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Forensic Engineering Analysis of Loading Dock Traffic Patterns

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Abstract

An efficient transportation system includes the safe and efficient movement of goods for distribution to consumers. Trucking transport is a major component of the transportation system which delivers goods to consumers. The flexibility of door-to-door deliveries that is not available through other modes of transportation such as rail or ship, makes trucking transport the final critical segment of the goods transport process. Distribution and terminal facilities for truck transport are generally designed to allow trucks to back into loading dock areas. In addition to providing proper dock heights and bay widths, the infrastructure of these facilities must provide adequate and proper traffic circulation patterns which in turn allow for safe and proper backing of trucks to the loading docks. This paper will detail the analysis of two facilities where road widening projects created a disruptive change in the traffic circulation pattern, which in one case required the reconstruction of the site to accommodate trucking deliveries, and in the other required the change in use of the property to one that no longer relied on trucking deliveries.

Introduction

Warehouses, retail facilities, distribution centers, ports, rail yards, and most any point of commerce depend on trucks to keep goods moving in and out of their facilities. Traffic circulation patterns are critical to the safe and efficient distribution of goods at these locations. The traffic design of truck loading and unloading facilities receives surprisingly little attention in traditional transportation engineering design documents and literature. Various trucking documents give the subject casual consideration at best. Therefore, the engineer designing and analyzing truck loading and unloading facilities must rely heavily on their own understanding of truck operations and traffic circulation at such facilities. The vague nature of some of the documents can lead an inexperienced or untrained professional to make serious errors when designing the layout and traffic flow at such facilities.

This difficulty was brought to light when a warehouse distribution facility fell victim to a road widening project that required the acquisition of right-of-way from the facility's truck circulation and backing area. Several engineers were involved in the analysis of the site for the various parties involved in the litigation that accompanied the right-of-way acquisition, including those representing the property owner, the business owner, the designer of the roadway, and the governmental agency responsible for the construction of the roadway. Differing opinions by experienced and seasoned engineers over the definition

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of "clockwise" and "counterclockwise" circulation led to tension and confusion at mediation, until a demonstration with a scale model truck resolved the issue to the satisfaction of the involved parties.

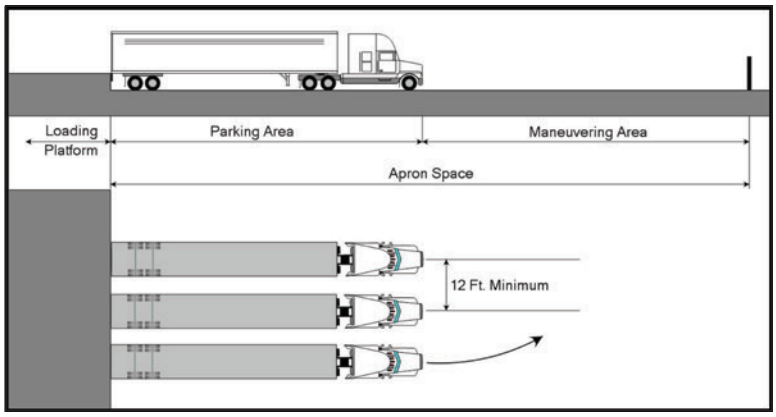

Figure 1
Typical loading dock layout.

Literature Review

Common Traffic and Transportation design publications pay little attention to the subject of the design of loading facilities. What follows is a representative of some of the statements that are found in Engineering literature about traffic circulation at loading and unloading facilities:

"*Make every effort to establish a counterclockwise traffic pattern. It affords best visibility, safety and efficiency. It permits drivers to maneuver and back into docks with a direct view of the dock and the trailer. The backing driver should always be looking into the mirror on the left side of the truck while backing*." (Rite-Hite Corporation)

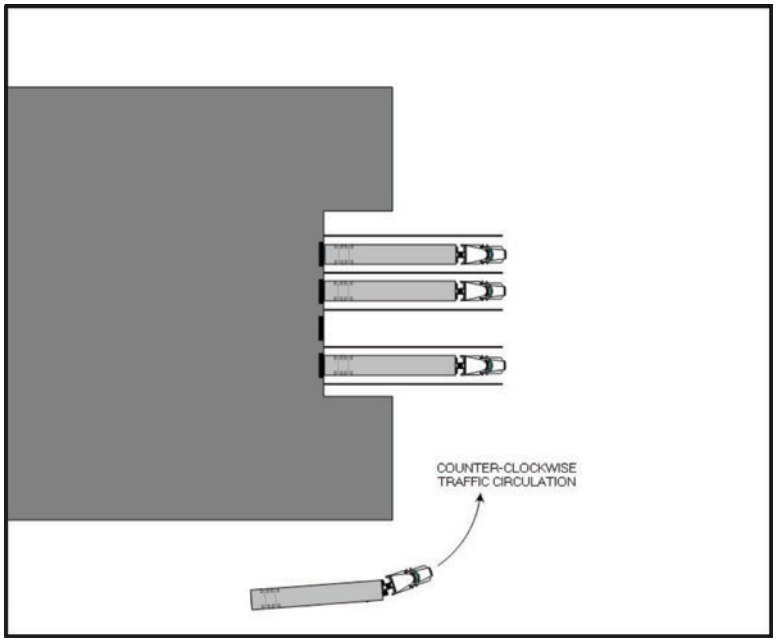

Figure 2
Loading facility with counter-clockwise traffic circulation.

"*The truck circulation pattern and loading position should be designed for a left-side wback-in maneuver. This allows the driver to sight along the left side of the vehicle when backing*." (Stover and Koepke)

"*The total maneuver area (apron plus length of truck) required in front of docks depends on the overall length of trucks, the turning radii, direction of traffic circulation, and the width of berths. A maneuver length from the edge of the loading dock of not less than twice the overall length of the longest vehicle using the facility has been recommended. Another recommendation is for the maneuver space of 105 ft with counterclockwise circulation and 165 ft with clockwise circulation to avoid blind right-hand backing maneuvers*." (ITE Traffic Engineering Handbook)

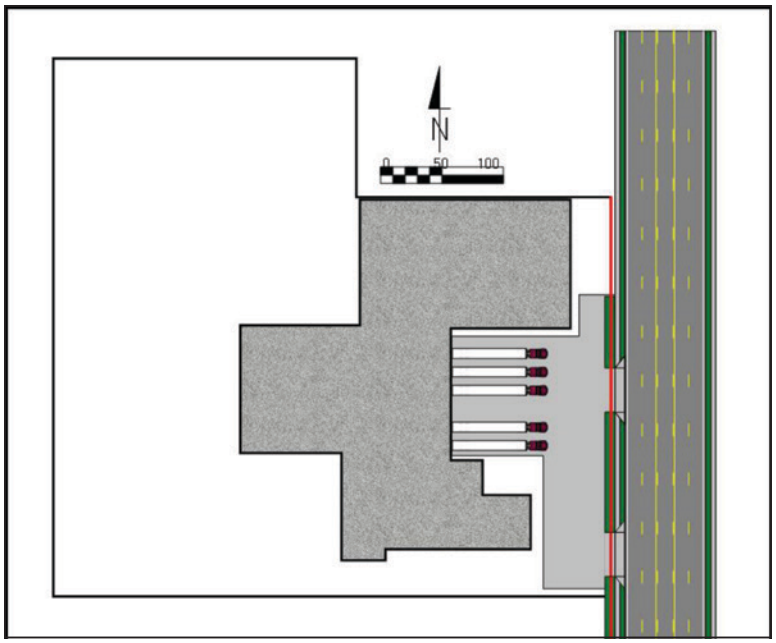

Figure 3
Tractor-trailer on site with counter-clockwise traffic circulation positions itself for backing maneuver.

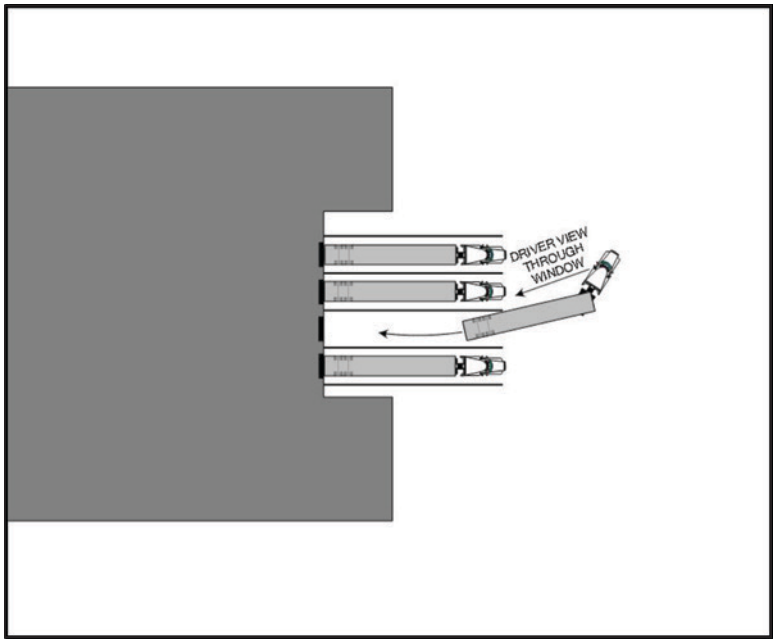

Figure 4
Following the counter-clockwise circulation around the loading dock, the tractor-trailer rotates in a clockwise fashion while backing into the loading dock.

"*If traffic flow is counterclockwise, the maneuvering room must extend a minimum of 40' beyond the loading area. If traffic flow is clockwise, the maneuvering area must extend at least 100' beyond the loading area*." (Kelley Company)

While these statements and guidelines may make clear and perfect sense to those in the trucking industry, we found that many of our well-educated colleagues in the engineering and legal arena were quite confused by these statements. Within the context of one case that will be discussed in this paper, it was incumbent on the author to clearly explain to the attorneys, the mediator, and his fellow engineers how trucks operate within loading and unloading facilities, and to clearly explain what was not so clearly stated in the documents.

Components of the Traffic Circulation and Loading Area

The traffic circulation area consists of various components as illustrated in Figure 1. The loading dock is the elevated platform that is constructed at the same height as the floor of a typical trailer; generally approximately 48 inches in height. The parking area is that area in front of the loading docks where trucks park after having backed up directly to the loading dock. The trucks will park with the back of the trailer flush against the loading dock to allow forklifts and dollys to easily pass between the loading dock and the interior of the trailer. The length of the parking area should be equal to the length of the longest anticipated tractor-trailer combination. The maneuvering area is that traffic area directly in front of the parked trucks that is used for traffic circulation and backing. The dimensions of the maneuvering area vary based on the anticipated length of trucks that

will use the facility and on the spacing between each loading dock. The parking area and the maneuvering area combine to form the apron space.

Clockwise vs. Counterclockwise Traffic Circulation

Surprisingly, there seems to be a great deal of confusion over the statement, "Make every effort to establish a counterclockwise traffic pattern." The confusion is caused by the fact that if a truck circulates around the site in a counterclockwise fashion prior to backing into a loading bay, the truck will then pivot in a clockwise fashion as it is backing up. As an example, Figure 2 shows a tractor-trailer circulating counterclockwise around a site. The truck will continue past the loading dock an appropriate distance and turn the cab slightly to the left before stopping as shown in Figure 3. The truck then backs up toward the loading dock with the truck turning in a clockwise fashion. During this backing maneuver the driver can see the loading dock either through the driver's side view mirror, or by looking over his shoulder through the window toward the loading dock as seen in Figure 4.

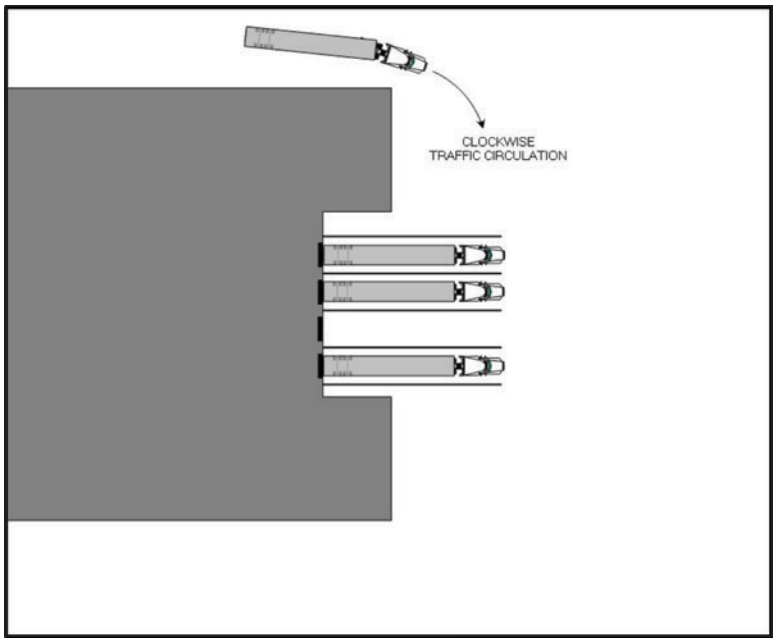

Figure 5
Loading facility with clockwise traffic circulation.

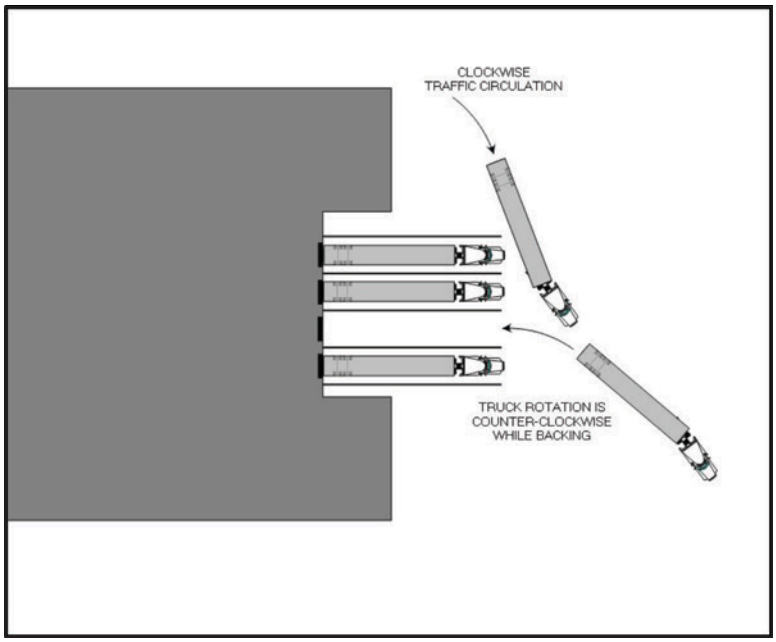

Figure 6
Tractor-trailer on site with clockwise traffic circulation positions itself for backing maneuver.

Alternatively, Figure 5 shows a tractor-trailer circulating clockwise around a site. When the truck continues past the loading dock, the driver attempts to position the truck in such a way that the vehicle will rotate counterclockwise while backing as seen in Figure 6. However, Figure 7 illustrates that as he does so, the driver's side view mirror shows a reflection of an area off to the side, and his view out the driver's side window looks perpendicular away from the loading dock. At the same time, the side-view mirror on the passenger side shows only the side of the trailer. Such a maneuver is called "blind backing" as the driver is unable to see his anticipated target destination at the loading dock.

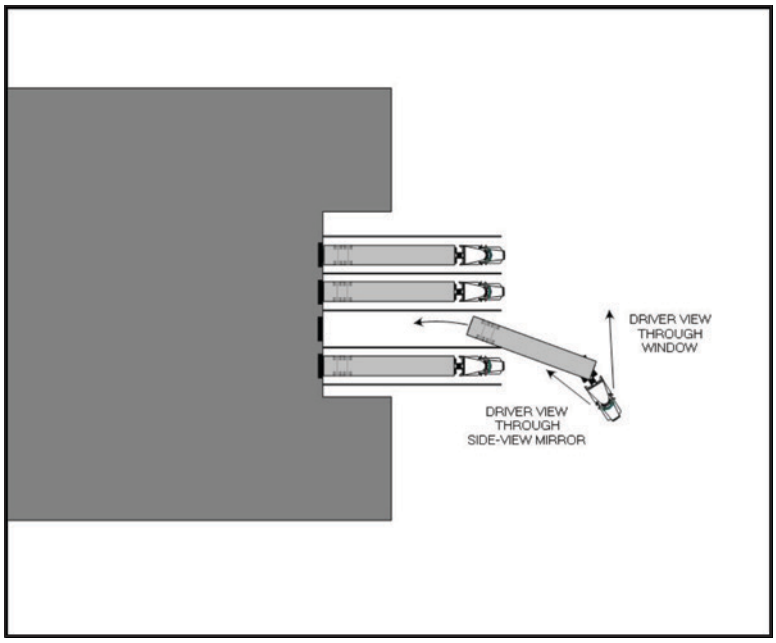

Figure 7
Following the clockwise circulation around the loading dock, the tractor-trailer rotates in a counter-clockwise fashion while backing into the loading dock resulting in a blind backing maneuver.

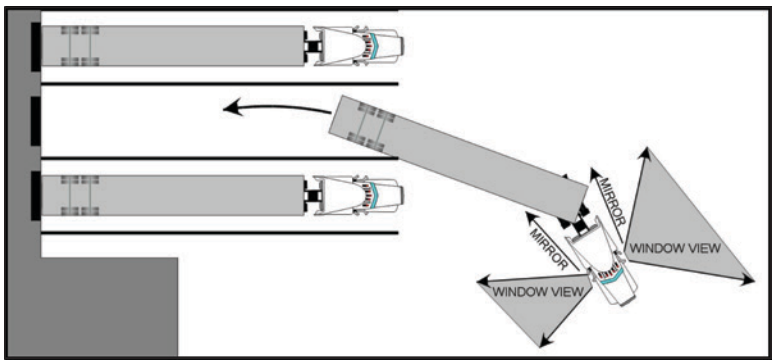

Figure 8
Illustration of driver's inability to see where trailer is backing during a blind-backing maneuver which results from a clockwise traffic circulation pattern.

Such a backing maneuver generally requires the assistance of a spotter to guide the driver while backing to the loading dock. Figure 8 is a diagram which illustrates a driver's inability to see where a truck is backing during a blind backing maneuver which results from a clockwise traffic circulation pattern.

If a clockwise traffic circulation pattern cannot be avoided, blind backing can be eliminated by increasing the depth of the maneuvering area. The maneuvering area must be increased enough that tractor-trailers have room to pull forward and align both the tractor and trailer parallel to the loading stalls, which allows the trucks to back straight into the loading bay.

Case Study

Figure 9 shows a distribution facility located on a two-lane roadway. Trucks backed up to a covered loading dock that was open with no bay doors. Trucks typically parked approximately every 14 to 15 feet center-to-center, making room for approximately five trucks to be parked at the loading dock at any given time. To access the site, tractor-trailers would exit the highway and enter the site through the second driveway as shown in Figure 10. The truck, which was southbound on the highway, would make a 180-degree turn and travel north along the front of the building as shown. As a truck reached the northern portion of the maneuvering area, it would aim the truck toward the corner, and then turn the cab to the left as shown in Figure 10. The truck would then stop, having positioned itself in such a manner that the driver could see the loading dock by looking out the driver-side window over his left shoulder. The driver would then back the truck toward the loading dock as the truck turned in a clockwise direction.

The distribution had successfully operated from this location for many years when Transportation officials determined that the adjacent roadway should be widened to four lanes with a two-way center turn

lane. The roadway construction also included the installation of curb, gutter and sidewalk. In order to accommodate the roadway project, it was necessary for the Transportation Agency to acquire a strip of land from the distribution property approximately 30 feet in width. Included in this right-of-way acquisition was a significant portion of the truck maneuvering area. The right-of-way acquisition area is shown as shaded area in Figure 11. The remainder property with the widened roadway is shown in Figure 12.

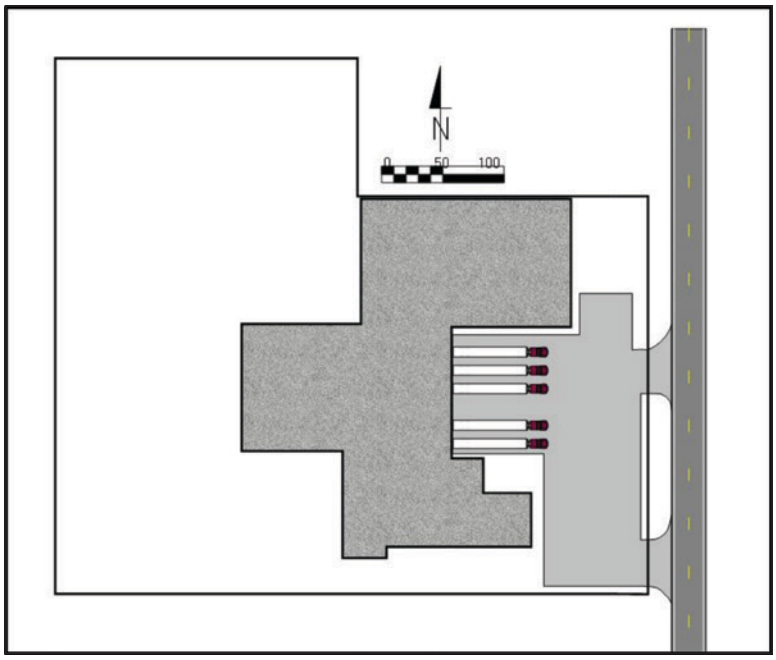

Figure 9
Site plan of distribution facility.

As a result of the right-of-way acquisition and the subsequent roadway construction, trucks could no longer make a 180-degree turn through the second driveway. By moving the roadway closer to the buildings, such a maneuver could no longer be made without the truck striking the front of the building as shown in Figure 13. Transportation officials proposed to the property owners that the facility could continue to be used merely by having trucks enter the site through the first driveway, pulling ahead in front of the second driveway, and then backing in a counterclockwise fashion as shown in Figure 14. They pointed to the documents listed in the "Literature Review" section that state that a counterclockwise traffic circulation pattern should be used, and then pointed to the counterclockwise turning of the trucks as they backed up to the loading docks in their proposed traffic circulation plan. One engineer for the Transportation Agency claimed to have called the author of one of the publications who confirmed to him that the preferred design was a counterclockwise traffic circulation pattern. This was incorrectly interpreted by the engineer to mean that a truck should turn in a counterclockwise fashion as it backs up to a loading dock.

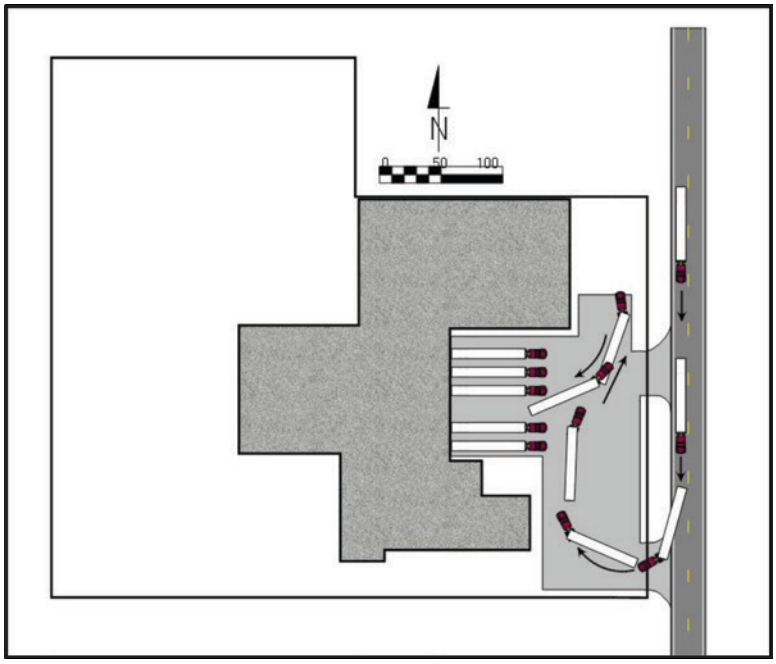

Figure 10
Truck access, circulation, maneuvering, and backing at distribution facility. Note that the truck traffic on the site is counter-clockwise relative to the building.

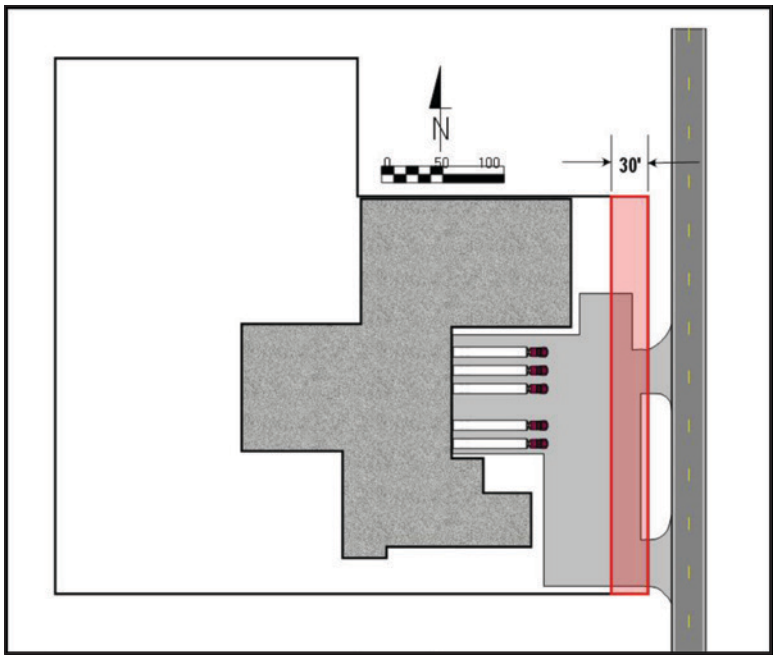

Figure 11
Site plan of distribution facility showing proposed right-of-way acquisition.

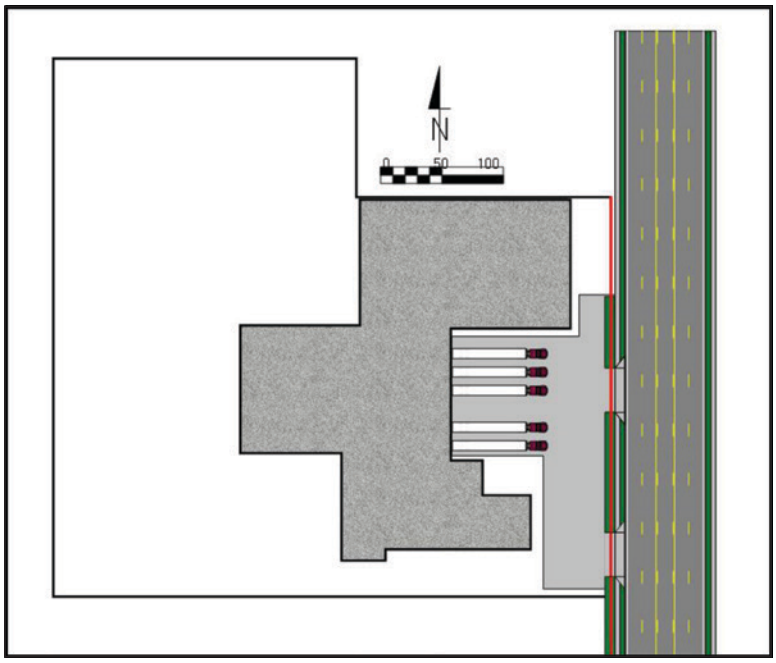

Figure 12
Site plan of the distribution facility after the right-of-way acquisition and after construction of the road widening project.

Mediation

The case was presented at mediation, where the Transportation Agency had their team of engineers present to assist in the presentation of the Agency's case, and to assist in the mediation negotiations. During the mediation those engineers incorrectly convinced the mediator that their solution was compliant with industry recommendations through their misunderstanding that counterclockwise traffic circulation meant a counterclockwise back-up maneuver. The author was called by his attorney clients for an explanation. The author was able to successfully demonstrate to the mediator, with the assistance of a scale model tractor-trailer, that a counterclockwise backing maneuver creates a "blind backing" situation, while a counterclockwise traffic circulation pattern leads to a proper clockwise backing maneuver. Reference to Figure 10 shows that even though trucks did not have the need to circulate completely around the building, that prior to backing the trucks circulated in a counterclockwise fashion with respect to the loading area. This counterclockwise traffic circulation pattern then led to a proper clockwise backing maneuver.

Cure

A second mediation was scheduled, at which time Transportation Agency engineers and officials agreed that the change in the traffic pattern which was caused by the right-of-way acquisition resulted in the need for a blind backing maneuver. In order to cure this problem, the owners proposed that a new loading dock be constructed on the rear side of the facility as shown in Figure 15. This would involve abandoning the existing loading and unloading area and reconfiguring the interior of the warehouse building to accommodate relocated loading docks. However, as seen in Figure 15,

this proposed plan results in a clockwise traffic circulation, which leads to a blind backing maneuver.

The property was not configured in a way that would allow a proper counter-clockwise traffic circulation pattern. In order to utilize the facility with the clockwise traffic circulation pattern, a 140-foot maneuvering area was constructed. This maneuvering area, which is approximately equal to the length of two tractor-trailers, allows tractor-trailer vehicles to pull forward far enough to be able to back straight into the loading docks as shown in Figure 16, thus eliminating any blind backing.

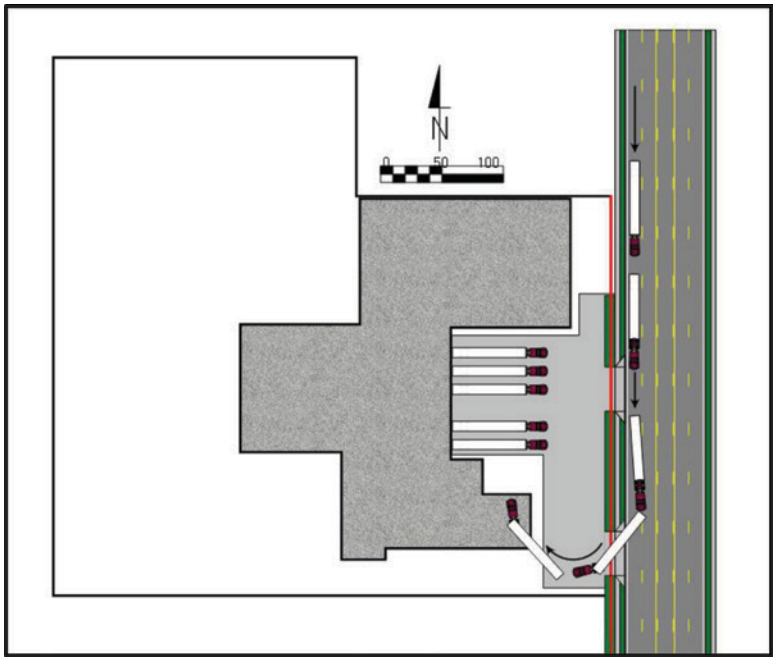

Figure 13
Truck access, circulation, maneuvering, and backing at distribution facility. The project left insufficient room for trucks to access the site in a way that allows counter-clockwise traffic circulation relative to the building.

Conclusion

The case was settled with the Transportation Agency paying the property owner for the property that was taken, the costs of remodeling the site and constructing a new loading dock in the back, and for lost business revenues during the construction and remodeling activities. A proper understanding of tractor-trailer dynamics and operation is critical to understanding the language and diagrams in the published literature.

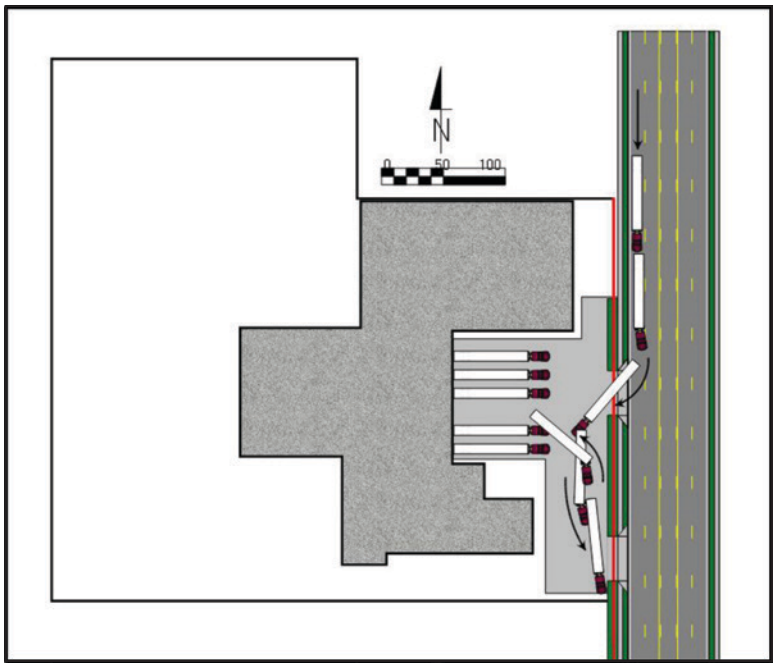

Figure 14
Alternate site access that creates a clockwise traffic circulation pattern relative to the building, resulting in blind backing.

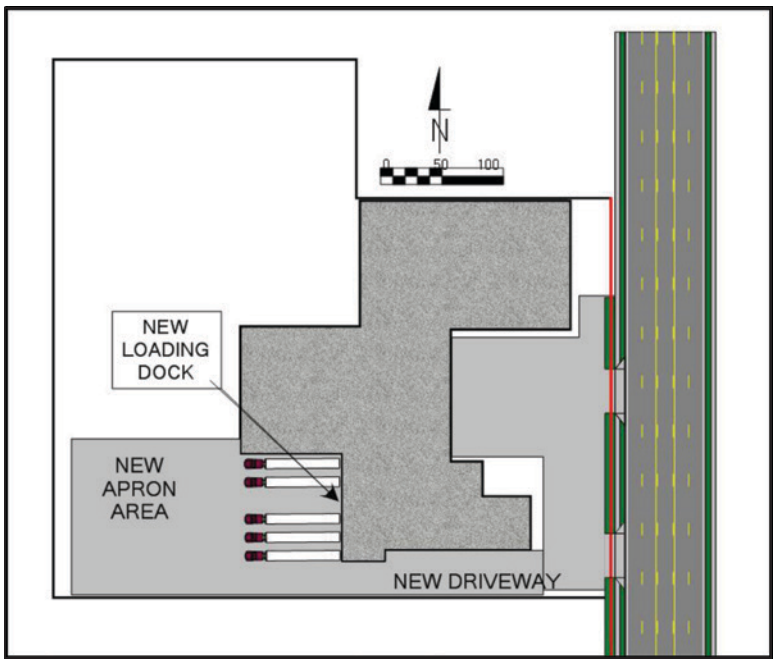

Figure 15
Proposed site plan for distribution facility creating new loading docks in the back.

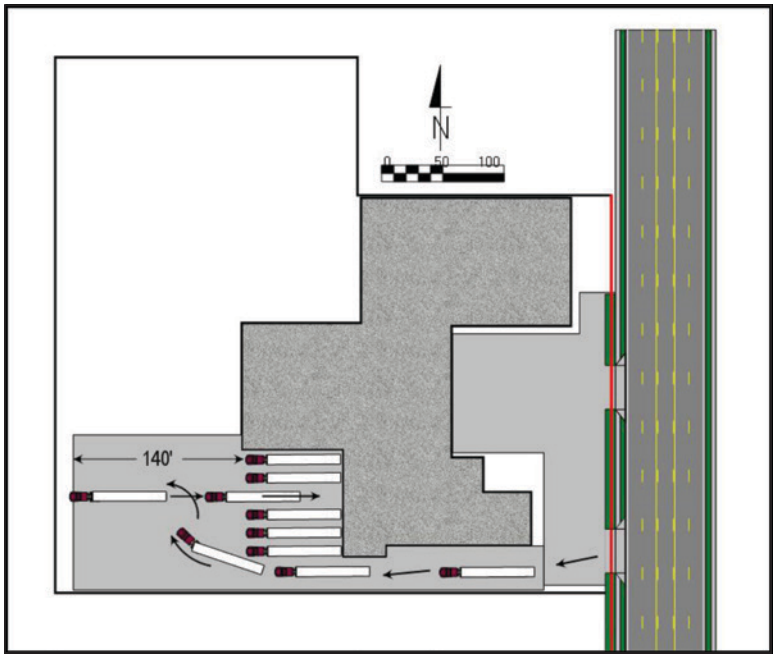

Figure 16
Access, traffic circulation, and truck maneuvering on the remodeled site. Even though the on-site traffic pattern is clockwise relative to the building, the increased maneuvering space eliminates blind backing.

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