cycles.** Peep windows, teardrop windows, and reduced window tinting can generally be retrofitted onto existing vehicles, providing immediate safety benefits.

Safer Streets Through Vehicle Design

Vehicle downsizing and associated direct vision improvements decrease the time it takes for a driver to see a person, apply the brakes, and come to a stop to avoid a crash. For example, at 25 mph the driver with improved direct vision may stop in about 90 feet, whereas the driver with indirect vision may not stop until 120 feet. The sooner a person is detected, the sooner the brakes can be applied, and the less likely the vehicle is to strike, injure or kill them. Critically, because larger vehicles have longer stopping distances, increasing the amount of time that the driver has to recognize and react to a conflict is key to reducing crashes and fatalities. In addition, reducing vehicle size and increasing direct vision from the cab allows the driver to establish eye contact and communicate, see and anticipate more people, and do so reliably at night or in bad weather.

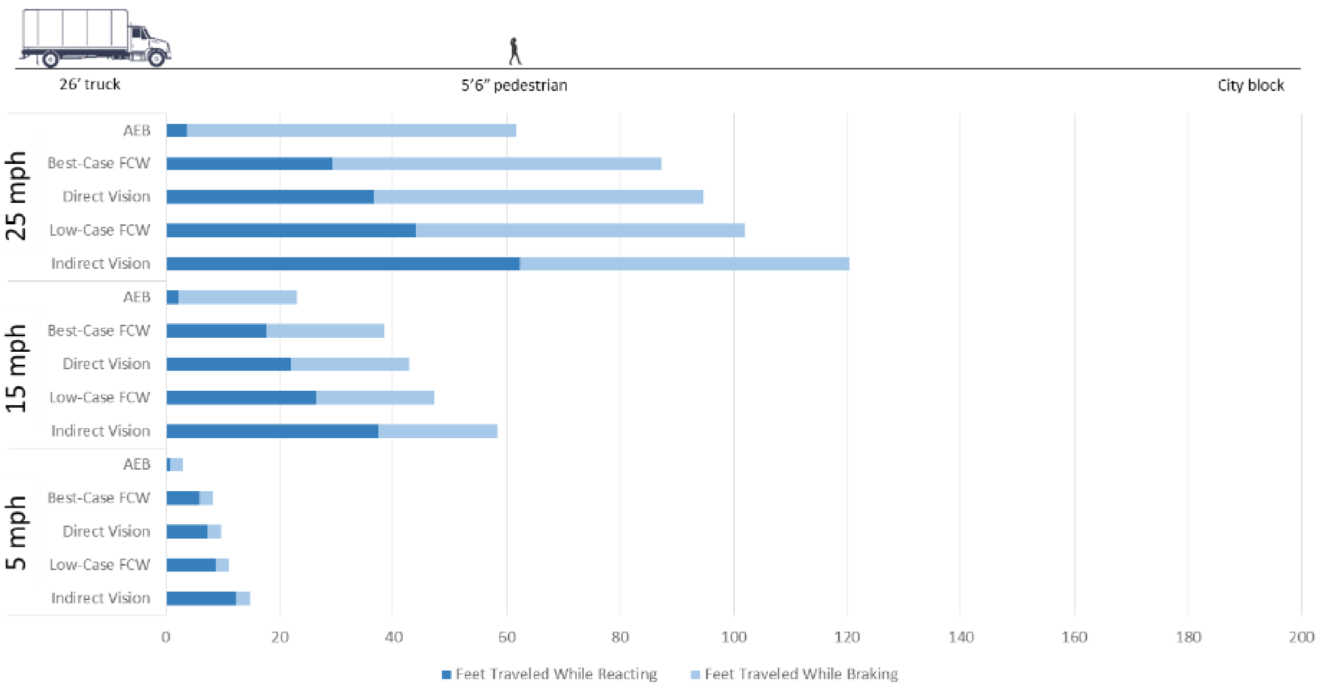


Figure 1: Response times and truck braking distances by speed and technology type. The objective at any speed is to move from the bottom bar (indirect vision) to the top three bars (direct vision, best-case Forward Collision Warning/FCW, and Automatic Emergency Braking/AEB) because the driver or vehicle will detect a person sooner.

Downsizing and increasing the visibility from the cab can mean safer larger vehicles on today's streets, but the benefits do not end there. Smaller, downsized vehicles typically have increased maneuverability, which allows cities to implement a wider array of life-saving traffic calming street designs. For instance, San Francisco's newly introduced "triple combination pumper" fire truck made by Ferrara Fire Apparatus, is smaller than its predecessor by a matter of inches but boasts a turning radius that is 25% smaller (25' vs 33'), allowing for a significant improvement in vehicle maneuverability.[8] Similarly, operators have found that transitioning from conventional cab-forward vehicles to cab-over vehicles allows for increased safe operations on narrow streets and in intersections with tight curb radii. Strategic adoption of these types of vehicle design changes allows traffic engineers the freedom to implement more robust safety designs without worrying about vehicle access. Especially in older, more space-constrained cities, requiring, promoting, or encouraging the use of cab-over vehicles may also offer additional benefits by reducing the space required to park or store vehicles.

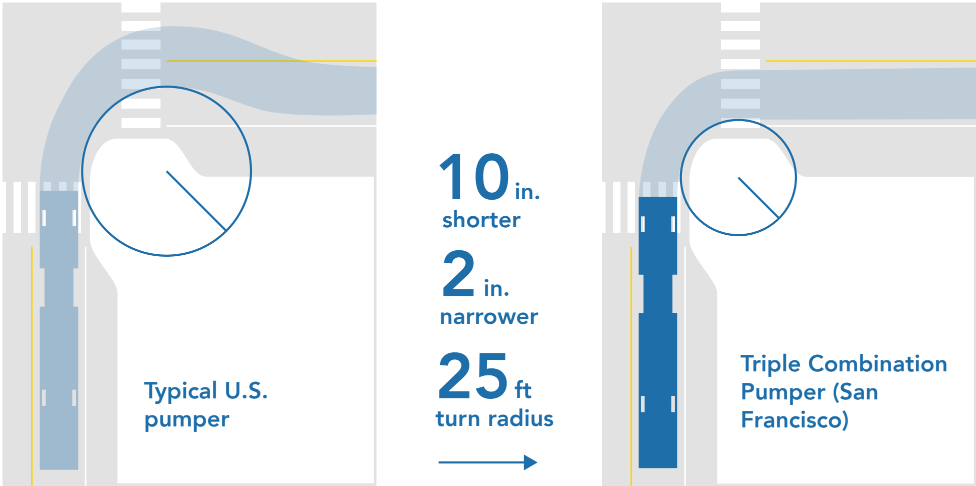


Figure 2 (top): Differences in turn radii between pumper trucks. Left - standard pumper truck. Right - Triple Combination Pumper by Ferrara Apparatus as used in San Francisco. Image: NACTO
Figure 3 (bottom): San Francisco Ferrara Apparatus.

Improved direct vision is especially important for trucks and other large vehicles. For example, the blind spots of a "worst-in-class" conventional cab dump truck can hide a bike lane or the entire width of a crosswalk at an intersection. While most current intersection and bike facility designs account for passenger car blind spots, trucks' blind spots are typically larger and vary more extremely by make and model. Downsizing or replacing such a large truck with a higher vision alternative can significantly reduce the blind spot threat to pedestrians, cyclists, and other road users.

Blind spot sizes vary by truck model and pedestrian height

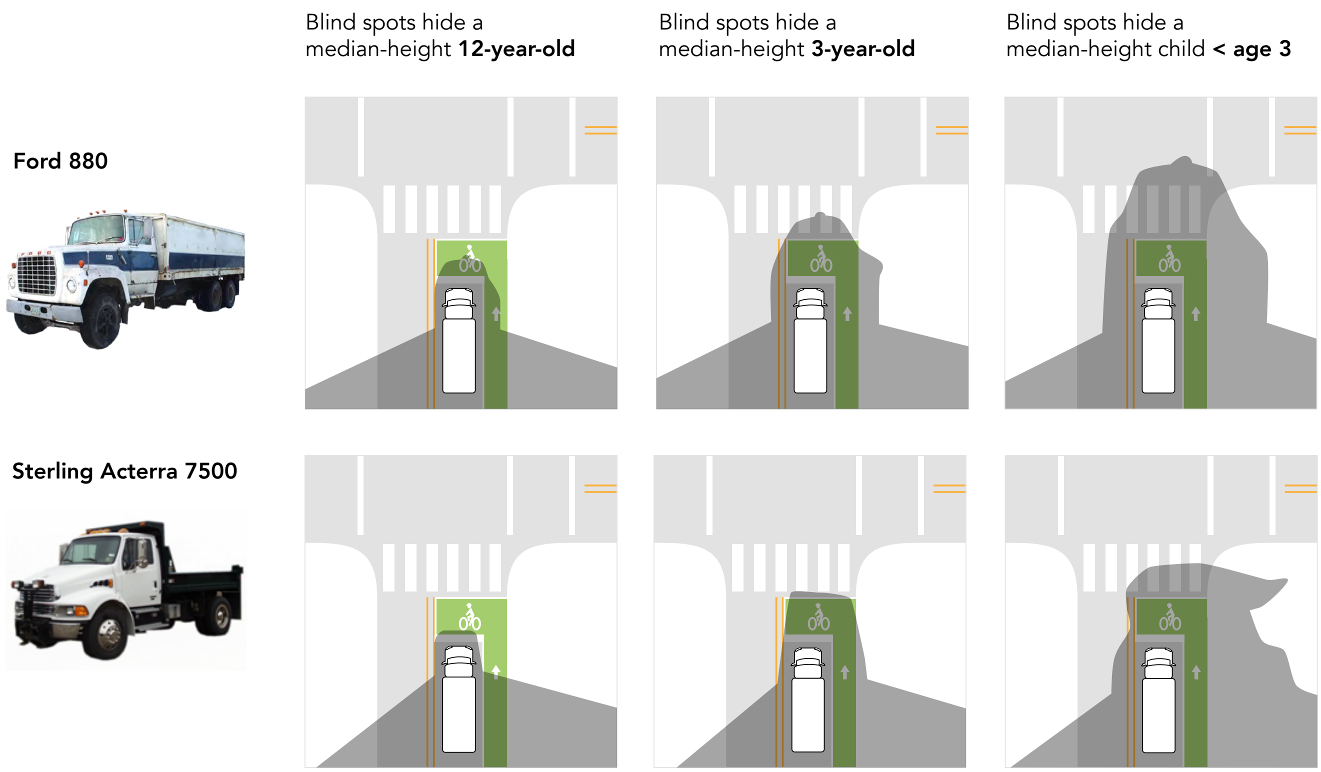


Figure 4: A vehicle with smaller blind spots better allows a median-height driver to see people in a bike box or a crosswalk, especially children. For the 50% of drivers who are below median height, the blind spots are actually larger than shown.[10]

Vehicle downsizing and associated increased direct vision are key tools in a package of safety enhancements. To increase opportunities to reduce crashes, cities and fleet operators should peruse parallel implementation tracks, retrofitting direct vision designs (e.g. peep windows) into vehicles that are not scheduled for replacement or overhaul in the near future, while including downsizing requirements into procurement contracts for future vehicles. Concurrently, cities should also implement pedestrian-focused street design strategies that increase physical separation between people and vehicles, improve sightlines, reduce speeds, and narrow crossing distances.

Lastly, the availability of vehicle designs and technologies is largely driven by customer demand, which in turn is largely driven by awareness, policy, and economics. Crucially, a significant percentage of trucks and buses in U.S. fleets are owned and operated by public agencies.[9] A critical mass of coordinating city fire departments, for instance, could likely influence the design of future fire apparatus offered in the U.S.[10] With city fleets leading implementation, additional vehicles such as garbage trucks, public works trucks, and transit vehicles could follow fire apparatus in incorporating downsizing as part of fleet replacement and vendor procurement. As municipal fleets demonstrate demand, new opportunities for downsizing might also present themselves for the private market. This dynamic presents cities with an opportunity to lead the implementation of safer large vehicle designs through retrofits and new purchases of certain vehicle-based safety technologies.

Vehicle Downsizing

Vehicle downsizing, sometimes referred to as rightsizing, is a policy or practice of preferentially replacing existing vehicles with the smallest appropriate vehicles, potentially offering improved direct vision of other road users, improved maneuverability in urban environments, and reduced conflict with human-scale street geometry. Vehicle downsizing options can range from adjusting dimensions of vehicles (e.g., replacing a truck with a differently designed, smaller truck) to restructuring operations practices to allow for the use of different types of vehicles (e.g., using EMTs on bicycles or motorcycles to respond to certain emergency calls).

Vehicle downsizing presents opportunities to increase safety in three major ways:

1. By reducing the size and mass of vehicles operating on urban streets, thereby reducing their lethality when a crash occurs
2. By increasing the maneuverability of the vehicle and the driver's ability to see the road, thereby reducing the likelihood that a crash will occur
3. By reducing the street width and turn radii required for vehicle passage, thereby increasing opportunities for cities to introduce life-saving, traffic calming street design treatments and increase protected space for pedestrians and cyclists

This section provides information about the benefits, limitations, and implementation considerations associated with vehicle downsizing and then provides a deeper exploration of best practices associated with **Direct Vision Improvements**. In addition, this section provides a **vehicle capacity comparison for fire trucks and box trucks**, and identifies the makes and models of fire trucks currently on the market that can increase maneuverability versus conventional U.S. fire trucks without sacrificing firefighting capacity.

Many Ways to Downsize

It is important to recognize that downsizing does not mean simply replacing a large truck with a smaller truck. Rather, vehicle downsizing can include a range of vehicle design changes and replacements, all of which work to increase vehicle maneuverability and the driver's ability to see the road. Opportunities for changes to vehicle design include changes to:

- Wheel cut/cramp angle and wheelbase
- Steering configuration
- Cab height, design, and window placement

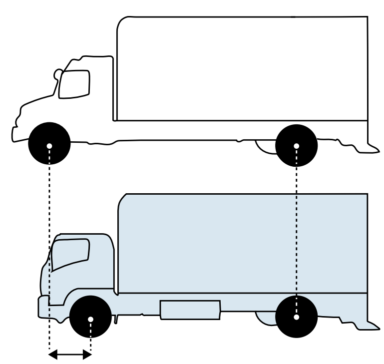
A change in vehicle dimension...	***...can mean a reduction in street/environment dimension.***
Wheelbase →	Turn radius
Wheelcut →	Turn radius
Steering axle configuration →	Turn radius
Width →	Lane width
Driver seat height →	Blind spots

Figure 5: Small changes in vehicle dimensions can significantly reduce blind spots and the amount of space required on the road.

Opportunities for vehicle design changes

Wheel cut/cramp angle and wheelbase

Two factors determine curb-to-curb turn diameter, i.e., the minimum street width for a vehicle to perform a U-turn. These are the wheel cut (maximum turn angle of the steering axle) and the wheelbase (distance between front and rear axle). Both can be changed independently of the overall vehicle length, which offers opportunities to increase maneuverability without impacting capacity. Vehicle width can also be varied separately from length, affecting narrow lane operation. For example, most school buses are 96 inches wide, six inches narrower than most transit buses.[11,12,13]



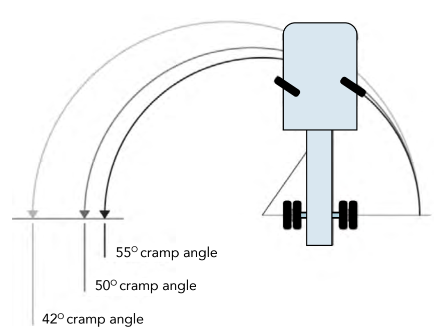


Figure 6 (top, on right) Cab-over trucks have a shorter wheelbase for a given body length and payload, permitting tighter turn diameters. Image adapted by NACTO
Figure 7 (bottom, on right): Trucks with a tighter wheel cut (called "cramp angle" for fire apparatus) also have a smaller turn diameter. [14]

Steering configuration

Steering configuration refers to whether a rear steer axle is provided to reduce the turn radius of a 3-axle truck or bus[15] to more safely navigate city streets, reducing the risk of the rear wheels mounting curbs when making turns. Rear-steer axles, often known as tag axle steering or steerable tag axles, are to a limited extent available[16] on U.S. trucks, but they have been a common feature for years on U.S. motor coaches[17] and RVs[18] as well as on European trucks[19] (see Figure 8). They are also available, though less common, on some trailers, and have even been available on U.S. fire apparatus.[20]

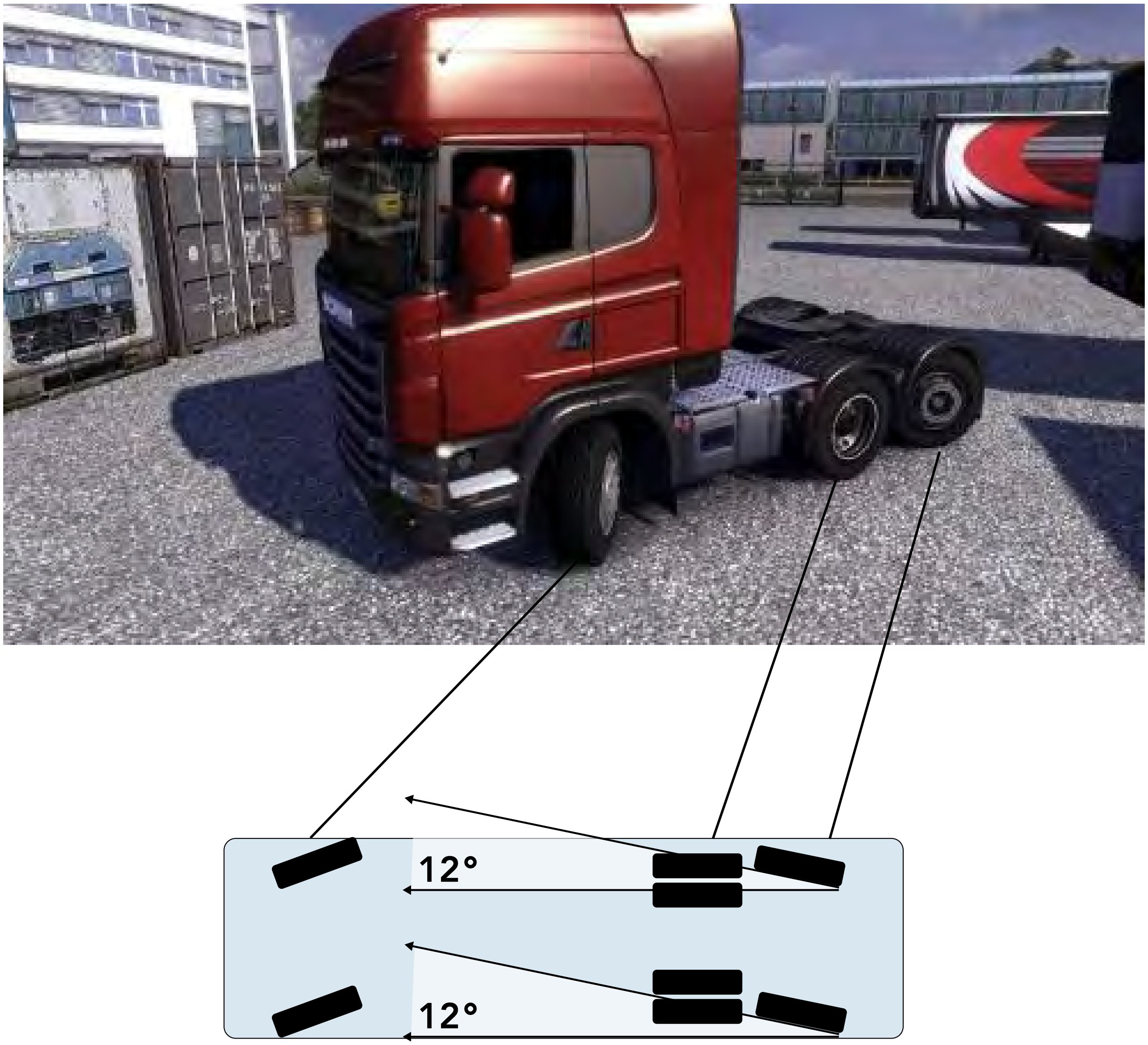


Figure 8. Tag axle steering reduces turn radius for safely navigating tight quarters.[21] (Note: top image shows wheels on the rear tag axle rotated in a direction opposite the wheels on the front axle, as demonstrated in the bottom diagram.)

Cab height, design, and window placement

Finally, reduced cab height is already a common feature in refuse, emergency response, and courier trucks, which drivers frequently board and exit. This dimension is independent of the size of the vehicle. It can improve visibility and help the driver to make eye contact and communicate intent with nearby pedestrians and cyclists. Similarly, changes to window placement and modifications to the design of the vehicle hood can also significantly improve visibility of and communications with people outside the vehicle. Examples of changes to window placement include retrofitting in "peep" windows to allow drivers to see people and objects directly alongside or purchasing high-vision cabs featuring expanded windows. Vehicle hood design options include sloped hoods and cab-over models.

Figure 9: Low-entry cabs and additional "peep" windows in truck cabs let drivers see adjacent people and objects

Figure 10: The Mitsubishi Fuso Canter, pictured here in New York City, features a low-entry, reduced height cab which increases the driver's ability to see people and objects.

Capacity Comparison: Fire Trucks & Commercial Freight Vehicles

Smaller Size Does Not Always Mean Reduced Capacity

When considering downsizing as a safety strategy in an urban truck or bus fleet, it is important to be able to understand possible tradeoffs in performance or capability. While a shorter or narrower vehicle may not have the same payload or capacity, the vehicle may still be equally capable of performing its intended job, while having a tighter turn radius and more safely navigating downtown streets. A truck or bus with a 20 percent shorter wheelbase has a minimum turn radius that is also 20 percent smaller. Indeed, a smaller vehicle with greater maneuverability can offer more efficient operation through more direct routing and fewer delays in dense traffic. Road diets provide a useful analogy. Road diets involve reallocating inefficiently used road space for a more multimodal street with similar or even higher capacity to move people.[22] Like streets, certain inefficient large vehicle designs can be made more compact while maintaining if not increasing their capacity.

In addition, reductions in absolute capacity can potentially be addressed by policy changes regarding freight and goods movement; these may include improved curbside management, designated delivery hours or routes, and urban-scaled distribution hubs.[23] Since smaller vehicles afford benefits to the cities in which they operate, it is reasonable to consider a holistic solution to their implementation that takes into account the need for public sector cooperation and coordination.

One oft-posed potential unintended consequence of downsizing (specifically, reducing truck capacity) is increased congestion and increased crashes. This assumes that current trucks are loaded to capacity and that reducing individual vehicle capacity therefore requires more trucks. However, load factors of trucks can vary on average from approximately 50% to 90%.[24] In the U.S., shippers typically hire a full truckload (FTL) freight carrier instead of a less-than-truckload (LTL) carrier even when their cargo uses only as little as 25% of the trailer's capacity[25]. Still if current trucks are assumed to all be loaded to capacity, the possible unintended consequence is that, for example, three smaller trucks will generate more vehicle miles traveled and more potential for collisions than two large trucks. If so, it is difficult to predict whether the number of injury crashes would increase or decrease. It is possible that each individual small truck would generate fewer injury crashes due to improved visibility and maneuverability, or due to other factors that offset the increase in truck miles. Small trucks may more easily fit in loading zones without double parking, a common cause of urban congestion. Additionally, miles traveled by smaller trucks may not increase as expected if local distribution centers proliferate (e.g., Amazon urban fulfillment centers[26]) and disrupt today's last-mile logistics patterns.

Downsizing Fire Trucks

Member cities in the Working Group reported that the size of today's fire apparatus can limit cities' ability to implement lower-speed streets and intersections for pedestrian, cyclist, and vulnerable road user safety. Wide suburban roads and sprawl in the second half of the last century have allowed fire apparatus manufacturers to design increasingly larger vehicles that assume 20 to 26 feet of clear width on every street in their service areas. These larger fire apparatus can be incompatible with many existing streets in older cities and towns. In many communities, smaller vehicles could potentially help emergency response personnel reach more building stock and population in less time, in addition to allowing designers to implement more compact, safer street designs.

Based on Volpe's research, as well as interviews with Portland, OR and San Francisco, CA fire officials, it is clear that U.S. fire apparatus have significantly grown in size over the past century, paralleling growth in the size of freight trucks.[27] New equipment has been added to fire trucks to address new types of emergencies (e.g., gas leak, hazmat, biochemical attack, etc.) as building fires have diminished to approximately 3-5 percent of incident calls nationally.[28] Fire apparatus have grown in size to the point that emergency vehicles were recently exempted from federal truck weight limits, even though many non-Interstate Highway bridges are not designed for up to 92,000 pound fire vehicles.[29] According to the Federal Highway Administration Office of Bridges and Structures, "…bridge safety, serviceability, and durability might be compromised by these [fire apparatus]."[30]

Fire apparatus include two principal types: pumpers (or "engines"), which supply water or foam, and aerial ladder trucks, intended to provide aerial access for firefighters, evacuees of a building, and pumped water or foam. Ladder trucks are larger than pumpers yet must generally be able to access all streets in a city. [31] As most states have adopted the International Fire Code, which authorizes fire departments to stop street construction and modification projects, ladder trucks have at times become the limiting factor constraining traffic fatality reduction projects, livable street design, and traffic calming initiatives.[32]

Assessing ladder truck performance

According to the Portland, OR Fire Department, the key performance metrics for a ladder truck are ladder height (vertical) and reach (horizontal), as well as pumping capacity. Fire departments in Europe and Japan operate significantly smaller vehicles, and there appears to be renewed attention in the U.S. fire service community on how improved fire suppression and pumping technology can permit downsizing a fire apparatus while maintaining capability.[33]

There are other differences between U.S. and international fire departments, including that some international agencies use different vehicle types depending on the emergency call received. One notable example is the use of motorcycles for EMT response and triage in some cities, which can significantly increase the speed of response because of those smaller vehicles' ability to navigate narrower and/or more congested streets. Daytona Beach and Austin-Travis County are two U.S. jurisdictions that have already incorporated motorcycles into their fire EMT response operations. Importing similar approaches to other U.S. cities, in addition to fire engine and ladder truck designs, could provide a more comprehensive approach to maintaining and even improving emergency response capabilities while giving street designers more flexibility to create environments that better accommodate and protect all road users.

Comparing the performance of European and American fire trucks

Aerial ladder trucks used in major European and Asian cities such as London and Tokyo provide equivalent or greater ladder height and reach with improved vehicle maneuverability. European aerial ladder apparatus can reach just as high, with two-thirds the vehicle length and up to half the required turn radius.[34] European and Asian models are likewise significantly lighter.[35]

Notably, the 2009 revision of NFPA 1901 allows for the use of European-style ladders in the U.S, which may open the door for European apparatus designs not available before. Almost all European aerials have platforms on which firefighters can stand, and some offer removable platforms. These aerial designs appear to be more targeted for urban areas with narrow streets than current U.S. designs.[36]

Additional approaches available for reducing the footprint of ladder trucks include smaller stabilizers and stabilizers that can be shortened or only deployed on one side ("short-jacked"). This can reduce width requirements at a fireground by 10 feet, for example requiring only 9 feet instead of 19 feet of additional width.[37]

Comparing Aerial Ladder Trucks

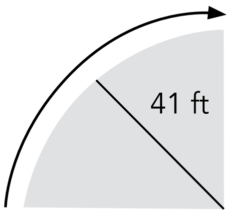
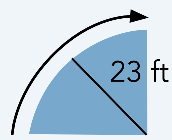
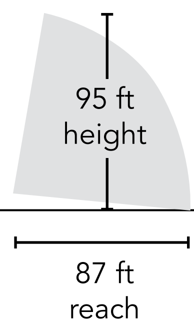
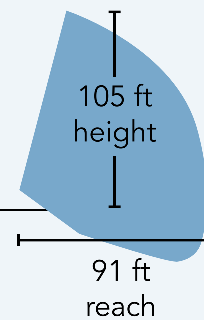
	E-One Cyclone HP 95 Ladder Truck	**Magirus M32L-AS (Iveco 160 E 30)**
		
Region	United States	Europe
Turn radius		
Wheel base	260 in.	190 in.
Overall length	574 in.	393 in.
Ladder height	95 ft	105 ft
Ladder reach	87 ft	91 ft
Visualized ladder radii Ground line		

Figure 11: Comparing the Performance of European and American Fire Trucks. Image adapted by NACTO

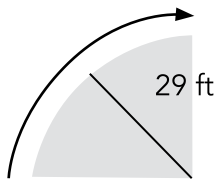
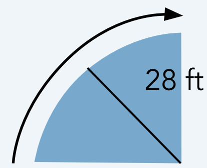
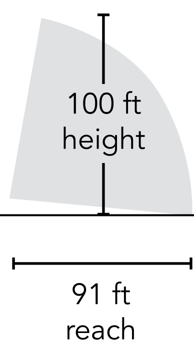
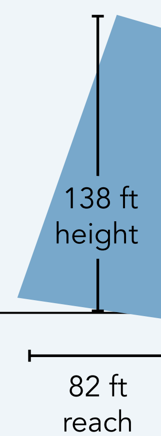
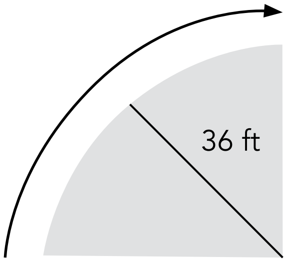
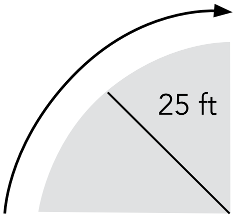
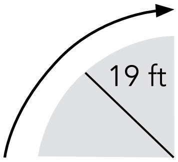
	Seagrave TDA Tiller Aerial Ladder	Magirus 42L-AS Ladder (Iveco 180 E32)
		
Region	United States	Europe
Turn radius		
Wheel base	155 in. tractor; 305-341 in. trailer	201 in.
Overall length	684-720 in.	504 in.
Ladder height	100 ft	138 ft
Ladder reach	91 ft	82 ft
Visualized ladder radii		

Figure 11 continued: Comparing the Performance of European and American Fire Trucks. Image adapted by NACTO

Comparing Pumper Fire Trucks

For pumper trucks, some smaller sized, similar capacity vehicles are already in use in the U.S. In San Francisco, the SFFD pumper maintained pumping capacity but reduced turning radius by 24% (from 33 ft to 25 ft). Even smaller vehicles such as the "Rapid Attack Apparatus" pumper are available with no further reduction of carrying or pumping capacity. Fire pump capacity can be maintained across vehicle sizes.

	Standard Pumper	SFFD Pumper	"Rapid Attack Apparatus" Pumper
			
Carrying capacity	750 gallons	500 gallons	500 gallons
Fire pump capacity	1,500 gal/minute	1,500 gal/minute	1,500 gal/minute
Turn radius			
Wheelbase	201 in.	169 in.	129 in.
Overall length	384 in.	334 in.	266 in.

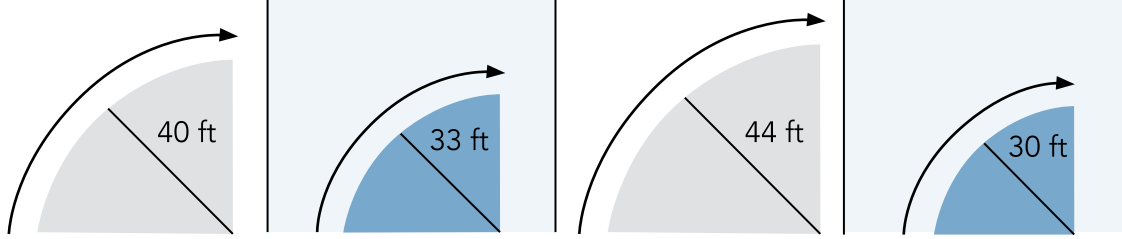
Same pumping capacity, smaller turning radius →

Figure 12: Comparing the Performance of European and American Fire Trucks. Image adapted by NACTO

Downsizing Commercial Freight Vehicles

Opportunities for vehicle downsizing without negative impacts on capacity also exist for commercial freight operators. Preliminary comparison research shows that at the same Gross Vehicle Weight Rating (GVWR) (which tracks with payload capacity), it is possible to get both tighter turn radius *and* a larger cargo body.

	Rigid	**Rear Steer**	**Conventional**	**Cab-over**
				
Axles	3-axle		2-axle	
Max cargo body length	30 ft	25 ft	24 ft	28 ft
Overall length	454 in.	Not available	463 in.	414 in.
GVWR	52,000 lbs	52,000 lbs	33,000 lbs	33,000 lbs
Turn radius	40 ft	33 ft	44 ft	30 ft



Same GVWR, smaller turning radius

Same GVWR, longer cargo body, smaller turning radius

Figure 13: Comparing the Performance of Commercial Freight Vehicle Models. Image adapted by NACTO

Benefits & Considerations in Vehicle Downsizing

Vehicle downsizing represents a key opportunity for cities and private fleet operators to reduce risks to pedestrians, cyclists, and other vulnerable road users by deploying vehicles that are more compatible with operation in dense, urban settings.

This report identifies a number of benefits associated with vehicle downsizing. These include:

- Can improve drivers' situational awareness
- Can improve operational safety
- Can leverage existing budget & procurement cycles

At the same time, research suggests some areas where additional considerations must be taken into account as operators downsize or rightsize large vehicles. These include:

- Potentially long full fleet replacement timeline
- Possibility of less-credentialed drivers

Benefits of Downsizing

Can improve drivers' situational awareness

Smaller vehicles can offer improved visibility and provide the driver with greater situational awareness to see and avoid collisions with people in the vicinity of the vehicle. Improved visibility of nearby road users is a function of the driver's height from the ground, how low the cab glazing extends on all sides, and the geometry of the dashboard, hood, doors, and pillars.

Can improve operational safety

Improved operational safety can stem from downsized vehicles' reduced turn radii and off-tracking of the rear wheels, which can reduce associated curb mounting and endangerment of people when making turns at intersections and driveways, as well as potentially reduce damage to street infrastructure. Reduced encroachment on sidewalk extensions, median refuges, adjacent travel lanes, bike lanes, and bike boxes[38] can similarly translate to safety improvements for people. This operational benefit is two-fold, as it allows street designers to implement more of these safety features as part of roadway and streetscape projects for improved access, mobility, and safety.

Can leverage existing budget & procurement cycles

Vehicle downsizing represents a unique opportunity for fleet operators because it makes use of pre-planned, regular vehicle replacement schedules to acquire new, smaller vehicles. In doing so, the cost of downsizing is typically already budgeted for. However, as large vehicle fleet turnover can take over a decade, downsizing is a longer-term strategy than ADAS. Two possible ways to accelerate the impact of downsizing are prioritizing the assignment of existing downsized vehicles to areas where they may be most beneficial, such as the use of motorcycles for EMT response and triage; and using municipal contracts to select for vendors with access to rightsized vehicles, so that they are available as required when fleet vehicles are replaced. Downsizing places emphasis on identifying new vehicles that support collision avoidance through improved situational awareness and greater operational compatibility with urban street design that supports multimodal safety and access.

Challenges and considerations for downsizing

Potentially long full fleet replacement timeline

As noted above, full large vehicle fleet turnover can take over a decade, depending on the size of the fleet. As such, some of the safety benefits of downsizing, such as opportunities for street redesign, may not be immediate. One way to accelerate the impact of downsizing is to have cities or operators focus the assignment of existing downsized vehicles to areas where they may be most beneficial, such as the use of motorcycles for EMT response and triage. Cities should also explore procurement options proactively, to ensure that they are able to select vendors with access to rightsized vehicles, so that they are available as required when fleet vehicles are replaced.

Possibility of less-credentialed drivers

The first possible unintended consequence is that downsizing might increase the proportion of less-qualified drivers operating smaller trucks. This concern is related to the fact that driving trucks with gross vehicle weight ratings up to 26,000 pounds does not require a commercial driver license (CDL). However, it is not clear whether non-CDL drivers operate a given vehicle less safely than CDL drivers. Volpe could not identify research that has addressed this question. Complicating the issue are the facts that (1) no national statistics appear to exist that compare the crash rates of CDL versus non-CDL truck operators; [39] (2) safety performance is federally measured at the commercial motor carrier (company) level rather than the driver level; and (3) there is no minimum training requirement currently in place to obtain a CDL.[40] Since CDL driver convictions can be better tracked than non-CDL driver convictions spread across different states,[41] the least safe CDL drivers can potentially be identified and more easily held accountable over time than the worst non-CDL drivers. However, companies employing non-CDL drivers may also invest more in training them to minimize crashes and protect their reputation.[42] In short, it is difficult to predict whether more or fewer injury crashes would result from a larger fraction of non-CDL urban truck drivers.

Best Practice: Improved Direct Vision

Heavy-duty vehicles are less maneuverable and take longer to stop than light-duty vehicles. As a result, reducing driver reaction time is a key tool to improving safety. Direct Vision improvements, such as high-vision cabs and peep windows, may start low on the priority list of cities seeking to invest in more "high tech" solutions for their fleet safety. However, the ability of Direct Vision improvements to enhance a driver's direct field of vision by reducing large blind spots is one of the key tools operators have to reduce safety risks presented by their vehicles. Increasing municipal drivers' direct vision from the cab may also help cities and operators reduce costs associated with city insurance and crash liability claims.

Direct Vision improvements consist of a wide slate of related tools, some of which can be retrofitted onto existing fleet vehicles and others which must be specified in the purchase of new vehicles, in some cases at no added cost. Often, retrofits and short- and long-term procurements can be combined to create meaningful safety improvements incrementally. Elements of Direct Vision include:

- Peep & Teardrop Windows
- Sloped-hood Cabs
- Cab-Over Engine Designs
- High Vision Cabs (includes cab-over & window enhancements)

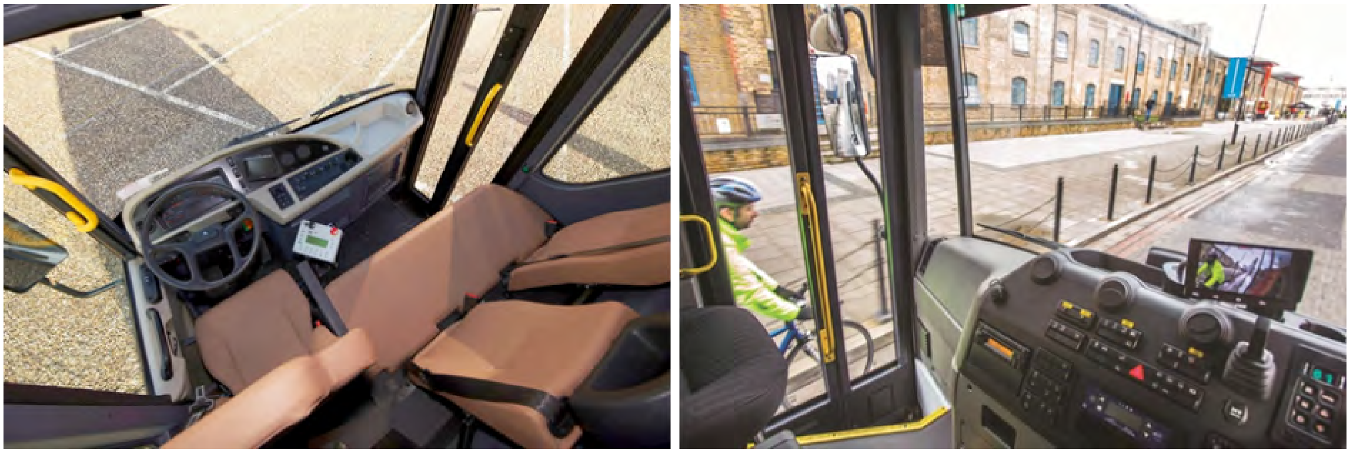
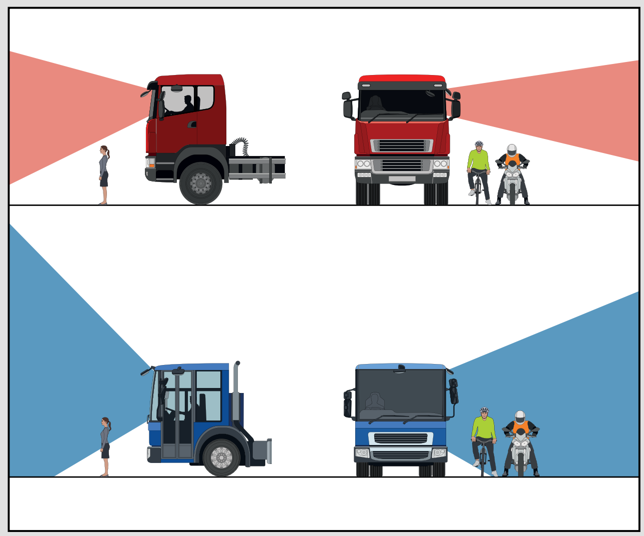


Figure 14: High-vision cabs expand near-vehicle visibility for drivers. Courtesy of Transport for London.

What Are High-Vision Cabs?

Whereas other vision-enhancing mechanisms—e.g., mirrors, lenses, cameras, and sensors—are intended to compensate for poor direct vision, high-vision cabs allow drivers to better see adjacent roadway, pedestrians, cyclists, and other road users with their naked eyes. This minimizes the complexity and fatigue potential of processing multiple inputs, reduces new blind spots created by the installation of mirrors, and facilitates eye contact with people to communicate awareness and intent through facial or hand signals. There are several key components of high-vision cab design that distinguish it from traditional cab design:

- Cab-over or cab-forward design, wherein the driver sits forward of the front axle (versus conventional cab design wherein the engine and front axle are forward of the driver)
- Lower driver seat height and reduced dashboard height/ size to allow a better view of surroundings
- Increased glazing and lower windowsills throughout the cab body and doors.



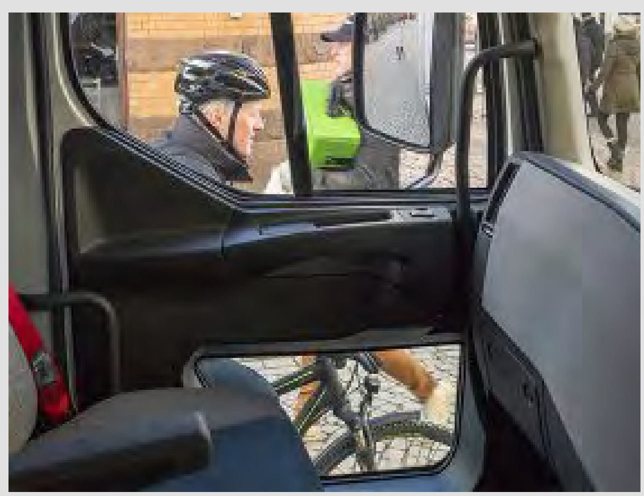


Figure 15 (top): The Mercedes Benz Econic MGT Euro5 high-vision cab in use for freight in Europe.

Figure 16 (middle): Sightlines from a limited direct vision heavy goods vehicle versus an increased direct vision model. Image courtesy of Transport for London.

Figure 17 (bottom): View of a cyclist from a high-vision truck cab.

Direct vs. Indirect Vision

A limited but growing body of primarily international studies establishes the effectiveness of improved direct vision in reducing crashes and injuries. A 2006 University of Michigan study found that 20 percent of truck-initiated crashes are linked to poor direct vision and noted that direct vision is currently unregulated in the U.S.[43] In the United Kingdom, Loughborough University has linked truck-person crashes to the level of direct vision in the involved vehicle. Construction vehicles and above-average cab height with low levels of direct vision correlated with involvement in fatal crashes with bicyclists in London.[44]

Transport for London's Freight and Fleet Office commissioned studies of direct vision, including synthesis of literature, extensive driver surveys, and laboratory-based experiments.[45,46] Results from a University of Leeds study showed that driver responses to seeing a pedestrian were on average 0.7 seconds faster by direct vision than by indirect vision, i.e. through mirrors. Viewing pedestrians indirectly doubled the driver response time and thus doubled the distance traveled before the driver could apply the brakes or steer to avoid a crash.[47]

In addition, compared to indirect vision (e.g. cameras or mirrors), driver direct vision introduces fewer human factor concerns and caveats. Continuously checking multiple mirrors and camera screens can lead to input fatigue for the operator, potentially reducing the safety benefit of these add-on devices. Hence direct vision allows drivers to respond more quickly to avoid a crash than does indirect vision.[48,49,50]

Drivers in direct/high-vision cabs out-perform drivers in standard cabs, even when distracted

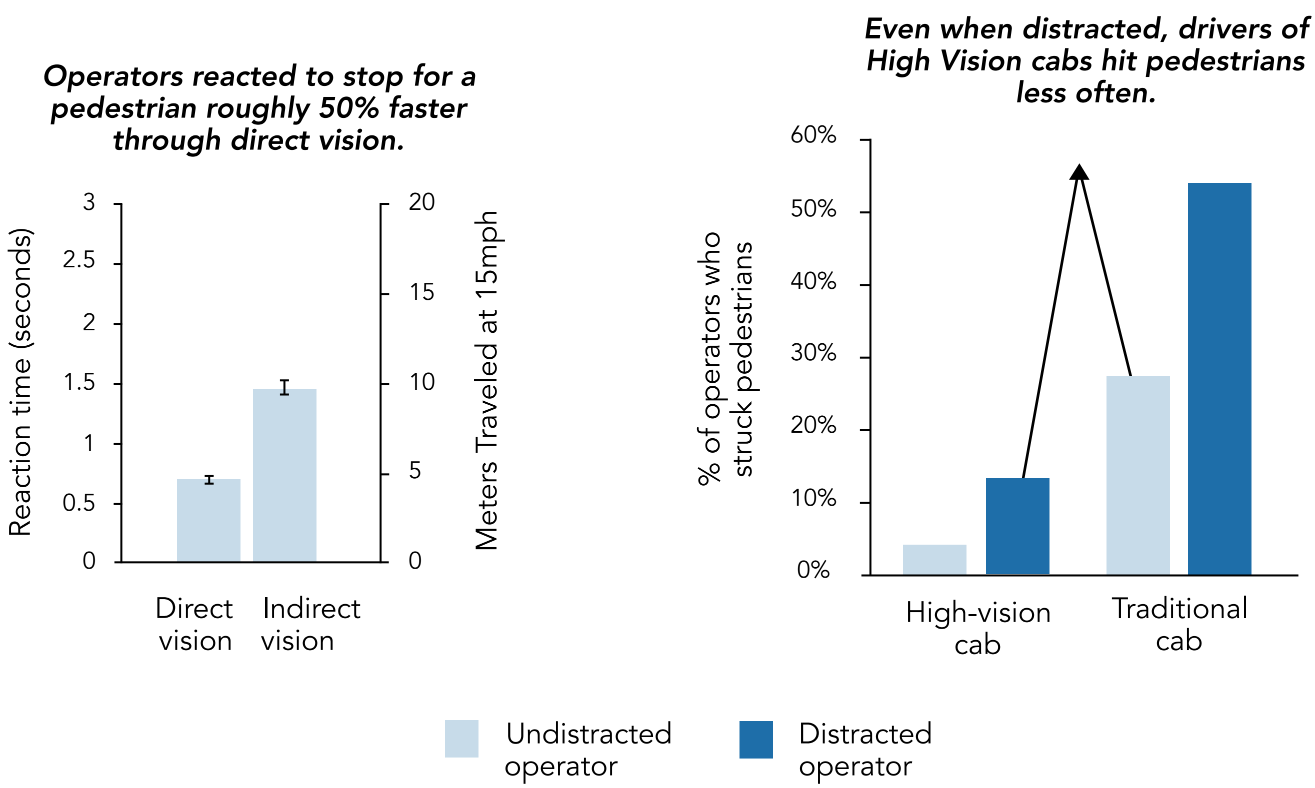


Figure 18: Left: Improved driver response time for direct compared with indirect vision. Right: Increase in crashes with pedestrians when using a traditional cab versus a low-entry, high-vision cab. (Source: TfL) Image adapted by NACTO

Evidence of Effectiveness

In the University of Leeds Study, the number of drivers in the study who struck simulated pedestrians was about five times greater in the traditional cabs than in the low-entry, high-vision cabs. When the drivers—which included professional truck drivers—were required to perform a mental task while operating, more than half of the drivers in traditional cabs struck pedestrians, compared to only about 12% of high-vision cab drivers. The findings suggest that distracted truck operators may especially benefit from a direct line of sight to people to avoid collisions.[51]

User accounts of improved direct vision offered by even small additional "peep windows" in the passenger door appear to corroborate the safety benefit of increased driver situational awareness. Milwaukee County recently purchased new snow plows equipped with peep windows (see example in Figure 31) and reported: "With the peep window on the passenger side door, they can see what's happening…without leaning toward the window."[52] A U.S. trucking magazine that test drove truck models with peep windows noted their improved visibility in the passenger-side blind spot due to the additional glazing.[53]

Volpe interviews with municipal fleet officials indicate a general awareness that cab-over trucks tend to have smaller blind spots than long-nose conventional cabs. The City of Boston preferentially dispatches cab-over Public Works trucks to downtown neighborhoods for this reason.[54]

Considerations for Implementation

When selecting tools to increase the drivers' direct vision, cities and private operators should look carefully to ensure that the selected tools meet their safety goals, be cognizant of system limitations, and identify resources and opportunities to address driver concerns.

In particular, purchasers should consider:

- How can they best combine high-vision cab elements, via retrofits and short- and long-term procurements, to transform their fleets?
- How can workplace safety be improved through Direct Vision tools like low-entry, cab-over-engine models?
- What driver perceptions must be addressed to ensure smooth transition to new cab types?
- How will they assess claims about the degree of vision possible?

How can they best combine high-vision cab elements, via retrofits and short- and long-term procurements, to transform their fleets?

A combination of retrofits and short- and long-term procurements may allow for either an incremental or a transformative approach to improving direct vision on a truck fleet. Peep windows, teardrop windows with lower windowsills, and reduced window tinting[55] can generally be retrofitted on existing vehicles. Sloped-hood conventional cabs (similar to the cabs of most newer school buses) can be specified on certain new trucks instead of boxy hoods at no marginal cost.[56] Furthermore, cab-over models can supplant conventional cabs, offering both increased maneuverability (due to reduced wheelbase) and improved direct vision. Ultimately, low-entry, high-vision cab-overs with maximum windshield and door glazing offer the greatest potential for improved direct vision.

Transforming Truck Cabs

Figure 19: Progression from a low vision truck cab to a high-vision truck cab can be incremental or transformative. Image adapted by NACTO

Availability across truck original equipment manufacturers (OEMs) affects which of these strategies can be implemented by cities. Virtually all OEMs offer sloped hoods and peep window options, most OEMs offer cab-over models, and a growing number are offering low-entry cab-over models with superior direct vision. Low-entry, high vision cab-over models are still primarily marketed to the refuse truck market, but they can be used in many other freight, construction, and special applications as well, e.g. the municipal dump truck in the rightmost panel of Figure 27. At least within the Mack lineup, cab-over models can cost about $10,000 more than conventional cab counterparts.[57] For a $200,000 new concrete truck or a $250,000 new refuse truck,[58] this represents four to five percent of the total purchase cost.

A city can incorporate any of these specifications in new vehicle purchases relatively quickly and replace priority vehicles within 3-5 years. Vehicle turnover and phasing in high-vision cabs may take 7-15 years for an entire fleet.

While the maximum benefit may be achieved through procurement of new high-vision cab trucks, agencies can also take an incremental approach to improve direct vision for their existing vehicles and to reduce blinds spots on new trucks with low or no additional cost.

How can workplace safety be improved through Direct Vision tools like low-entry, cab-over-engine models?

As raised by members of the Working Group, truck drivers may be supportive of low-entry cab-over trucks due to their potential for reducing workplace injury when entering and exiting the cab. In 2015, the U.S. transportation and warehousing industry had 19,940 non-fatal and 34 fatal falls, slips, or trips.[59] The lower the cab, the safer it can be for the worker who needs to climb in and out (e.g. for garbage, pothole/sidewalk repair, tree watering, oil/gas delivery, etc.).

The difference between two steps and four steps can mean more injuries and workers' compensation costs. In a Washington State study[60] of the state's 48,000 trucking workers, falls on ingress and egress of the vehicle accounted for 8 percent of all lost work time claims, or 400,000 lost workdays. Yet only about 6 percent of refuse truck claims and only about 3 percent of courier messenger claims were due to falls from vehicles in the Washington State study.[61] Since refuse trucks and courier step vans typically have lower cab heights than general freight trucks, these findings demonstrate that in addition to improving direct vision for pedestrian safety, lower cab height may improve truck operator safety. Newly available models with even lower entry could potentially further improve worker safety. For example, the Freightliner EconicSD's low entry has a first step 19 inches above the ground, half the first-step height of some conventional waste collection trucks, and a kneeling feature that further reduces step-in height.[62]

What driver perceptions must be addressed to ensure smooth transition to new cabs?

Certain driver perceptions and their relative lack of familiarity with low entry cab-over trucks can also pose a barrier to embracing this type of vehicle for improved urban maneuverability and direct vision.

First, an outdated perception that cab-overs are less safe than conventional cabs persists among some truck drivers. Driver safety concerns about cab-over trucks trace back to discontinued vehicle designs from the 1970s-80s; improvements since the 1990s have essentially closed this safety gap with conventional trucks, making cab-over trucks statistically as safe for their drivers, while potentially safer for other motorists and vulnerable road users around them.

However, over these same decades, cab-over trucks became ten times less common in the U.S.—declining from about 50 percent of all trucks to only about 5 percent.[63] This may explain why the negative perception has persisted. Appendix B summarizes safety data that challenge this negative perception.

Second, driver comfort and in-cab features have tended to lag in cab-over truck models over the years compared to conventional trucks, so drivers have come to associate cab-overs with less comfort.[64] However, there is no reason this has to be the case, and it appears that any remaining cab-over comfort gap is on its way to being closed with more recent manufacturer offerings.[65] Cities and other fleet customers can also demand superior comfort and features, especially as European high-vision cabs bring increased competition to the U.S. market.

Third, drivers' perceptions of low-entry, high-vision cab-overs can be colored by an association with refuse trucks, the industry in which the design is most commonly found today. In a study by Transport for London, some drivers reported feeling this stigma when first presented with a low-entry, high-vision cab. But once they had an opportunity to drive the high-vision truck themselves and to experience the improved confidence of driving it on crowded city streets, drivers reported they did not want to return to trucks with less direct vision.[66]

Addressing driver culture and perception may take time but is critical to successful implementation of the high-vision truck cabs that could potentially provide the greatest safety benefit for people walking and biking nearby. Countering outdated driver perceptions of cab-overs with fact and emphasizing driver benefits such as improved workplace safety and situational awareness may be important parts of any effort to change perceptions. But based on TfL's experience, piloting these vehicles and encouraging hands-on experience may go the furthest to encouraging acceptance and smoothing implementation.

How will they assess claims about the degree of vision possible?

In the U.S. there are no regulations or standards for manufacturer claims about degree of direct vision. Thus, the only data available to U.S. fleet purchasers to help identify best-in-class direct vision truck models is generally proprietary, sales-oriented comparisons published by various OEMs. To quote one city fleet agency that Volpe interviewed, "Any OEM that we ask will tell us their cabs are high-vision." Volpe is not aware of any third-party, independent organizations that currently characterize and publish field-of-view comparisons. In the absence of objective criteria or standards for direct vision, even truck fleets that operate in dense cities do not appear to consistently purchase and dispatch trucks that minimize blind spots. Driver preference is a major influence for which models are purchased and used.[67]

In 2016 Transport for London developed a Direct Vision Standard (DVS), which assesses and rates how much a truck driver can see directly from their cab in relation to other road users, because no such standard existed. The European Union now appears likely to develop a continental standard based on the DVS in the coming decade. Thus the DVS may be a starting point for U.S. efforts to characterize direct vision.

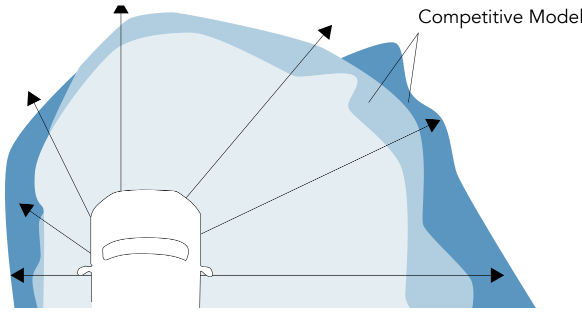


Figure 20: Example of a proprietary direct vision comparison between truck competitors. Reference: Freightliner.

As an initial U.S. effort, a low-cost, independent direct vision measurement system was recently developed and demonstrated by the Franklin W. Olin College of Engineering, with oversight from Volpe, the Working Group, the Santos Family Foundation for Traffic Safety, and other stakeholders. The Visibility in Elevated Wide vehicles (VIEW) method relies on a low-cost, app-based analysis of panoramic photos that anyone can collect from the driver's seat of a vehicle of interest, using a standard smartphone and a low-cost camera stand. The user uploads the panoramic photo to a website and enters four measurements to calculate the blind volume/visible volume rating, as shown in Figure 29. The team has developed a prototype database[68] to upload and freely access crowdsourced direct vision ratings of large vehicles by Vehicle ID Number, make, model, and weight class. As the number of entries grows, the online database will be more comprehensive and accurate for comparing the direct vision ratings of U.S. vehicle makes and models that a fleet may be considering. The Working Group can choose to pilot, improve, and leverage this methodology to inform future city vehicle procurement.

Figure 21: Comparing direct vision of a cabover and conventional cab truck using the VIEW method.

Implementation Examples

Downsizing and direct vision technologies are increasingly common, especially in Europe. The domestic and international examples of vehicle downsizing, high-vision/low-cab, window enhancements, and cab-over-engine designs deployed on trucks are provided below to illustrate how some public and private fleets are rolling out these safety strategies.

Downsizing Examples

Key to vehicle downsizing is to think holistically both about what capacity is needed and whether employing other operational practices can allow for the use of different or smaller vehicles. Many cities have found that vehicle downsizing in the context of upgrades to operational practices have resulted in a net increase in performance. Examples include:

- San Francisco, CA developed and implemented a Vision Zero specification for new "triple combination pumper" trucks operating in Chinatown and other dense neighborhoods of the city. The specification includes a shorter wheelbase, narrower width, 24 percent tighter turn radius, increased and non-tinted glazing, and flush roll-up doors.[69]
- Austin-Travis County EMS in Texas[70] and Daytona Beach Fire Rescue in Florida are using motorcycles to supplement or in lieu of full-size fire and ambulance trucks for medical calls. The Daytona Beach program started in 1994 and has reduced response times from 8-10 minutes with fire apparatus to 2-3 minutes with motorcycles.[71]
- Philadelphia, PA, Las Vegas, NV, Cambridge, MA, and other cities have deployed bicycle EMS units in downtown districts and during large events to further decrease response times for medical emergencies.
- Somerville, MA uses a compact Hino cab-over refuse truck platform for municipal building, park, and litter basket collection.
- Houston Waste Management deployed German-produced Rotopress refuse trucks with 40 percent larger capacity *and* 40 percent smaller turn radius than a rigid refuse truck.[72]

Figure 22: Houston Waste Management deployed German-produced Rotopress refuse trucks with 40 percent larger capacity and 40 percent smaller turn radius than a rigid refuse truck.

Figure 23: The Magirus 32L-AS articulated turn-table ladder truck.

Figure 24: The compact Hino cab-over refuse truck used by Somerville (MA).

Figure 25: Bicycle EMTs in Philadelphia, PA

Direct Vision Examples

Blind spot-reducing features, including peep windows, sloped-hood conventional cabs, and low-entry cab-over models have all been implemented on many private and public sector fleets across the U.S. For example:

- New York City's Safe Fleet Transition Plan[73] prioritizes high-vision cabs as an available safety strategy.
- NYC Department of Sanitation, Waste Management, Republic Services, and other refuse fleets extensively use low-entry cab-over models such as the Mack LR.
- San Francisco Fire Department's new pumper truck incorporates increased glazing with no tinting to improve eye contact with pedestrians and cyclists.
- Recology's Bay Area refuse and recycling fleet utilizes almost exclusively low-entry, higher-vision cabs.
- Boston Sand and Gravel Company operates a large number of Mack MR cab-over cement mixers on urban construction sites.
- Internationally, based on the Transport for London direct vision standard, the European Commission has proposed to legislate "Truck and Bus Front End Direct Vision" on new trucks and buses in the EU starting in 2028. [74] Major work truck and urban delivery fleets across Europe are increasingly deploying high-vision cabs, such as Veolia's utility fleet[75] and CEMEX's concrete mixer and dump truck fleet.[76]

Figure 26: The Mack LR high-vision waste management truck used by NYC Department of Sanitation. Photo attribute: Seth Granville

Figure 27: A high-vision waste management truck used by Recology San Mateo, CA

Figure 28: The Mercedes Benz Econic cement mixer deployed by UK construction firm Tarmac

Figure 29: In-door peep windows on a UPS truck in New York City

Figure 30: Peeper windows and increased visibility doors can be retrofit into existing vehicles. New York City Metropolitan Transit Agency, New York, NY

New Availability in U.S. Markets

Notably, the Mercedes-Benz Econic high-vision trucks used in Europe became available for the first time in the U.S. in summer 2018, rebranded as the Freightliner EconicSD,[77] and Dennis Eagle announced its 2019 introduction of the ProView high-vision truck to the U.S.[78] While both are marketed to the refuse truck industry, these high-vision models can and are being used for many other applications as well, including dump trucks, refrigerated boxes, tankers, cement mixers, and even tractor trailers for urban distribution.[79]

Figure 31: The Freightliner EconicSD

Figure 32: The Dennis Eagle Proview

Appendices

Appendix A: Project Scope and Structure

To better understand the opportunities for large vehicle redesign to improve safety outcomes on urban streets, the National Association of City Transportation Officials (NACTO) partnered with the United States Department of Transportation (USDOT) John A. Volpe National Transportation Systems Center (Volpe) to convene the Vision Zero Vehicle Safety Technology Working Group (Working Group). Two companion reports, "Optimizing Large Vehicles for Urban Environments: Downsizing" and "Optimizing Large Vehicles for Urban Environments: Advanced Driver Assistance Systems" are the work products of that Working Group.

The purpose of the Working Group was to identify vehicle-based safety technology priorities, support Volpe in the development of actionable best practices, and inform an implementation roadmap for the Working Group member cities. The Working Group focused on two technology themes and developed a best practice for each.

The first theme, vehicle downsizing, was explored as a long-term strategy and included a preliminary capacity analysis comparing conventional U.S. fire trucks and commercial freight vehicles with similar vehicles in Europe and Asia. Volpe focused its best practice research a short-term, often retrofitable option within the broad topic of vehicle downsizing: blind spot reductions through direct vision improvements to the truck cab. Including direct vision, the design technologies explored by the Working Group include:

- Direct vision improvements/high-vision cabs,
- Reduced wheelbase/turn radius (may result in reduced weight), and
- Curtain-side loading/unloading.

In the second theme, advanced driver assistance systems (ADAS), Volpe focused best practice research into two near-term technologies for reducing vehicle stopping times: forward collision warning (FCW) and automatic emergency braking (AEB). Since 1995, the National Transportation Safety Board (NTSB) has annually published the "Most Wanted List of Transportation Safety Improvements" to advocate for safety technologies. The 2017-2018 Most Wanted List marked the second consecutive year that the agency recommended increased implementation of collision avoidance technologies, including forward collision warning systems, automatic emergency braking, adaptive cruise control and lane departure warning systems.[80] NTSB called for commercial vehicle operators to install forward collision warning systems at a minimum. Including FCW and AEB, the technologies explored by the Working Group include:

- Driver alerts:
  - Blind spot monitoring
  - Forward collision warning
  - Lane departure warning
  - Smart detection cameras
- Closed-loop automatic driving systems:
  - Adaptive cruise control
  - Automatic emergency braking
  - Lane centering

Defining the Scope:

In selecting themes and best practices, the Working Group looked to for opportunities that met a short list of criteria with clear fatality reduction benefits. In short, the Working Group focused on technologies that could:

- Improve both crash avoidance and crash mitigation capabilities (e.g. by improving drivers' situational awareness and reducing reaction time)
- Represent a mix of short- and long-term implementation strategies
- Represent a mix of open-loop, closed-loop, and/or passive technologies
- Require minimal additional driver training

In particular, technologies that could address both crash avoidance and crash mitigation were particularly of interest because they are the fundamental strategies to improving the safety of heavy-duty vehicles operating in dense urban environments. Crash avoidance can be achieved through infrastructure changes, road user education, improved situational awareness, and reduced reaction time. Crash mitigation, meanwhile, represents the last line of defense in situations in which a crash is not avoided, and is intended to reduce the severity of crashes, primarily by redirecting road users away from critical danger points (e.g., as with side underride guards and wheel guards) or reducing the speed and therefore force of impact (e.g., as with automatic braking). Given that heavy-duty vehicles are less maneuverable and take longer to stop than light-duty vehicles, reduced driver reaction time was an important criterion for selecting a focus technology.

Exploring technologies with both shorter- and longer-term implementation timelines was intended to give Working Group members flexibility in considering technologies and practices that are responsive to their unique contexts and priorities. Finally, it was important to balance the implications of technology complexity: open-loop technologies (advisory to a human who must take action) are currently more available, while closed-loop technologies (automated without a human taking action) can be less susceptible to driver error and may require less driver training. More advanced automation technology (sometimes referred to as "driverless" vehicles) is still likely a decade or more from large-scale availability, especially in more complex urban environments, and was therefore not a Working Group focus for this study.

About the Working Group:

The Working Group met approximately bimonthly over the course of one year and is scheduled to conclude in fall 2018. At the time of the project kickoff in September 2017, the member cities included the following:

- Boston, Massachusetts
- Chicago, Illinois
- Los Angeles, California
- San Francisco, California
- Seattle, Washington
- Washington, District of Columbia

Appendix B: Cab-Over Safety Data Versus Perceptions

Driver input is strongly considered by fleets when purchasing vehicles. There persists a perception of reduced rear-end crash safety for cab-overs, as well as a general unfamiliarity with them for some U.S. truck drivers. This may be largely due to lack of familiarity by newer drivers, but for more experienced drivers it may be related to recalling an actual safety gap that existed over a generation ago.

A 1991 Michigan TRI study compared crash safety for conventional vs. cab-over trucks.[81] In fatal frontal impacts the percentage of ejected drivers was 50 percent higher for cab-over styles. For restrained drivers in severe impacts, the probability of injury was 20 percent higher in a cab-over compared to a conventional cab, and probability of fatality was 40 percent higher. This was all using the Trucks Involved in Fatal Accidents (TIFA) files compiled by the Center for National Truck Statistics at TRI. According to NTSB information 20 percent of cab-overs had sufficient survival space, compared to 35 percent of conventional cab tractors. It showed that cab-over tractors had higher incidence of ejection and higher injury level for non-ejection. Notably, the share of cab-over trucks on the road declined significantly (from around 40% in 1980 to around 5% in 2010) since deregulation of truck size in 1982.[82]

However, recent U.S. cab-over v. conventional fatality statistics, taken from UM's TIFA, show the cab-over trucks have gotten markedly safer. In 2015, the fatality percentages in conventional cab tractor crashes wearing a seat belt was 10.7, vs. 12.9 for cab-over trucks. For drivers who were not wearing a seat belt, the conventional fatality percent was 58.0 vs. 60.8 percent for cab-over. Communicating to drivers that cab-over trucks are as safe as conventional trucks, while providing increased maneuverability and visibility that may help avoid crashes in the first place, may be a key strategy in adoption.

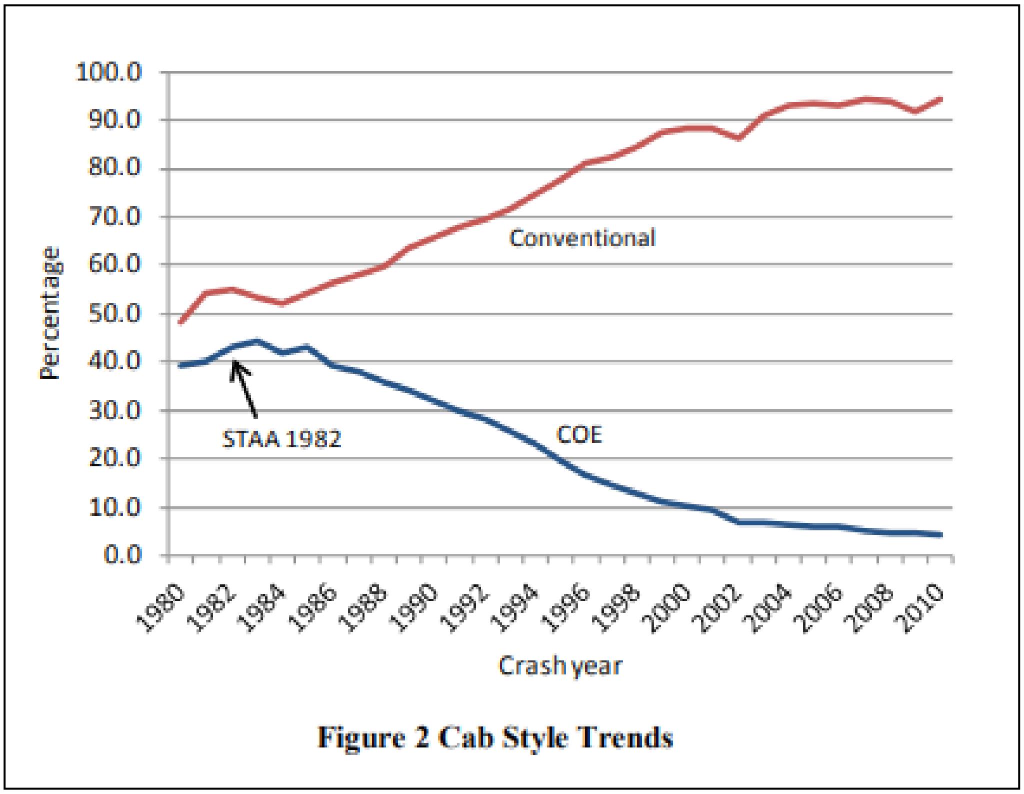


Figure 33: Cab Style Trends

Appendix C:
Turn Radius Vehicle Geometry Factors

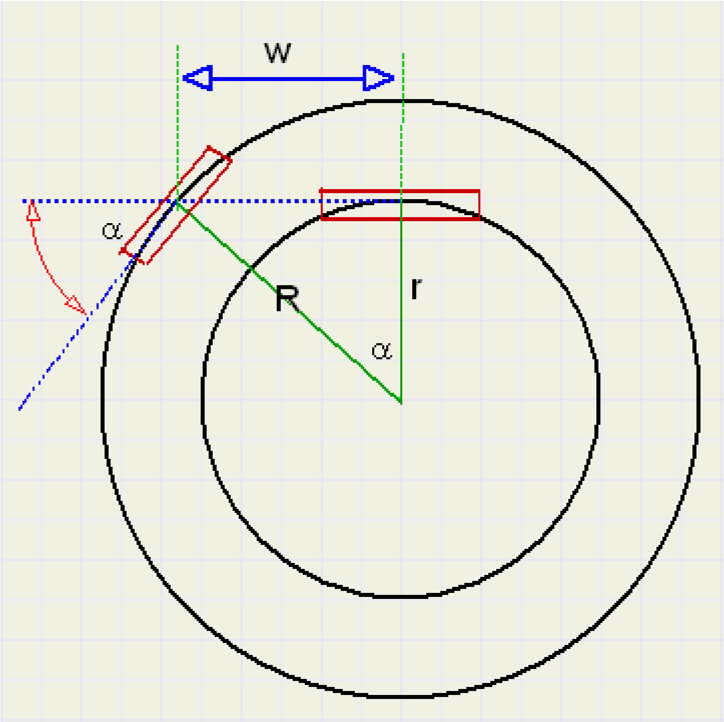


Figure 34. Inner and outer turn radius relationship to wheelbase w and wheel cut α.[83]

Front wheel turn minimum radius R = w/sin α
Rear wheel turn minimum radius r = w/tan α
where w = wheelbase and α = wheel cut

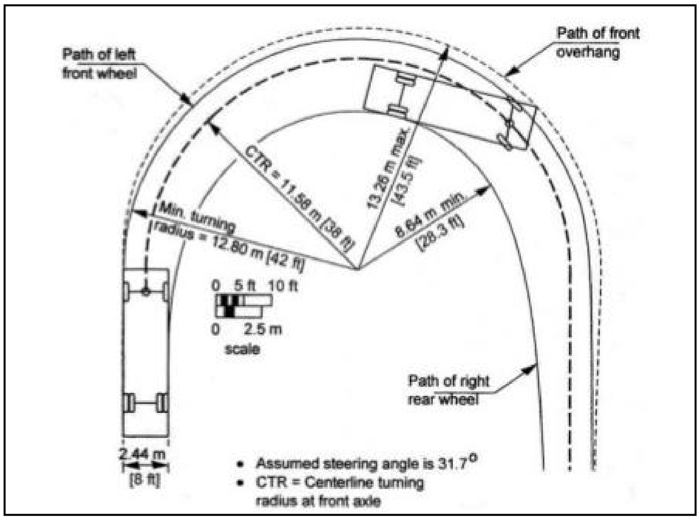


Figure 35. The swept path is the area between the paths of the left front and the right rear wheels on a turn.[84]

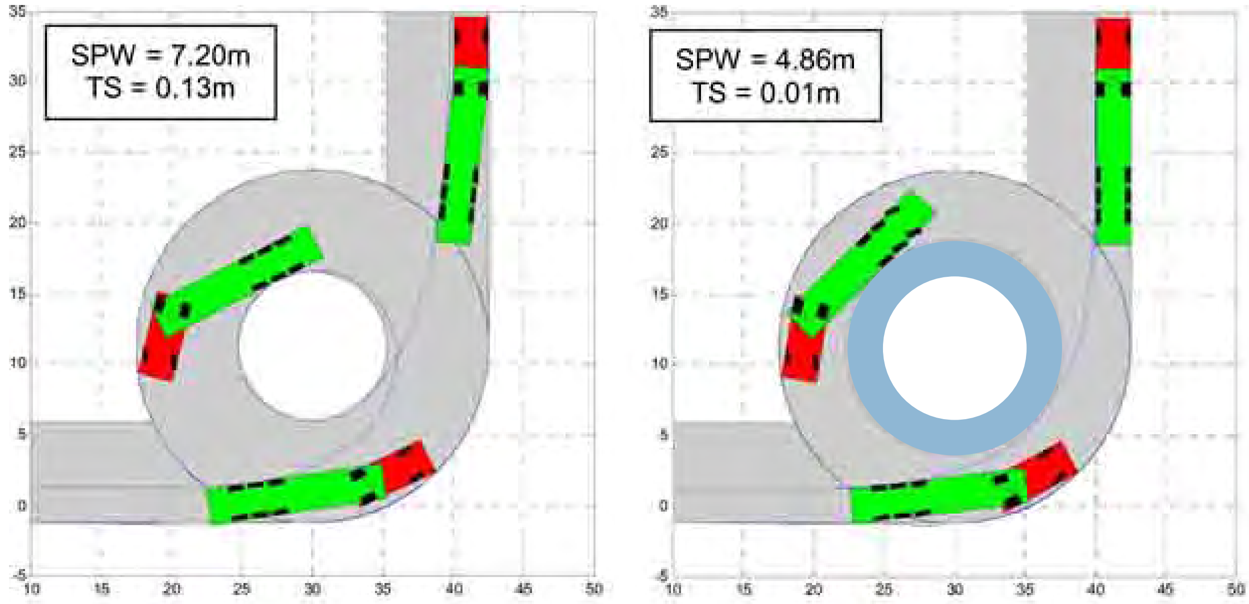


Figure 36. Reduction in swept path made possible with steerable rear axles on a trailer; the blue donut represents the area no longer mounted by the rear wheels on a turn. [85]

Appendix D: Figures

Appendix E:
References & Citations

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8 For example: https://www.cambridgema.gov/cfd/News/2018/07/emsbicycleteam.aspx

9 1.8 million Class 1-5 trucks in government owned fleets versus 2.3 million commercial fleets, or 44 percent public sector share, per https://www.automotive-fleet.com/operations/247265/2015-fleet-vehicles-by-industry-segment

10 Interview with Portland Fire Department Chief Michael Myers. April 23, 2018.

11 Referred to as "cramp angle" in the context of fire apparatus.

12 Or between the front axle and the pivot point between a double rear axle for a three-axle vehicles.

13 http://www.ksde.org/Portals/0/School%20Bus/1985NCST.pdf

14 Adapted from https://www.spartanchassis.com/er/er_performance.asp and https://www.isuzucv.com/en/app/site/pdf?file=ftr_brochure.pdf

15 By effectively reducing the wheelbase from a pivot point between the second and third axles to the second axle, making the vehicle turn as though it only had two axles.

16 For example: http://www.hendrickson-intl.com/Auxiliary/Truck-Steerable-Lift-Axle

17 For example MCI and Prevost buses: http://www.mcicoach.com/service-support/serinfo/serinfo11A.htm

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19 Where they are referred to as "6x2 / 4" axle configurations

20 https://nimbuslogistics.in/tag/steerable-axle/; https://www.youtube.com/watch?v=1VSVnuXCeYc

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33 https://www.firerescue1.com/fire-products/fire-apparatus/articles/287182018-Rapid-response-vehicles-The-answer-to-downsizing-fire-apparatus/

34 Notably, U.S. fire apparatus manufacturer Pierce introduced an "all-steer" tandem axle ladder truck in the 2000s that significantly reduced turn radius:
https://www.youtube.com/watch?v=1VSVnuXCeYc
However, it did not catch on broadly and may have been discontinued in 2005.

35 26 tons versus 39.5 tons, per https://www.fama.org/wp-content/uploads/2018/01/TC009-Em-Veh-

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36 http://www.fireapparatusmagazine.com/articles/print/volume-15/issue-4/departments/keeping-it_safe/aerial-firefighter-safety-ladders-versus-platforms.html

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38 https://nacto.org/publication/urban-bikeway-design-guide/

39 Interview with David Goettee, FMCSA Research division, March 20, 2018

40 The forthcoming Entry Level Driver Training required to obtain a CDL will introduce minimum training requirements for the first time starting in 2020, but no minimum number of training hours. https://www.fmcsa.dot.gov/registration/commercial-drivers-license/eldt/faqs

41 Interview with David Goettee, FMCSA Research division, March 20, 2018

42 For example: http://money.cnn.com/2017/08/15/technology/business/ups-virtual-reality/index.html

43 https://deepblue.lib.umich.edu/handle/2027.42/83927

44 https://www.rospa.com/rospaweb/docs/advice-services/road-safety/cyclists/hgvs-and-vulnerable-road-users.pdf

45 https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/direct-vision-evidence-from-london---hannah-white.pdf

46 http://content.tfl.gov.uk/road-safety-benefits-of-direct-vs-indirect-vision-in-hgv-cabs-technical.pdf

47 https://consultations.tfl.gov.uk/roads/direct-vision-standard-phase-1/user_uploads/road-safety-benefits-of-direct-vs-indirect-vision-in-hgv-cabs-summary.pdf

48 https://hfast.mie.utoronto.ca/wp-content/uploads/Publications/DAddario_Pamela_M_201403_MASc_thesis_final.pdf

49 http://www.clocs.org.uk/wp-content/uploads/2017/03/HANNAH-WHITE-DVS-FINAL.pdf

50 See Muttart, 2003 (SAE), Muttart, 2005 (driving Assessment), as well as Fisher & Tan - These studies showed that when visual angle increased, so did reaction time. The relationship was 0.03 seconds per degree. Thus, a glance to the rearview mirror (~25 degrees), is associated with an increase in response time of near 0.7 s. This is consistent with findings by TfL: https://consultations.tfl.gov.uk/roads/direct-vision-standard-phase-1/user_uploads/road-safety-benefits-of-direct-vs-indirect-vision-in-hgv-cabs-summary.pdf

51 https://phys.org/news/2017-02-larger-windscreen-lorry-safety.html#jCp; http://www.clocs.org.uk/wp-content/uploads/2017/03/HANNAH-WHITE-DVS-FINAL.pdf

52 http://www.government-fleet.com/channel/equipment/news/story/2010/12/milwaukee-county-uses-kenworth-t470-snowplows-to-clear-roads.aspx

53 https://www.fullyloaded.com.au/truck-reviews/0806/kenworth-t388-truck-review

54 Discussion with Bill Coughlin, City of Boston

55 For example, the SFFD "Vision Zero" pumper truck specification.

56 For example: Thomas Saf-T-Liner C2 and Freightliner M2 106 (truck): https://freightlinerads.azureedge.net/2911-m2_utility_brochure-2018-02-06.pdf

57 Per the McNeilus Companies, a leading refuse and cement truck manufacturer, a Mack Terra Pro or LR (cab-over) chassis costs about $10,000 more with same performance as a Granite (conventional).

58 Lee, Jennifer, "*Sanitation Dept. Unveils Hybrid Garbage Trucks.*" The New York Times, August 25, 2009. Accessed via: https://cityroom.blogs.nytimes.com/2009/08/25/sanitation-dept-unveils-hybrid-garbage-trucks/

59 http://www.nsc.org/Membership Site Document Library/2015 Injury Facts/NSC_InjuryFacts2015Ed.pdf

60 http://www.lni.wa.gov/Safety/Research/Files/Trucking/PreventingTruckingInjuries.pdf

61 https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0016/111283/preventing-falls-from-trucks-campaign-report.pdf

62 http://www.government-fleet.com/channel/vehicle-research/news/story/2018/04/freightliner-econicsd-waste-collection-truck-unveiled.aspx

63 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812061_heavytruckinjurycountermeasures.pdf

64 Correspondence with McNeilus Companies

65 For example: http://www.wastetodaymagazine.com/article/mack-lr-collection-truck/

66 https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/direct-vision-evidence-from-london---hannah-white.pdf

67 Discussions with Cemex and McNeilus

68 https://blindspotcalculator.herokuapp.com/

69 https://www.wired.com/story/sanfrancisco-smaller-firetrucks/; SFFD presentation to Working Group, January 2018

70 http://www.govtech.com/public-safety/Motorcycle-Medics-Reach-the-Injured-Faster-in-Austin.html

71 http://www.codb.us/index.aspx?nid=456

72 http://www.wm.com/about/press-room/2012/20120126_Rotopress.jsp

73 http://www.nyc.gov/html/dcas/downloads/pdf/fleet/VOLPE_Recommendations_for_Safe_Fleet_Transition_Plan_SFTP.pdf

74 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016SC0431

75 https://www.veolia.co.uk/media/media/veolia-further-advances-road-safety-through-ps5-million-investment

76 https://www.youtube.com/watch?v=ytf9BV0XgIM

77 http://www.government-fleet.com/channel/vehicle-research/news/story/2018/04/freightliner-econicsd-waste-collection-truck-unveiled.aspx

78 https://www.truckinginfo.com/288078/dennis-eagle-launches-proview-refuse-truck-in-u-s

79 https://www.mercedes-benz.co.uk/content/unitedkingdom/mpc/mpc_unitedkingdom_website/en/home_mpc/truck/home/new_trucks/model_range/new-econic/new-econic/fascination/the-new-econic-from-mercedes-benz.html and https://www.commercialmotor.com/news/mercedes-benz-new-econic-tractor-uk-time-christmas

80 https://www.ntsb.gov/safety/mwl/Documents/MWL2016_Brochure_web.pdf and https://www.ntsb.gov/safety/mwl/Documents/2017-18/MWL-Brochure2017-18.pdf

81 https://deepblue.lib.umich.edu/bitstream/handle/2027.42/907/81896a12.0001.001.pdf?sequence=2&isAllowed=y

82 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812061_heavytruckinjurycountermeasures.pdf

83 http://www.davdata.nl/math/turning_radius.html

84 Adapted from https://www.slideshare.net/NayanaD123/ce2026-traffic-engineering-and-management-notes

85 https://nimbuslogistics.in/tag/steerable-axle/

December 2018

DOT-VNTSC-NACTO-18-01

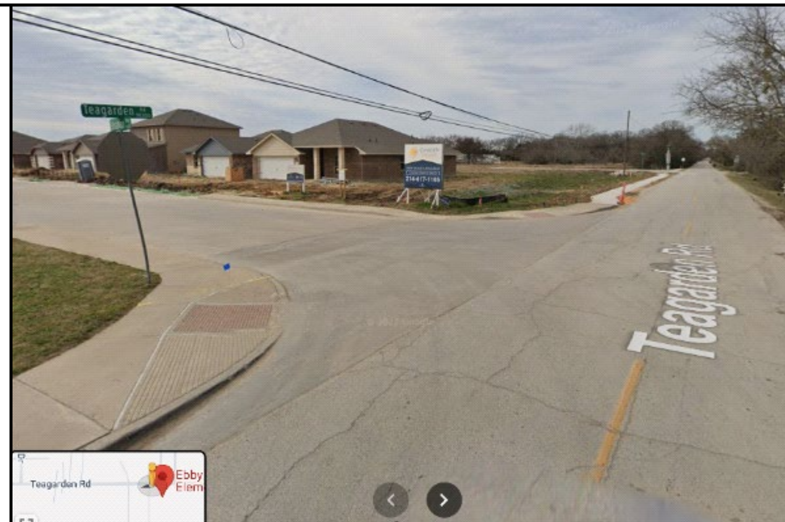
National Association of City Transportation Officials

Prepared by
U.S.DOT Volpe Center

Tab C
Examples

Location	Issue(s)	
Northwest corner of Peavy Road and Garland Road	Second uneccessary pole for pedestrian signaling that impedes pedestrian pathway and access for barrier free ramp; BFRs do not align with crosswalks and if angled, do not provide for required distance between bottom of ramp and vehicle lane.	
Northwest corner of Southwestern Blouvard and Skillman Street	Signalization poles located in pathways, blocking access for barrier free ramps and pedestrians.	

Southwest Corner of Main Street and Cesar Chavez	pole placement and design unnecessarily blocks path	
Northeast corner of Douglas and Sherry Lane	Certainly Oncore could be a better partner, but the City has also opted to use an additional pole for the sign and placed the signaling to block the barrier free ramp.	

Teagarden Road at Education Way	Sidewalk is set too close to the back of the curb; unnecessary use of diagonal barrier free ramp ramps; curb return radii is too large (which in turn dictates the use of the diagonal BFRs instead of ramps leading to the crosswalks)	
Northeast corner of Northwest Highway at Preston Road	Utility pole impeding a new barrier free ramp. Shortly after this section of NW Hwy was reconstructed, and a new BFR was built, a car hit the existing utility pole. When the pole was replaced by Oncor, they placed it in this same location. NW Hwy reconstruction was a TxDOT project, but they should adhere to City design standards and require the pole to be moved when the new BFR was built.	

Tab D
COD Street Design
Compliance Issues

M E M O R A N D U M

To: **Mr. T.C. Broadnax**

From: **Anthony R. Page**

Date: **June 29, 2022**

Re: **City of Dallas Street Design & Construction Standards – SEC. 51A-8.601(b) Compliance Issues**

Overview

In my capacity as an appointee to the Dallas Housing Finance Corporation and in other roles, I have heard concerns that City of Dallas street projects and private development projects impacting street design and construction are not, at times, being designed in compliance with SEC. 51A-8.601(b) and other City Council-adopted mandates. As a result, a sample of five construction plans prepared by different contractors working with the City of Dallas and private developers (the "Sample Set") was reviewed and reconciled with currently applicable legal design and construction standards (the "Standards"). On a preliminary basis, it appears that none of the plans are being prepared in compliance with SEC. 51A-8.601(b) and other City Council-mandated standards, and that contractors may also be designing to outdated standards issued by NCTCOG, the Department of Public Works and Dallas Water Utilities. SEC. 51A-8.601(b) outlines the "standards, criteria, and requirements" to which all street paving projects "must conform," including the Dallas Street Design Manual. However, there is no evidence that the engineers with whom the city of Dallas contracts to design such paving projects or private developers designing projects impacting city streets are being informed about the detailed requirements of SEC. 51A-8.601(b), nor are they apparently being required to comply with SEC. 51A-8.601(b) as a condition of payment and/or permitting.

To what extent are Dallas city streets continuing to be designed at variance with SEC. 51A-8.601(b) and related City Council policy guidance?[1] Understanding this was an initial review, this memorandum outlines possible actions the city of Dallas could implement to inform private contractors about city policies relating to street design and improve compliance with street paving design municipal statutory and regulatory requirements.

Review Process

An effort was made to identify all city of Dallas ordinances, resolutions, standards, criteria, and requirements pertaining to streets, and sidewalks (including private construction within the public right-of-way). These requirements were then compared with the general notes contained in city of Dallas street paving plans and guidance provided to contractors working with private property developers during the permitting process.

SEC. 51A-8.601(b) reads as follows:

"All street paving… must conform to the standards, criteria, and requirements of the following…

(1) The Thoroughfare Plan for the city of Dallas.
(2) The Central Business District Streets and Vehicular Circulation Plan.
(3) The Long Range Physical Plan for Parks and Recreational Facilities.
(4) The Street Design Manual of the city of Dallas.
(5) The storm drainage policy of the city of Dallas.
(6) The Drainage Design Manual of the city of Dallas.
(7) The Plan Development Checklist of the department.
(8) The Standard Construction Details of the department of public works.[2]
(9) The Texas Uniform Traffic Control Device Manual.
(10) The Dallas Central Business District Pedestrian Facilities Plan.
(11) The most recently adopted Dallas Bike Plan.
(12) The City of Dallas Planning Policies.

[1] As reflected in the Complete Streets Design Manual, the Dallas Street Process Manual, and Vision Zero.
[2] File 251D-1.

(13) All other codes and ordinances of the city of Dallas."[3]

Item 12 (The City of Dallas Planning Policies) appears to include compliance with the NCTCOG Standard Specifications, the City of Dallas Addendum to the NCTCOG Standard Specifications and the Dallas Water Utility Standard Drawings. Some of the most significant areas covered by item 13 are street, sidewalk and crosswalk standards that may be embedded in some of the city of Dallas' 1,000+ Planned Development District (PDD) ordinances.

In addition, the Dallas Street Process Manual and Complete Streets Design Manual are intended to guide design teams through the process of designing city streets.

General Note #5 of each street paving plan set in the Sample Set outlines the prerequisite for contractor payments, specifying the standards with which the contractor must strictly comply. The Standards were reconciled with the preconditions for contractor payment listed in General Note #5 of each plan in the Sample Set to identify discrepancies. Similarly, the generated plans were compared to the Dallas Street Design Manual to identify non-compliance with the Standards. With respect to private development projects proceeding through the permitting process, site development plans were similarly compared with the Dallas Street Design Manual to identify non-compliance with the Standards.

Preliminary Findings

Preliminary findings are as follows:

- With respect to each street paving plan, General Note #5 requires contractors to follow ***all*** of the staff-mandated standards but ***none*** of the City Council-mandated standards as a precondition to payment.
- In all three cases, contractors are being required to strictly comply with ***older*** versions of staff-mandated standards, rather than the ***current*** standards.
- Language which should be standardized across the General Notes from project-to-project in the Sample Set instead contains subtle variations in wording.
- References to Standards are frequently ambiguous as to which version of the applicable guidance is the authoritative version.
- During the street paving plan review (which is still underway), numerous violations of the Dallas Street Design Manual were identified, resulting in pavement designs which also contradict policies and guidance previously approve by City Council via the Complete Streets Design Manual, the Dallas Street Process Manual, and (now) the Vision Zero Policy.
- Similarly, contractors working with private developers indicate that they are being guided during the permitting process to design intersections, sidewalks, and driveways to dimensional standards which contradict the dimensional standards mandated by the Dallas Street Design Manual.

Recommended Actions

1) Contractors designing city streets (on behalf of the city of Dallas) and working for private developers on projects that impact city streets should be informed of Dallas' current official polices and Standards with respect to street design and construction and be required to adhere to the Standards as a condition of payment and/or project permitting.
2) General Note #5 of all street paving plans should be amended to require strict conformance with the City Council-mandated standards (the Dallas Street Process Manual, the Dallas Street Design Manual, the Complete Streets Design Manual, the Dallas Drainage Manual) along with staff-mandated standards as additional preconditions to payment. General Notes #1 & 5 should be conformed with the requirements outlined at SEC. 51A-8.601.(b)., and RFPs, RFQs should specifically mention compliance with this code section as being a requirement.
3) General Notes #1 & #5 of all street paving plans should be amended to include the release date and/or edition associated with each relevant document referenced.
4) Street designers should be required to use the most current version of the applicable document included in the Standards.

[3] Dallas City Code, SEC. 51A-8.601(b).

5) During the project scoping phase, a determination should be made as to whether all or a portion of the proposed work is planned to occur withing the boundaries of a Planned Development District (PDD) via the City of Dallas Interactive Zoning Map. If work is projected to occur within the boundaries of a PDD, the Dallas City Attorney's website should be consulted to identify potential PDD-driven street and sidewalk standards which may take precedence over a portion of the Standards. If different requirements are identified, they should be noted as special provisions on the plan set.

6) The plans associated with all street and sidewalk projects currently in the design process should be modified to bring them into legal compliance with SEC. 51A-8.601(b) as soon as possible.

7) NCTCOG should be asked to publish the 2021 City of Dallas Addendum in the indicated location on its website. (See: https://www.nctcog.org/envir/public-works/construction-standards)

8) Contractors should be instructed to obtain current copies of all documents comprising the Standards via the appropriate City of Dallas website locations prior to designing projects which impact streets, sidewalks, driveways, etc. Links to documents comprising the current version of the Standards should be clearly separated from prior versions, and language should be added to emphasize contractors should only be designing and building to the current versions of the relevant documents.

9) The City of Dallas Project Manager assigned to each street paving project should carefully review the General Notes at the commencement of the design process to ensure that each project is designed to the current version of each applicable document forming the Standards and that the contractor is required to strictly comply with the Standards as a condition of payment.

10) During the permitting process for private development projects, staff should ensure that each project is designed to the current version of each applicable document forming the Standards and that the contractor is required to strictly comply with the Standards as a condition of permit approval.

Attach. (Appendix A – Reconciliation of Sample Set Legal Compliance Issues)

Cc: The Hon. Omar Narvaez, District 6 Council Member & Chair, Transportation and Infrastructure Committee
The Hon. Paul Ridley, District 14 Council Member
The Hon. Chad West, District 1 Council Member
Mr. Majed Al-Ghafry, Asst. City Manager

General Note 1 & 5 deficiencies are outlined in the following table:

	Current Version	Required Version per General Notes 1 & 5[4]		
		Project A, Firm 1	Project B, Firm 2	Project C, Firm 3
Dallas Street Process Manual[5]	2019	omitted	omitted	omitted
Dallas Street Design Manual[6]	2019	omitted	omitted	omitted
Complete Streets Design Manual[7]	2016	omitted	omitted	omitted
PD-specific Street Standards[8]	various	omitted	omitted	N/A
Dallas Drainage Design Manual[9]	2019	omitted	omitted	omitted
NCTCOG Standard Specifications[10]	5th ed., 2017	4th ed., 2004	4th ed., 2004	4th ed., 2004
NCTCOG City of Dallas Addendum[11]	2021	2011	2011	2011
City of Dallas Std. Construction Details (File 251D-1)[12]	2021	2002	2002	2002
Dallas Water Utilities Standard Drawings[13]	2021	unknown	unknown	2011

[4] This table highlights some of the more significant of the items listed in ***SEC. 51A-8.601.(b)***, mentioned previously as comprising the "standards, criteria, and requirements" pertaining to City of Dallas streets and sidewalks.

[5] Provides guidance which shall be utilized in the design of public works facilities in the City of Dallas ***(City Council Resolution #19-1431, dated Sept. 11, 2019)***. This manual is intended to guide design teams through the process of planning and designing a street in the City of Dallas and is guided by the policy established in the Dallas Complete Streets Manual ***(Dallas Street Process Manual, Section 1.1, p.1)***.

[6] Sets forth standards which are the minimum criteria required by the City of Dallas to be used in the design of public works facilities ***(City Council Resolution #19-1431, dated Sept. 11, 2019)***. The purpose of the Street Design Manual is to provide requirements and establish minimum standards for designing streets and thoroughfares, and to assist in preparing construction plans in the City of Dallas, such that streets are built to be safe, comfortable, and sustainable for everyone). Any exceptions from the standards set forth in this manual must be accompanied by prior written approval from the Director of Public Works ***(Dallas Street Design Manual, Section 1.1, p. 2)***, upon finding that unsafe conditions would result from strict enforcement of these standards, or a special design will enhance safety or traffic flow ***(Resolution #19-1431)***. See also ***SEC. 51A-8.601.(b)(4)***, ***SEC. 51A-8.604.(a)***, & ***SEC. 51A-8.606.(b)***.

[7] Serves as a comprehensive policy guide for all public or private projects that impact the planning, design, construction, and operation of streets. Exceptions to this policy must be reviewed and approved by the Director of Public Works, the Director of Planning and Urban Design, and the City's Traffic Engineer upon a finding that application of Complete Streets principles is unnecessary, unduly cost prohibitive, contrary to public safety or prohibited by law ***(City Council Resolution #16-0173, dated Jan. 27, 2016)***. The Complete Streets Design Manual provides policies and design best practice guidelines to City agencies, design professionals, private developers, and community groups for the improvement of streets and pedestrian areas throughout Dallas. This manual is intended to direct transportation planners and engineers to routinely design and operate the entire right-of-way to enable safe access for all users, regardless of age, ability, or mode of transportation. It is intended to work alongside the Dallas Thoroughfare Plan and the Dallas Development Code to provide the policy framework for the design and use of Dallas' roadway network. ***(Complete Streets Design Manual, p. 15)***. See also ***SEC. 51A-8.601.(b)(12)***.

[8] When streets abut or traverse a PD, they be subject to design standards that supersede the standard City of Dallas requirements. These standards may include one or more of the following: minimum pavement width, minimum right-of-way, bulb-out sizing and/or placement, crosswalk width and/or design, lot entrance spacing, parkway (buffer) width, sidewalk width, etc. See ***SEC. 51A-8.601.(b)(13)***.

[9] Sets forth standards which are the minimum criteria required by the City of Dallas to be used in the design of drainage facilities ***(City Council Resolution #19-1431, dated Sept. 11, 2019)***. The purpose of the Drainage Design Manual is to establish standard principles and practices for designing drainage facilities in the City of Dallas. This manual is for use by all City of Dallas departments, consultants employed by the City, and engineers for development in the City ***(Dallas Drainage Design Manual, Sec 1.1, p. 2)***. See also ***SEC. 51A-8.601.(b)(6)***.

[10] Regional provisions recommended by the NCTCOG Public Works Council and endorsed by the NCTCOG Executive Board. ***(Public Works Construction Standards: North Central Texas, 5th Ed., NCTCOG, p. 6)***.

[11] Sets forth exceptions or requirements of the City of Dallas Water Utilities Department, Park and Recreation Department, Department of Public Works, and Aviation Department. These specifications take precedence over NCTCOG standards which may be in conflict. ***(City of Dallas 2021 Addendum to the Public Works Construction Standards: North Central Texas, p.2)***.

[12] Provides the minimum requirements established by the Department of Public Works for construction within the city right-of-way. ***(Dept. of Public Works, Standard Construction Details, City of Dallas, Texas, Updated Dec. 2021, cover page)***. See also ***SEC. 51A-8.601.(b)(8)***.

[13] Provides guidelines for the standard appurtenances of water and wastewater mains owned and operated by Dallas Water Utilities. ***(Dallas Water Utilities, City of Dallas, Standard Drawings for Water & Wastewater Construction, Oct. 2021, p.2)***.

Tab E
30% Plan Set Comments

[LETTERHEAD OF UPTOWN DALLAS INC.]

November 4, 2024

Dr. Ghassan "Gus" Khankarli, PE, PMP, CLTD
Director, Department of Transportation and Public Works
City of Dallas
1500 Marilla St, L1BS
Dallas, TX 75201

Re: McKinney/Cole Ave Two-Way Conversion (CSJ: 0918-47-286) – 30% Submittal Comments

Dear Dr. Khankarli,

We appreciate the opportunity to review and comment on the 30% plan submittal for the McKinney/Cole Ave Two-Way Conversion project. We commend the leadership of the Department of Transportation and Public Works for addressing safety issues within this High Injury Network area and for your commitment to implementing **best-practice urban street design principles**.

Our comments, outlined in **Exhibit A**, emphasize the need for **context-sensitive design** that advances **Vision Zero safety goals** and aligns with the City's Complete Streets objectives for multi-modal accessibility and pedestrian-friendly urban environments. To enhance **multi-modal accessibility** and **pedestrian safety**, we recommend incorporating several key design features: **narrowed traffic lanes**, **high-comfort sidewalks** (with dual perpendicular curb ramps aligned with pedestrian desire lines), and **enhanced crosswalk signage**. Additionally, we suggest **median refuges**, **bulb-outs** and **reduced curb radii** to slow vehicle turns and minimize pedestrian crossing distances.

Exhibit B – City of Dallas/NCTCOG/FHWA Guidance highlights key references supporting these standards and policies. Once your team has reviewed our comments, we would like to request a "page-turning" review session with staff and Kimley-Horn to discuss them further.

In the meantime, please feel free to reach out with any questions or for clarification on our feedback.

Sincerely,

Neal Sleeper, Chairperson
Two-Way Committee

Anthony R. Page, Chairperson
Public Realm & Capital Improvements Committee

Cc: The Hon. Paul Ridley
Commissioner Melissa Kingston
Changho Yi – City of Dallas
Cameron Anderson – City of Dallas
Srinivasa Veeramallu – City of Dallas
Alyssa Callin – City of Dallas
Joseph Marchione – City of Dallas

Ryan Delmotte – Kimley-Horn and Associates, Inc.
Sam Fries – Kimley-Horn and Associates, Inc.
Nathan New – Kimley-Horn and Associates, Inc.
Ramsey March – Uptown Dallas, Inc.
Noelle LeVeaux – Uptown Dallas, Inc.
Noah Flabiano – Uptown Dallas, Inc.
Vic Cervantes – McKinney Avenue Transit Authority
John Landrum – McKinney Avenue Transit Authority
Jim Pritchard – Pritchard Associates
Kyle Nix – Pritchard Associates

Attach: Exhibit A – Detailed 30% Submittal Comments
Exhibit B – City of Dallas/NCTCOG FHWA Selected Design Guidelines

Exhibit A - DETAILED 30% SUBMITTAL COMMENTS

I. GENERAL

Cover Sheet

1) Reduce design speed to 30 mph.
2) **Correct functional classification of Blackburn St** from Minor Arterial to Community Collector.

Proposed Roadway Sections Comments *(changes underlined and italicized)*

1) **Traffic lanes should be designed to 10' max width, except for shared-use trolley lanes, which should be designed to an 11' max width.**
2) **Allen Street** begin to end
   SWLK – 5'- 6'
   LDSCP – 0' - 5' (reclaim pavement for parkway between Sneed St. & Cole Ave.)
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')
   SHARED LANE – *11'* (narrow from 12' to 11')
   PARKING – 0' - 10' (widen to 10' max from 9' max)
   SWLK – 5' - 8'
3) **Blackburn Street** begin to end
   PRKG – *10'* (widen from 8' to 10')
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')
   LANE – 11'
   MED – 8'
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')
   PRKG – 0' - 11' (widen to 11' from 8')
4) **Carlisle St** STA 305+00 to STA 322+00[1]
   SWLK – 5'- 6'
   LDSCP – 3' - 5'
   PARKING – 0' – 10' (widen to 10' max from 9.5' max)
   LANE – 11'
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')
   LDSCP – 0' - 7'
   SWLK – 5' - 6'
5) **Cole Ave** STA 323+00 to STA 328+00
   SWLK – 5'- 6'
   LDSCP – 3' - 5'
   PARKING – 0' – 0' (9.5' max appears to be incorrect)
   LANE – 11'
   LANE – *10'* (narrow from 11' to 10')
   LANE – *10'* (narrow from 11' to 10')

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[1] Carlisle St STA 316+00 to STA 322+00 contains unique conditions and requires a separate proposed roadway section. Bulb outs are proposed at the north side of Hall St. (STA 316+25), south side of Carlisle Pl (STA 319+00) and south side of Lemmon Ave (STA 322+00).

LDSCP – 0’ - 7’
SWLK – 5’ - 6’

6) **Cole Ave** STA 328+00 to STA 334+50
SWLK – 6’
LDSCP – ?
PRKG – *10’* (widen to 10’ from 8’)
LANE – 11’
LANE – *10’* (narrow from 11’ to 10’)
LANE – *10’* (narrow from 11’ to 10’)
SWLK – 10’

7) **Cole Ave** STA 336+00 to end
SWLK – 4’- 8’
LDSCP – 0’ - 13’
PARKING – 0’ – 14’ (widen as necessary to recapture excess lane width)
LANE – *10’* (conform from 9’-12’ to 10’)
LANE – *10’* (narrow from 10’-12’ to 10’)
LANE – *10’* (conform from 9’-12’ to 10’)
PARKING – 0’ – 11’ (widen as necessary to recapture excess lane width)
LDSCP – 0’ - 5’
SWLK – 4’ - 11’

II. PAVING

Demolition Plan Comments

1) **Identify all pedestrian ramps** to be added and/or reconfigured.
2) **Retaining existing, legally required trees** wherever possible in the following location:[2]

   Carlisle St:
   STA 301+75 to STA 305+00 (10 trees total)

3) **Adjacent to the eastern edge of Cole Park, consider recapturing 9’ between the existing curb and the right of way limit (the location of the existing parkway and sidewalk) for parallel parking**.

   McKinney Ave:
   STA 153+50 to STA 161+50

Paving Plan Comments

1) **Position new sidewalks 5’ back from the curb with a minimum width of 6’**[3] in the following locations, as permitted by existing conditions. Require Oncor to relocate utility poles outside the sidewalk area whenever feasible:

   Allen St:
   STA 200+00 to STA 202+25 (vicinity of Carlisle St)

   Carlisle St:
   STA 301+75 to STA 305+00 (vicinity of Allen St; use existing sidewalk alignment)

   Cole Ave:
   Between Allen St (STA 204+00) and Sneed St (STA 0+00) in front of 2909 Cole

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[2] These street trees are required per SEC. 51P-193.126(b)(5).
[3] See *Dallas Street Design Manual, Sec. 4.5, p. 112-121;* SEC. 51P-193.126(b)(4).

STA 339+50 to STA 341+00 (vicinity of Haskell Ave)
STA 409+00 to STA 411+16 (vicinity of Harvard Ave)

Harvard Ave:
STA 214+50 to STA 215+00 (vicinity of McKinney Ave)
STA 219+00 to STA 222+00 (vicinity of Cole Ave)

Howell St:
STA 13+21.25 to STA 14+10 (vicinity of McKinney Ave)

McKinney Ave:
STA 103+25 to STA 106+00 (vicinity of Allen St)
STA 213+50 to STA 215+50 (vicinity of Harvard Ave)

Sneed St:
STA 3+25 to STA 4+81 (vicinity of Allen St)

2) **Reduce curb return radii to between 5' and 15'** where feasible and avoid utilizing curb return radii greater than 20' in the following locations:[4]

Allen St:
STA 202+00 (SW corner of alleyway)
STA 204+50 (NW corner of Cole Ave)
STA 204+75 (SE corner of Cole Ave)
STA 207+50 (SW & SE corners of Laclede St)

Carlisle St:
STA 302+50 (NE & SE corners of Allen St)
STA 304+50 (NW & SW corners of driveway)
STA 322+00 (SW & SE corners of Lemmon Ave)

Cole Ave:
STA 204+25 O/S 100 LT (NW & SW corners of driveway between Sneed St & Allen St)
STA 204+75 (SE corner of Allen St)
STA 331+00 (NW & SW corners of driveway)
STA 335+00 (SE corner of Blackburn St)

McKinney Ave:
STA 103+50 (NW corner of Howell St)
STA 139+00 (SW corner of Blackburn St)
STA 170+00 (SE corner of Fitzhugh Ave; eliminate right lane "flare")
STA 214+50 (NE & SE corners of Harvard St)

3) **Reduce curb radii to 1' to block illegal right turns into oncoming traffic** and/or where right turns movements do not exist at the following locations:

Cole Ave:
STA 322+50 (NW & NE corners of Lemmon Ave)
STA 326+40 (SW & SE corners of Lemmon Ave E)

McKinney Ave:
STA 126+50 (NW & NE corners of Lemmon Ave)
STA 130+50 (SW & SE corners of Lemmon Ave E)

[4] Consult Dallas Street Design Manual for appropriate design and control vehicles to be used, based upon street classifications.

4) **Locate all curb ramps to reflect pedestrian's desired path of travel through intersections**, while also considering sight lines of approaching motor vehicles. As curb radii are reduced and sidewalks are set 5' from the back of curb, review the following proposed pedestrian ramp locations for compliance:

   Carlisle St:
   STA 200+00 (NE, SW, & SE corners of Allen St, all crosswalks)
   STA 316+00 (NW, NE, SW, & SE corners of Hall St, all crosswalks)
   STA 322+00 (NW, NE, SW, & SE corners of Lemmon Ave, all crosswalks)
   STA 326+50 (NW, NE, SW, & SE corners of Lemmon Ave E, all crosswalks)

   Cole Ave:
   STA 1+25 (SW corner of Sneed St, Cole Ave crosswalk)
   STA 204+50 (NW, NE, SW, & SE corners of Allen St, all crosswalks)
   STA
   STA 410+75 (SW & SE corners of Harvard Ave, Cole Ave crosswalk)

   McKinney Ave:
   STA 138+75 (SW & SE corners of Blackburn Ave, McKinney Ave crosswalk)

5) **Eliminate all diagonal curb ramps and/or non-ADA compliant ramps** by substituting dual Type 7 (perpendicular) or Type 1 (directional) curb ramps (Re: TXDOT PED-18; City of Dallas DPW Sheet No. 1016) at the following locations:

   Carlisle St:
   STA 319+40 (NW corner of Carlisle Pl)

   McKinney Ave:
   STA 109+50 (NW & SW corners of McKinney Ave; to accommodate McKinney Ave crosswalks)
   STA 144+50 (NE corner of Noble Ave; existing)
   STA 153+50 (NW corner of driveway; existing)
   STA 162+00 (NW, NE, SW, & SE corners of Elizabeth St; existing)
   STA 177+00 (NW corner of Lee St; proposed) (NE, SW, & SE corners; existing)
   STA 183+25 (NW, NE, SW, & SE corners of Oliver St; existing)
   STA 196+00 to STA 196+75 (NW, NE, SW, & SE corners of Knox St; proposed)
   STA 204+00 (NW, NE, SW, & SE corners of Hester Ave; existing)
   STA 213+00 to STA 213+50 (NW, NE, SW, & SE corners of Monticello Ave; proposed)

   Sneed St:
   STA 0+75 (SE corner of Cole Ave; existing)

6) **Eliminate all blended transition curb ramps**[5] by substituting dual Type 7 (perpendicular) or Type 1 (directional) curb ramps (Re: TXDOT PED-18; City of Dallas DPW Sheet No. 1016) at the following locations:

   Carlisle St:
   STA 308+25 (SE corner of Bowen St)
   STA 322+00 (SW & SE corners of Lemmon Ave)

   Cole Ave:
   STA 364+00 to STA 365+00 (NW, NE, SW, & SE corners of Fitzhugh Ave)
   STA 385+50 (NE corner of Armstrong Ave)

   McKinney Ave:

[5] Blended transition curb ramps present the same problems as diagonal ramps: lack of alignment with/direct access to crosswalks and confusion for pedestrians with visual impairments.

STA 103+50 (NW corner of Howell St)
STA 106+00 (NW corner of Allen St; NE corner of Oak Grove Ave)
STA 114+00 (SW & NE corners of Bowen St)
STA 119+50 (NW, NE, SW, & SE corners of Hall St)
STA 126+00 (NW & SE corners of Lemmon Ave)
STA 131+00 (NW corner of Lemmon Ave E)
STA 140+00 (NW & NE corners of Blackburn St)
STA 190+00 (NE corner of Armstrong Ave)

7) Add Type 1 perpendicular curb ramps (TXDOT PED-18) at the following locations:

Allen St:
STA 207+50 (NW & SW corners of Laclede St)

Carlisle St:
STA 303+25 (NW & NE corners of Allen St; after resetting sidewalks 5' from back of curb)

Cole Ave:
STA 330+60 (NW & NE corners of Haskell Ave; after resetting sidewalks 5' from back of curb)

Harvard Ave:
STA 219+25 (NE & SE corners of Cole Ave)

McKinney Ave:
STA 144+00; 144+50 (NW, NE, SW, & SE corners of Noble Ave; to accommodate McKinney Ave crosswalks)

Sneed St:
STA 4+40 (NW & NE corners of Allen St; after resetting sidewalks 5' from back of curb)

8) Add Type 2 (parallel) curb ramps (TXDOT PED-18) at the following locations:

Allen St:
STA 207+25 (NW corner of Laclede St)

McKinney Ave:
STA 109+50 (NE & SE corners of Sneed St)

9) Add Type 7 (directional) curb ramp (Re: TXDOT PED-18) at the following locations:

McKinney Ave:
STA 102+75 (SW corner of Howell St)

10) **Establish pedestrian median refuges** by shifting sidewalks and extending medians in the following locations:

Blackburn St:
STA 404+00 (west side of Cole Ave) – extend median to align with the projected face of the Cole Ave west side curb; install Type 21 curb ramp in median (Re: TXDOT PED-18).

STA 405+25 (east side of Cole Ave) – extend median to align as closely as possible with the projected face of the Cole Ave east side curb; install Type 21 curb ramp in median (Re: TXDOT PED-18).

STA 409+00 (east side of McKinney Ave) – extend median to align with the projected face of the McKinney Ave east side curb; install Type 21 curb ramp in median (Re: TXDOT PED-18).

Fitzhugh Ave:
STA 404+00 (west side of Cole Ave) – extend median to align with the projected face of the Cole Ave west side curb; shift crosswalk alignment several feet to the west; install Type 21 curb ramp in median (Re: TXDOT PED-18).

Hall St:

STA 315+75 to STA 316+25 (west side of Carlisle St) – install 10' wide center concrete median with nose to align with the projected face of the Carlisle St west side curb; shift crosswalk alignment to the west, if required; install Type 21 curb ramp in median (Re: TXDOT PED-18).

STA 315+75 to STA 316+25 (east side of Carlisle St) – install 10' wide center concrete median with nose to align with the projected face of the Carlisle St east side curb; shift crosswalk alignment several feet to the east; install Type 21 curb ramp in median (Re: TXDOT PED-18).

STA 119+00 to STA 119+75 (west side of McKinney Ave) – install 10' wide center concrete median with nose to align as closely as possible with the projected face of the McKinney Ave west side curb, ensuring no interference with trolley dynamic envelope; shift crosswalk alignment several feet to the west; install Type 21 curb ramp in median (Re: TXDOT PED-18).

STA 119+00 to STA 119+75 (east side of McKinney Ave) – install 10' wide center concrete median with nose to align with the projected face of the McKinney Ave east side curb; shift crosswalk alignment several feet to the east; install Type 21 curb ramp in median (Re: TXDOT PED-18).

Gables Turtle Creek Cityplace Driveway (47' pedestrian crossing distance)**:**
STA 330+75 (west side of Cole Ave) – extend median to align with the projected face of the Cole Ave west side curb; install Type 21 curb ramp in median (Re: TXDOT PED-18).

11) **Install bulb outs with 10' - 15' curb return radii**[6] at the following locations:

Allen St:
STA 204+75 (SE corner of Cole Ave)

Armstrong Ave:
STA 190+00 (NW & NE corners of McKinney Ave; narrow Armstrong Ave to 20' width).
STA 384+00 (NW & NE corners of Cole Ave; narrow Armstrong Ave to 20' width).

Carlisle St:
STA 316+00 (SE & NE corners of Hall St.; narrow Carlisle St. to 30' width).
STA 319+00 to STA 319+50 (NE & SE corners of Carlisle Pl; narrow Carlisle St to 30' width; see CPC case #Z223-280 for details on new HAWK or RRFB mid-block pedestrian crossing).
STA 322+00 (SW & SE corners of Lemmon Ave; narrow Carlisle St to 30' width).

Cole Ave:
STA 364+00 (SE corner of Fitzhugh St; narrow Fitzhugh St. to 30' width).

Elizabeth St:
STA 161+75 (SW & SE corners of McKinney Ave; narrow Elizabeth St. to 20' width).
STA 356+00 (SW & SE corners of Cole Ave; narrow Elizabeth St. to 20' width).

N Haskell Ave:
STA 143+00 to STA 143+50 (NW & SW corners of Haskell Ave; narrow N Haskell to 20' width).
STA 339+00 to STA 339+50 (NE & SE corners of Haskell Ave; narrow N Haskell to 20' width).

McKinney Ave:
STA 109+25 (SW corner of Allen St; narrow McKinney to 31' width)
STA 364+00 (SW & SE corners of Fitzhugh Ave; narrow McKinney to 30' width).

12) **Shift centerline of Allen St. to the north at Carlisle St**. to allow for 5' parkway between south curb and realigned sidewalk in front of Carlisle & Vine Apartments.

Allen St:
STA 200+00 to STA 202+25

[6] See: https://safety.fhwa.dot.gov/saferjourney1/library/countermeasures/23.htm

13) **Narrow Allen St. between Carlisle** St and Cole Ave from 33' to 30' between Carlisle St & the alleyway (plus indented parking on southside of Allen St) and from 44' to 39' from alleyway to Cole Ave by adding 5' parkway to north side of Allen St.

    Allen St:
    STA 200+00 to STA 202+25 (narrow to 30')
    STA 202+25 to STA 204+25 (narrow to 39')

14) **Enlarge Howell Street "pork chop"** by extending base of pork chop to align with extended face of curb on west side of McKinney Ave. Install Type 21 curb ramp (Re: TXDOT PED-18).

    McKinney Ave:
    STA 14+00 to STA 14+25 (vicinity of Howell St)

15) **Widen and extend proposed McKinney/Oak Grove median** by designing SB lane of McKinney Ave with a 10' lane width and the northbound lane of McKinney Ave. to an 11' lane width. Align the nose of the southern end of the median with the extended curb face of the north curb of Oak Grove Ave and align the nose of the northern end of the median with the extended curb face of the south curb of the alley. Install Type 21 curb ramp at pedestrian crossing (Re: TXDOT PED-18).

    McKinney Ave:
    STA 105+50 to STA 107+50 (vicinity of Oak Grove Ave.)

16) **Widen and extend the proposed Cole Ave. median** by designing the SB lanes of Cole Ave with an 11' lane width and the NB lanes of Cole Ave. with a 10' width. Align the nose of the southern end of the median with the extended curb face of the north curb of Lemmon Ave E and align the nose of the northern end of the median with the extended curb face of the south curb of the SB One-Way Alley. Install Type 21 curb ramps at both pedestrian crossings (Re: TXDOT PED-18).

    Cole Ave:
    STA 327+00 to STA 328+50 (between Lemmon Ave E and SB One-Way Alley)

17) **Coordinate sidewalk placement on SW corner of Cole Ave. & Harvard Ave**. with Friends of Katy Trail (construction of new trail head underway at that location).

    Cole Ave:
    STA 409+00 to STA 411+18 (vicinity of Harvard Ave)

    Harvard Ave:
    STA 219+00 to STA 220+50 (vicinity of Cole Ave)

18) **Adjacent to the eastern edge of Cole Park, consider recapturing 9' between the existing curb and the right of way limit (the location of the existing parkway and sidewalk) for parallel parking, rerouting pedestrian traffic from existing sidewalk to parallel sidewalk to the west**.

    McKinney Ave:
    STA 153+50 to STA 161+50

19) **Investigate reducing the width of private driveways to 24'** at the following locations:

    Cole Ave:
    STA406+50 (Dunlap-Swain Tire driveway, 38' current width)

    McKinney Ave:
    STA123+25 (Walgreen's driveway, 40' current width)
    STA159+50 (McDonald's driveway, 36' current width)

III. DRAINAGE

Drainage Plan Comments

IV. UTILITIES

Utility Plan Comments

V. PAVEMENT MARKING AND SIGNING

Pavement Marking Plan Comments

1) **Use Reflective Pavement Marking Type 1 (White, 4-inch solid) for edge lines, reducing all traffic lanes to 10 feet wide, except for shared trolley lanes, which should be marked at an 11-foot width.**
2) **Install additional pavement markings at the specified locations.**

Allen St:
STA 207+50 (crosswalk connecting NW & SW corners of Laclede St)
STA 201+50 (crosswalk connecting NW & NE corners of Sneed St)

Carlisle St:
STA 303+25 (crosswalk connecting NW & NE corners of Allen St)
STA 319+00 (crosswalk connecting SW & SE corners of Carlisle Pl.; new PHB to be installed)

Cole Ave:
STA 339+00 (crosswalk connecting NW, NE, SW & SE corners of Haskell Ave)
STA 340+50 (crosswalk connecting NW, NE, SW & SE corners of Haskell Ave)
STA 407+50 (crosswalks connecting NW, NE, SW, & SE corners of Monticello Ave)

Harvard Ave:
STA 217+50 (crosswalks connecting NW, NE, SW & SE corners of Tracy St)
STA 219+25 (crosswalk connecting NE & SE corners of Cole Ave)

McKinney Ave:
STA 109+50 (crosswalks connecting NW, NE, SW & SE corners of Sneed St)
STA 144+50 (crosswalks connecting NW, NE, SW & SE corners of Noble St)
STA 135+50 (SB at Cityplace W Blvd; add straight and left turn arrow)
STA 156+50 (RRFB-related markings at new mid-block crosswalk)
STA 170+00 to STA 170+75 (adjust alignment of crosswalk on east side of McKinney crossing Fitzhugh to allow for pedestrian median refuge after extension of median westwards towards McKinney Ave)

Sneed St:
STA 1+00 (crosswalks connecting NW, NE, SW, & SE corners of Cole Ave)

Signing Plan Comments

1) **Install modified W10-2** sings, adjusted to accurately portray the roadway and trolley track geometries at the following locations**:**

W10-2

Allen St:

STA 105+50 O/S 115’ LT (facing EB traffic)
STA 204+00 (facing EB traffic)

Blackburn St:
STA 139+00 O/S 115’ LT (placed on both sides of EB Blackburn facing EB traffic)

Bowen St:
STA 114+00 O/S 100’ (west and east of McKinney Ave intersection; 2 locations)

Cityplace W Blvd:
STA 135+00 O/S 115’ RT (placed on both sides of Cityplace Blvd W facing EB traffic)

Cole Ave:
STA 205+50 O/S 100’ RT (facing NB traffic)
STA 330+50 O/S 20’ LT (facing EB traffic exiting Gables residential development)
STA 336+00 (facing SB traffic, 100’ before dynamic envelope)

Hall St:
STA 119+00 O/S 100’ (west and east of McKinney Ave intersection; 2 locations)

Lemmon Ave:
STA 126+00 O/S 115’ LT (placed on both sides of Lemmon Ave facing EB traffic)
STA 322+00 O/S 115’ LT (placed on both sides of Lemmon Ave face EB traffic)

Lemmon Ave E:
STA 130+50 O/S 115’ RT (placed on both sides of Lemmon Ave E facing WB traffic)
STA 326+50 O/S 115’ RT (placed on both sides of Lemmon Ave E facing WB traffic)

McKinney Ave:
STA 105+00 or alternate if trolley lane shift is relocated (NB, 100’ before lane shift)
STA 138+00 (NB, 100’ before dynamic envelope)

Oak Grove Ave:
STA 105+50 O/S 115’ LT (facing SB traffic)

2) **Install W15-1** (fluorescent green) at the following locations (in place of 144 “SLOW PLAYGROUND AREA” and coupled with W13-1P “25 MPH”)**:**

W15-1

Cole Ave:
STA 348+00 (NB)
STA 356+00 (SB)
McKinney Ave:
STA 154+00 (NB)
STA 161+00 (SB)

3) Install the specified sign combinations at all unsignalized crosswalks outside of school zones:

			
W11-2; W16-9P	R1-5bL	R1-6a	W11-2; W16-7pL W11-2; W16-7pR (Back-to-back)
100 feet before crosswalk	20 ft before crosswalk at advance stop/yield line	At crosswalk (on centerline)	At crosswalk

Carlisle St:
STA 319+00 (new PHB to be installed)

Cole Ave:
STA 207+25; STA 207+25 (Laclede St)
STA 328+25 (West Village)
STA 339+50 (Haskell Ave)
STA 356+00; STA 356+50 (Elizabeth St)
STA 371+00; STA 371+25 (Lee St)
STA 377+40; STA 377+75 (Oliver St)
STA 398+00; STA 398+50 (Hester Ave)
STA 407+25; STA 407+75 (Monticello Ave)

Harvard Ave:
STA 217+50; STA 218+00 (Tracy St)
STA 219+25; STA 220+00 (Cole Ave/Katy Trail)

McKinney Ave:
STA 153+00; STA 153+50 (in front of church)
STA 161+75; STA 162+25 (Elizabeth St)
STA 176+75; STA 177+00 (Lee St)
STA 183+25; STA 183+50 (Oliver St)
STA 203+75; STA 204+00 (Hester Ave)
STA 213+00; STA 213+50 (Monticello Ave)

4) Install the specified sign combinations at all unsignalized crosswalks within school zones:

			
S1-1; W16-9P	R1-5bL	R1-6a	S1-1; W16-7pL S1-1; W16-7pR (Back-to-back)
100 ft in advance of crosswalk	20 ft in advance of crosswalk at stop/yield line	At crosswalk (on centerline)	At crosswalk

Cole Ave:
STA 207+25; STA 207+25 (Laclede St)
STA 339+00; STA 339+50 (Haskell Ave)
STA 340+25; STA 340+75 (Haskell Ave)

McKinney Ave:
STA 109+25; STA 109+75 (Sneed St)
STA 144+25; STA 144+50 (Noble Ave)
STA 153+00; STA 153+50 (in front of church)

5) Install the specified sign combinations 100 feet in advance of all trolley stops:

CUSTOM SIGN
36"X36"

W16-9P

Cole Ave (facing SB traffic):

STA 1+00 O/S 25' LT
STA 331+50

McKinney Ave (facing NB traffic):
STA 111+50
STA 123+50
STA 137+00

6) Install all ways Stop Sign (R1-1) and All Way (plaque) (R1-3P) at the following intersections:

Elizabeth St:
STA 162+00 (McKinney Ave.)
STA 356+50 (Cole Ave.)

Cole Ave./Elizabeth St. Traffic Counts (2035)

SB Cole	R	S	L
	3	422	36
	(12)	(346)	(35)

WB Elizabeth		
R	7	(13)
S	7	(12)
L	45	(52)

EB Elizabeth		
L	17	(15)
S	20	(8)
R	23	(20)

NB Cole	L	S	R
	12	177	22
	(23)	(341)	(10)

Total Weekday AM Peak Hour Traffic Volume =	791
Total Weekday PM Peak Hour Traffic Volume =	(887)
Use Greater of AM/PM Peak Hour Traffic Volume	887

Peak Hour Turning Movement < 1,200; utilize all-way stop

Elizabeth St. AM Peak Hour Traffic Volume	119
Cole Ave AM Peak Hour Traffic Volume	672
AM Peak Hour Balance	18%
Elizabeth St. PM Peak Hour Traffic Volume	(120)
Cole Ave PM Peak Hour Traffic Volume	(767)
PM Peak Hour Balance	16%

McKinney Ave./Elizabeth St. Traffic Counts (2035)

SB McKinney	R	S	L
	2	211	19
	(7)	(172)	(18)

WB Elizabeth		
R	13	(25)
S	17	(20)
L	22	(27)

EB Elizabeth		
L	34	(30)
S	32	(13)
R	12	(10)

NB McKinney	L	S	R
	24	355	43
	(46)	(684)	(20)

Total Weekday AM Peak Hour Traffic Volume =	784
Total Weekday PM Peak Hour Traffic Volume =	(1,072)
Use Greater of AM/PM Peak Hour Traffic Volume	1,072

Peak Hour Turning Movement < 1,200; utilize all-way stop

Elizabeth St. AM Peak Hour Traffic Volume	130
Cole Ave AM Peak Hour Traffic Volume	654
AM Peak Hour Balance	20%
Elizabeth St. PM Peak Hour Traffic Volume	(125)
Cole Ave PM Peak Hour Traffic Volume	(947)
PM Peak Hour Balance	13%

7) Install Solar LED edge lit sign (W11-15) at Katy Trail crossing:

Harvard Ave:
STA 220+25
STA 219+75

VI. TRACK

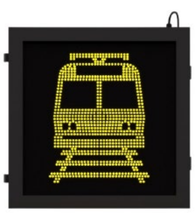
Track Plan Comments

1) Move NB McKinney Ave inside to outside lane shift from STA 105+00 to STA 111+00. Add NB trolley-activated traffic signal to stop NB traffic to allow for trolley signal phase facilitating lane shift.

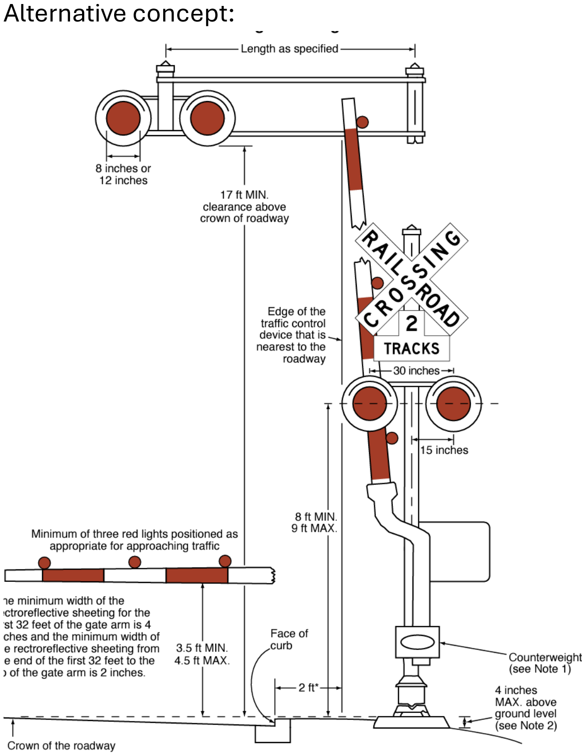
VII. TRAFFIC SIGNAL

Traffic Signal Plan Comments

2) Install LED light rail transit vehicle approaching W10-7 blank out sign on SB-facing signal mast arm at following Bowen & McKinney, to be activated along with NB McKinney red signal phase upon request by trolley operator prior to engaging in contraflow movement into trolley barn:



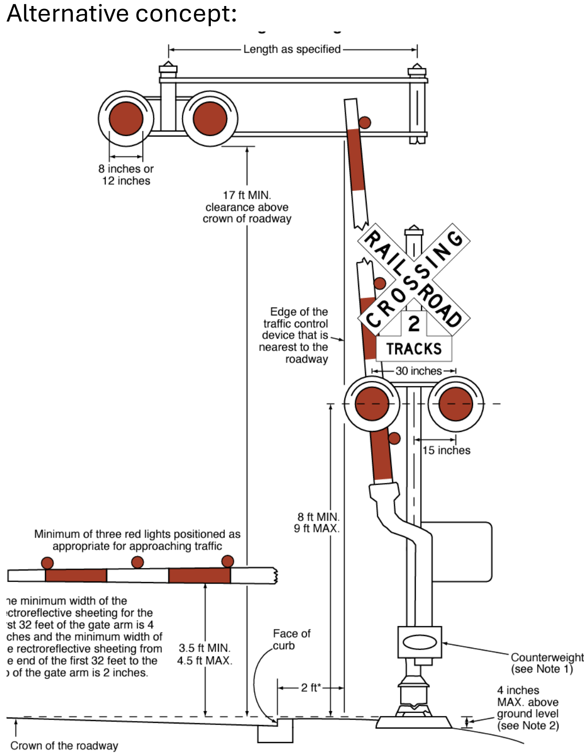
Alternative concept:



McKinney Ave:
STA 114+60

3) Install LED light rail transit vehicle approaching W10-7 blank out sign on new SB-facing signal mast arm at STA 110+75, to be activated along with NB McKinney red signal phase upon request by trolley operator prior to commencing inside to outside lane shift at STA 111+00:

Alternative concept:



McKinney Ave:
STA 110+75

4) Install all-way stop in place of the proposed traffic signal at the intersection of Allen St. & Cole Ave to maintain trolley safety and add pedestrian safety, as peak hour traffic counts are under 1,200 vph.[7]

Allen St:
STA 204+50

5) Insall all-way stop in place of the proposed traffic signal at the intersection of Allen St. & Carlisle St, where peak hour traffic counts also appear to be under 1,200 vph.[7]

Allen St:

[7] See *McKinney-Cole Corridor Two-Way Conversion Feasibility Report*, Kimley-Horn and Associates, August 21, 2015, p.6.

STA 204+50

6) Include leading pedestrian intervals with all new signal phasing.

7) Install all signal equipment outside pedestrian sidewalk areas to the greatest extent feasible.

Exhibit B – City of Dallas/NCTCOG/FHWA Selected Design Guidelines

Complete Streets Design Manual – Serves as a comprehensive policy guide for all public or private projects that impact the planning, design, construction, and operation of streets. Exceptions to this policy must be reviewed and approved by the Director of Public Works, the Director of Planning and Urban Design, and the City's Traffic Engineer upon a finding that application of Complete Streets principles is unnecessary, unduly cost prohibitive, contrary to public safety or prohibited by law.[8] **The Complete Streets Design Manual provides policies and design best practice guidelines to City agencies, design professionals, private developers, and community groups for the improvement of streets and pedestrian areas throughout Dallas**. **This manual is intended to direct transportation planners and engineers to routinely design and operate the entire right-of-way to enable safe access for all users, regardless of age, ability, or mode of transportation**. It is intended to work alongside the Dallas Thoroughfare Plan and the Dallas Development Code to provide the policy framework for the design and use of Dallas' roadway network.[9]

Dallas Street Design Manual – Sets forth standards which are the minimum criteria required by the City of Dallas to be used in the design of public works facilities ***(City Council Resolution #19-1431, dated Sept. 11, 2019)***. **The purpose of the Street Design Manual is to provide requirements and establish minimum standards for designing streets and thoroughfares, and to assist in preparing construction plans in the City of Dallas, such that streets are built to be safe, comfortable, and sustainable for everyone). Any exceptions from the standards set forth in this manual must be accompanied by prior written approval from the Director of Public Works *(Dallas Street Design Manual, Section 1.1, p. 2)***, upon finding that unsafe conditions would result from strict enforcement of these standards, or a special design will enhance safety or traffic flow ***(City Council Resolution #19-1431)***. See also ***SEC. 51A-8.601.(b)(4), SEC. 51A-8.604.(a),*** *&* ***SEC. 51A-8.606.(b)***.

Vision Zero Action Plan – Lays out the strategy for how the City will advance its goal of zero traffic fatalities and a 50% reduction in severe injuries by 2030 ***(City Council Resolution #22-0865)***. The recommendations are derived from verified best practices from literature, other governmental organizations, the City's own data analysis, and public feedback. **Vision Zero Action Plan[10] Relevant Guidance**

Overall theme
- Manage speeds to safe levels as determined through engineering studies that incorporate local conditions.

Department of Transportation and Public Works selected action items:
- Install new or improved pedestrian crossings at locations identified by data as having pedestrian safety issues.
- Promote safe, active transportation around schools.
- Implement major Vision Zero capital safety projects.

NCTCOG Complete Streets (Context Sensitive Design Policy) Official Findings[11]
- Safe, convenient, and connected roadways that accommodate the mobility needs of all users and modes of transportation are critical to livability.

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[8] *City Council Resolution #16-0173*, dated Jan. 27, 2016
[9] City of Dallas. *Complete Streets Design Manual*. Dallas, TX: City of Dallas, 201, p. 15. See also SEC. 51A-8.601.(b)(12).
[10] City of Dallas. *Vision Zero Action Plan*. Dallas, TX: City of Dallas, 2022.
[11] NCTCOG Resolution #R22-04, November 10, 2022.

- A Safe Systems approach should be applied to the planning, design, construction, operation, and maintenance of transportation systems to provide safe and convenient travel through a variety of transportation modes for all users.
- Streets should be designed to complement and support the adjoining land uses and community character emphasizing each project is unique and should be designed to fit its own distinct context, circumstances, and local characteristics.
- Streets that integrate and provide multiple mobility choices contribute to the public life of a community support healthy economic development, facilitate the efficient movement of people and goods, improve public health, advance environmental stewardship, reduce fuel consumption and maximize the use of roadway infrastructure.

Design Controls

City of Dallas requirements and policy

	Design Speed	Design Vehicle	Control Vehicle
Dallas Street Design Manual[12]	Sec. 2.5.3.2. Because of the pedestrian-oriented nature of these areas, the target speed should be kept low (25-30 mph). Sec. 4.2.2. Target speed is based on the overall character and context of the street location and is intended to correlate closely to the posted speed and is the maximum speed that vehicles should operate on the completed street in its final developed condition.	Sec. 4.2.1. Intersections: Minor Arterial to Principal Arterial (intersections with Lemmon Ave & Lemmon Ave E): SU-30 Minor Arterial to Minor Arterial (intersection with N Fitzhugh Ave) : SU-30 Collector to Minor Arterial (Blackburn St, Bowen St): DL-23 Local to Minor Arterials (all other intersections): DL-23 Streets: Blackburn St, Bowen St., Carlisle St, Cole Ave, Fitzhugh Ave, Lemmon Ave, Lemmon Ave E, McKinney Ave: BU-40	Sec. 4.2.1. Intersections: Minor Arterial to Principal Arterial (intersections with Lemmon Ave & Lemmon Ave E): SU-30 Minor Arterial to Minor Arterial (intersection with N Fitzhugh Ave) : WB-50 Collector to Minor Arterial (Blackburn St, Bowen St): SU-30 Local to Minor Arterials (all other intersections): SU-30 Streets: Blackburn St, Bowen St., Carlisle St, Cole Ave, Fitzhugh Ave, Lemmon Ave, Lemmon Ave E, McKinney Ave: BU-40
Complete Streets Design Manual[13]	Complete Streets Policy Framework – Target Speed by Street Type and Functional Classification: Target speeds for mixed use and residential streets with a functional classification of "Minor Arterial" or "Collector" shall be set at 25-30 mph. Street Zone Design Elements – Traffic Calming Elements: Mixed use and residential streets in Dallas should be designed for a target design speed of 25 mph.	Complete Streets Policy Framework – Design Vehicle: This is the vehicle that must be regularly accommodated without encroachment into the opposing traffic lanes. A condition that uses the design vehicle concept arises when large vehicles regularly turn at an intersection with high volumes of opposing traffic (such as a bus route).	Complete Streets Policy Framework – Design Vehicle: This vehicle's infrequent use of a facility must be accommodated, but encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the street side is acceptable. A condition that uses the control vehicle concept arises when occasional large vehicles turn at an intersection with low opposing traffic volumes (such as a moving van in a residential neighborhood or once-per-week delivery at a business) or when large vehicles rarely turn at an intersection with moderate to high opposing traffic volumes (such as emergency vehicles

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	Design Speed	Design Vehicle	Control Vehicle
AASHTO[15]	Recommends design speeds of 20 to 30 mph for local urban streets, considered appropriate for areas with high levels of pedestrian activity, mixed land uses, and transit routes or share spaces with cyclists.	Typically recommends using a single-axle truck (SU-30) as the design vehicle.	No single, specific control vehicle.
ITE[16]	Table 6.4 – Recommends target speeds in residential and mixed-use environments of 25 - 30 mph on general urban mixed streets.	In urban areas it is not always practical or desirable to choose the largest design vehicle that might occasionally use the facility, because the impacts to pedestrian crossing	Infrequent use of a facility must be accommodated, but encroachment into the opposing traffic lanes, multiple-point turns, or minor

[12] City of Dallas. *Dallas Street Design Manual*. Dallas, TX: City of Dallas, 2019.
[13] City of Dallas. *Complete Streets Design Manual*. Dallas, TX: City of Dallas, 2016.
[14] https://www.fhwa.dot.gov/design/altstandards/index.cfm
[15] American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*. 7th ed. Washington, DC: AASHTO, 2018.
[16] Institute of Transportation Engineers and Congress for the New Urbanism. *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*. Washington, DC: Institute of Transportation Engineers, 2010.

		distances, speed of turning vehicles and so forth may be inconsistent with the community vision and goals and objectives for the thoroughfare	encroachment into the streetside is acceptable. A condition that uses the control vehicle concept arises when occasional large vehicles turn at an intersection with low opposing traffic volumes (such as a moving van in a residential neighborhood or once-per-week delivery at a business) or when large vehicles rarely turn at an intersection with moderate to high opposing traffic volumes (such as emergency vehicles).
NACTO[17]	Recommends design speeds of 20 to 30 mph for local urban streets serving residential and mixed-use areas.		NACTO prioritizes maintaining short crossing distances and pedestrian safety over accommodating large vehicles with wide turning radii. To do this, NACTO encourages keeping curb radii tight (e.g., 10-15 feet), even if it means that larger control vehicles like fire trucks or delivery trucks may need to use more than one lane or mount a curb when making a turn. This approach ensures that streets remain walkable and comfortable for pedestrians while still allowing for occasional larger vehicle access.
NACTO Global Designing Cities Initiative[18]	Sec. 9.1 - The design speed for urban areas should not exceed 40km/h (25 mph), with exceptions for specific corridors.	Sec. 9.2 – The design vehicle is the least maneuverable vehicle that routinely uses a street or facility.	Sec. 9.2 – The control vehicle is the least maneuverable vehicle that is ever planned to use a street, but potentially at very low speeds or with multipoint turns.

[17] National Association of City Transportation Officials. *Urban Street Design Guide*. Washington, DC: Island Press, 2013.
[18] Global Designing Cities Initiative. *Global Street Design Guide*. Washington, DC: Island Press, 2016.

Geometric Design

City of Dallas requirements and policy

	Maximum Lane Width	Maximum Curb Return Radii	Sidewalk Width & Placement
Dallas Street Design Manual	Sec. 2.3.1: 10' lane widths are applied where the application of the standard roadway section is undesirable because of economic, environmental, community, or other constraints.	*Sec. 4.4.5.5: For areas with high pedestrian activity and low volumes of traffic, a curb radius of 10 feet shall be employed where feasible. The absolute minimum allowable curb radius is 5 feet which may be used with Director approval… Curb radii should be designed with the smallest possible design vehicle for that street.* *Sec. 4.4.5.7: Buses require an effective radius of 20 to 30 feet depending on lane widths and target speeds. Curb radii should be designed to be as small as possible for pedestrian safety and comfort. Where curb extensions are desired for pedestrian crossings, a bus must be allowed to encroach into the oncoming travel lane or the middle lanes.*	*Sec. 4.5.2.2: Sidewalks in high-density mixed-use areas should include a buffer zone of at least 2'-6' between the curb and the sidewalk. The sidewalk should be 6' wide.*
Complete Streets Design Manual	Complete Streets Policy Framework – Street Elements Widths – Recommended Width Chart for Dallas Complete Streets Elements: Mixed-Use and residential streets must have minimum lane widths of 9' – 10'.	Intersection Design Elements – Key Geometric Design Guidance – Curb Radii: An actual curb radius of 5'-10' should be used wherever possible.	Complete Streets Policy Framework – Street Elements Widths – Recommended Width Chart for Dallas Complete Streets Elements: Sidewalks on mixed-use streets should be a minimum of 6' wide and should be setback 5' – 6' from the curb.

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	Minimum Lane Width	Maximum Curb Return Radii	Sidewalk Placement
AASHTO	Recommends 10'-11' lane widths in urban settings where lower speeds and multimodal considerations are present. AASHTO notes that narrower lane widths can help reduce vehicle speeds and provide space for other road users, such as pedestrians and cyclists.	Notes minimum curb return radii in many urban areas of 10 to 15 feet, particularly in pedestrian-heavy environments where reducing vehicle speed and improving pedestrian safety is prioritized and supports using the smallest practical radius that accommodates the design vehicle while balancing pedestrian safety	Recommends a 4' to 6' buffer zone for street trees between the sidewalk and the curb. The sidewalk should be a minimum of 5' wide, with 8' to 12' width preferred.
ITE	Recommends 10' lane widths for local streets and urban thoroughfares with lower speed limits (typically 35 mph or less). This width promotes slower speeds.	Recommends using smaller radii, typically between 5 to 15 feet, in walkable urban areas to slow down turning vehicles and enhance pedestrian safety.	Recommends a buffer zone of 4 to 6 feet, with minimum sidewalk widths of 6 to 8 feet in urban mixed-use zones.
NACTO	Recommends 10' as the optimal lane width for most urban streets, particularly where speeds are 35 mph or less. This width encourages slower driving	Recommends minimum curb return radii of 5 to 10 feet in most urban areas, particularly in pedestrian-priority environments. Where larger	Recommends a 5' to 8' buffer zone and 6' wide sidewalk in urban, mixed-use areas.

	speeds, which improves safety for all road users, especially pedestrians and cyclists	vehicles need to turn, radii up to 15 feet may be acceptable, but alternative design solutions (such as mountable curbs or curb extensions) are preferred to maintain pedestrian safety.	
NACTO Global Designing Cities Initiative	Sec. 6.6.4 – Lane widths of 3m (10') are appropriate in urban areas and have a positive impact on street safety without impacting traffic operations. For designated transit routes, one travel lane of 3.3 m (11') may be used in each direction. Lanes greater than 3 m (10') are discouraged as they enable unintended speeding and double parking and consume valuable right of way at the expense of other modes.	Sec. 6.6.5 – In urban settings, smaller corner radii of 1.5m (5') are preferred and corner radii exceeding 5 m (16') should be the exception.	Sec. 6.3.4 – Medium-density residential streets should maintain a clear walking path of 2.4 m (8') with tree pits of with a minimum width of 1.5 m (5').

Pedestrian accommodations

City of Dallas requirements and policy

	Type/alignment of Pedestrian Curb Ramps	Curb Extensions/ Bulb-outs	Pedestrian Median Refuges (Islands)
Dallas Street Design Manual	Sec. 4.4.5.4: Crosswalks shall align with the sidewalk clear zone. Sec. 4.4.5.5: Public sidewalk curb ramp type shall be determined by existing public right-of-way width and the existence of other site constraints, in the following recommended priority: (i) perpendicular, (ii) parallel or combined, and (iii) diagonal.	Sec. 4.5.7: Curb extensions, also known as bulb-outs, are encouraged on block corners and mid-blocks of streets where on-street parking exists. The minimum width of a curb extension is 6 feet, the width of a parked car. The length is a minimum of the width of a parked car.	Sec. 2.5.3.3, p. 20: Medians on low-speed urban thoroughfares are used for access management, accommodation of turning traffic, safety, pedestrian refuge, and landscaping. Well-designed medians can serve as a focal point of the street or an identifiable gateway into a community, neighborhood, or district through the use of landscaping, lighting, and urban design features. Sec. 4.4.5.4: Islands are recommended where pedestrians must cross 3 or more traffic lanes. Raised islands in crossings shall be cut through level with the street or have public sidewalk curb ramps at both sides and a level area 48 inches long minimum and a minimum of 36 inches wide or as wide as the connecting sidewalk (whichever is wider. Crossing islands shall not be less than 6 feet in length from island curb face to curb face, and shall typically be the same width as the crosswalk and align with that crosswalk. A "nose" is recommended for the raised island to extend past the cut through crossing to guide vehicles away from awaiting pedestrians.
Complete Streets Design Manual	Intersection Design Elements – Key Geometric Design Guidance – Curb Ramps: Wherever feasible, curb ramps should be located to reflect pedestrians' desired path of travel through an intersection. If possible, two separate curb ramps should be provided at corners instead of a single ramp that opens diagonally at the intersection.	Intersection Design Elements – Key Geometric Design Guidance – Curb Extensions: Curb extensions reduce the effective width of the street by extending the curb line across a parking lane to the beginning of the adjacent travel lane. Curb extensions have a variety of potential benefits: • Additional space for pedestrians to queue before crossing • Improved safety by slowing motor vehicle traffic and emphasizing pedestrian crossing locations • Less exposure for pedestrians by reducing crossing distances • Space for ADA compliant curb ramps where sidewalks are narrow • Enhanced visibility between pedestrians and other roadway users • Restricting cars	Intersection Design Elements – Key Geometric Design Guidance – Crossing Islands: Crossing islands are raised, protected areas within a crosswalk that divide a roadway into segments, so pedestrians only have to cross one direction of traffic at a time. Crossing islands reduce pedestrian exposure and are particularly valuable when used along multi-lane roadways. Crossing islands can be used at signalized intersections, but signal timing should always be designed to allow pedestrians to cross the entire roadway in one stage. Application Crossing islands design should: include at-grade pedestrian cut-throughs as wide as the connecting crosswalks

		from parking too close to the crosswalk area • Space for utilities, signs, and amenities such as bus shelters or waiting areas, bicycle parking, public seating, street vendors, newspaper stands, trash and recycling receptacles, and stormwater management elements or street parks	and detectable warning strips, and be gently sloped to prevent ponding and ensure proper drainage; direct pedestrians at an angle to face on-coming traffic; be at least 6' wide, but preferably 8' wide; accommodate turning vehicles if applicable; extend beyond the crosswalk at intersections; incorporate diverging longitudinal lines on approaches to crossing islands, per TMUTCD standards.

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	Type/alignment of Pedestrian Curb Ramps[19]	**Curb Extensions/ Bulb-outs**	**Pedestrian Median Refuges (Islands)**
AASHTO	Recommends that pedestrian curb ramps be aligned with crosswalks to ensure direct and safe pedestrian access and separate for each crossing direction at intersections, rather than using a single diagonal ramp.	Recommended where on street parking is allowed; minimum width of 6 feet, and length extending the full length of the crosswalk.	Noted to play a crucial role in improving safety, especially on wider roads with multiple lanes. Recommend minimum width of 6' and length to accommodate full width of crosswalk plus a buffer between the pedestrian waiting area and travel lanes.
ITE	Recommends the use of dual curb ramps whenever possible. Ramps should be aligned with the direction of travel in the crosswalk to avoid forcing pedestrians to navigate diagonal paths.	Recommended where on street parking is allowed; minimum width of 6 to 8 feet, and length extending the full length of the crosswalk.	Noted to play a crucial role in improving safety, especially on wider roads with multiple lanes. Recommend minimum width of 6' and length to accommodate full width of crosswalk plus a buffer between the pedestrian waiting area and travel lanes.
NACTO	Strongly recommends the use of dual curb ramps where possible. Curb ramps should be aligned with the direction of travel in the crosswalk.	Recommended where on street parking is allowed; minimum width of 6 to 8 feet, and length extending the full length of the crosswalk.	Recommended where on street parking is allowed; minimum width of 6 to 8 feet, and length extending the full length of the crosswalk. The cut through should be at least 5 feet wide to allow two people to pass comfortably. Two-stage crossings are noted to provide added benefits.
NACTO Global Designing Cities Initiative	Sec. 6.6.4 – Lane widths of 3m (10') are appropriate in urban areas and have a positive impact on street safety without impacting traffic operations. For designated transit routes, one travel lane of 3.3 m (11') may be used in each direction. Lanes greater than 3 m (10') are discouraged as they enable unintended speeding and double parking and consume valuable right of way at the expense of other modes.	Sec. 6.3.7 - Bulb-outs are extensions of the sidewalk into the parking lane. They should be installed whenever on-street parking is present to increase visibility, reduce the crossing distance, provide extra waiting space, and allow for seating or landscaping. The length of a bulb-out should at least be equal to the width of the pedestrian crossing, but should preferably extend to the stop bar.	Sec. 6.3.6 – Pedestrian refuge islands should be at least 1.8 m (6 feet) deep but have a preferred depth of 2.4 m (8 feet). The width of the cut-through should equal the width of the pedestrian crossing or be at least as wide as the clear path. When the cut-through is wider than 3 m (10 feet), install bollards to impede vehicles from parking or maneuvering in the pedestrian refuge. A pedestrian refuge island is ideally 10–12 m (33-39 feet) long, providing enough protection at each end of the waiting space. Longer islands

[19] Both ADA/PROWAG and the NCRP also provide guidance on this issue.

			can be used to deter motorists from using the space for U-turns. Pedestrian refuge islands should be clearly visible to drivers, be well lit, and provide reflectors for improved nighttime visibility. Pedestrian refuge islands should include curbs, bollards, or other features to protect people waiting to cross.

Additional pedestrian accommodation guidance

ADA/PROWAG
Sec. R305.2.1 (Perpendicular Curb Ramps) mentions that curb ramps should be aligned with the direction of travel; Sec. R304.5.3 (Location) states that where feasible, curb ramps should be aligned with the crosswalk to minimize travel distance, reinforcing the benefit of having separate ramps for each crossing direction; Sec. R305.2.2 (Turning Space Requirements) discusses diagonal curb ramps and notes that, when such ramps are used, they may create difficulty for pedestrians, especially those with vision impairments, in determining which direction to travel. It also suggests that ramps that align with each crosswalk direction are preferable to diagonal curb ramps.

NCHRP[20] – Curb ramps should slope and align in the direction of travel to the associated crosswalk to serve as a wayfinding aid for pedestrians who are blind. Curb ramps should serve a single direction of pedestrian travel (i.e., directional curb ramps), rather than serving two diverging crosswalks via a diagonal curb ramp. Diagonal curb ramps require people in wheelchairs to enter the street at an angle and then turn in their desired direction. They also do not direct people with vision disabilities into the correct crossing.[21]

Emergency vehicle design guidance

Dallas Street Design Manual – Sec. 4.4.5.5, p.104: Larger vehicles and emergency vehicles must be able to make turns without encroaching into pedestrian zones or pedestrian islands, however, they may encroach into adjacent or opposite travel lanes if needed.

Complete Streets Design Manual – Complete Streets Policy Framework - Encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the street side is acceptable.

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AASHTO – Curb radii should be as tight as possible to maintain short pedestrian crossing distances, even if it means that fire trucks may need to use more of the intersection space during their infrequent movements.

ITE – When emergency vehicles turn at intersections with low opposing traffic volumes or rarely turn at intersections with moderate to high opposing traffic volumes, encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the streetside is acceptable.

NACTO – Urban street designs should prioritize the needs of pedestrians, cyclists, and transit users while ensuring that emergency vehicles can still perform their duties effectively. This often involves designing streets that support slower speeds but allow for the occasional use of full street width by emergency vehicles when necessary. Recommend tight curb radii at intersections to keep pedestrian crossing distances short, which

[20] National Cooperative Highway Research Program.
[21] Dowds, Jon, et al. *Guide for Pedestrian and Bicyclist Safety at Alternative and Other Intersections and Interchanges*. p.20. NCHRP Research Report 948. Washington, DC: Transportation Research Board, 2020.

aligns with safety goals. To accommodate larger emergency vehicles, mountable curbs and truck aprons can be used. These design elements allow emergency vehicles to make wider turns when needed while keeping the design pedestrian-friendly for everyday use.

NACTO Global Designing Cities Initiative Sec. 9.2 – Where emergency vehicles are much larger than the design vehicle, they can be permitted to make turns by using all areas of the right-of-way, including mountable corner islands or median tips, and portions of the sidewalk, where necessary. Flexible bollards, mountable curbs, and other devices facilitate emergency movements. Work with emergency responders to reduce the size or turn radius needed by newly purchased vehicles.