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Effect of Grade Separation on Pedestrian Railroad Trespass Activity at Shuttlesworth Drive in Collegeville, AL

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13. ABSTRACT (Maximum 200 words)

The Volpe Center, under the direction of FRA's Office of Research, Development, and Technology, conducted a research study to evaluate the effects of closing and replacing the Fred L. Shuttlesworth Drive grade crossing (Crossing ID 352514C) with a vehicular and pedestrian overpass bridge on trespassing along a rail corridor in Birmingham, AL. Trespassing events were coded for 10 hours per day for 5 weekdays before construction of the overpass bridge and then again for approximately 5 months after the opening of the overpass bridge.

Results indicate that the rate of trespassers increased by 72 percent, from 44.74 to 76.91 per 100 pedestrians entering the railroad right-of-way, after the construction of the overpass bridge. However, high-risk trespass activities (trespassing during train events and trespassers physically interacting with a train) decreased significantly after the construction of the overpass bridge. Trespassing during train events decreased by 84.3 percent, from 7.05 to 1.10 trespassers per train event, and trespassers physically interacting with a train decreased by 92.6 percent, from 1.62 to 0.12 trespassers per train event after the construction of the overpass bridge.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

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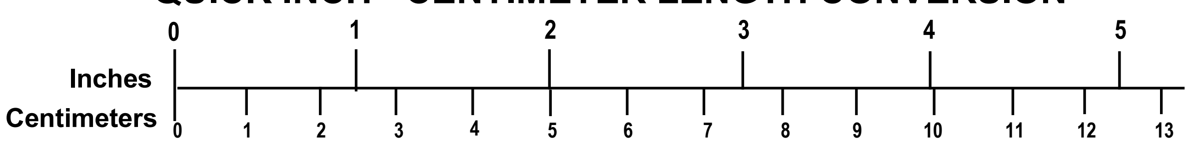
QUICK INCH - CENTIMETER LENGTH CONVERSION



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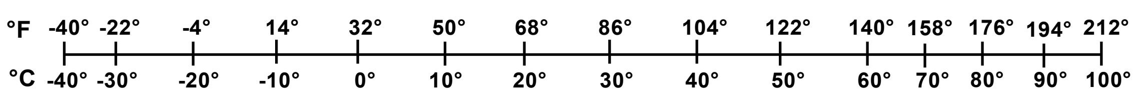

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

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Executive Summary

Trespassing on railroad rights-of-way (ROW) in the United States contributed to 1,080 casualties in 2017. Of these, more than 50 percent (575) resulted in death, excluding known suicides.[1] This data does not include trespass at highway-rail grade crossings. Preventing ROW trespassing is a challenging task because a substantial portion of our nation's railway is unguarded. A number of treatments and tactics have been utilized to combat it, including fencing, education, law enforcement activities.

The practice of grade separation is often viewed as the best method of ensuring railway safety. By moving pedestrians and motor vehicles onto a different plane than trains, minimal contact between the modes can be achieved. However, previous research regarding the utilization of grade-separated pedestrian facilities indicates that pedestrian traffic often rejects the use of separated facilities if utilizing them is perceived as inconvenient (Moore and Older, 1965). Further research in this area has yielded similar results, and bolstered the notion that pedestrians are more likely to make decisions based on convenience more than other factors such as safety.

The John A. Volpe Transportation Systems Center (Volpe Center) was tasked by Federal Railroad Administration (FRA) Office of Research, Development, and Technology (RD&T) with evaluating the effect of grade separation on railroad trespass activity and quantifying this effect at various distances from the grade separation site. A research team conducted before-and-after study along a freight rail corridor in the Collegeville neighborhood of Birmingham, AL. The team coded trespassing events for 10 hours per day from 7:00 a.m. to 5:00 p.m. for 5 weekdays before construction of the overpass bridge and then again for approximately 5 months after the opening of the overpass bridge in 2017. Trespass events were coded based on where pedestrians entered and exited the railroad ROW and activity involved as well as whether a train was present on the corridor during the event.

After closing the at-grade crossing and replacing it with an overpass bridge, more pedestrians entered the railroad ROW by trespassing rather than via the overpass bridge. The trespassing rate increased by 72 percent, from 44.74 to 76.91 per 100 pedestrians entering the railroad ROW, after the construction of the overpass bridge. Additionally, trespasser movements also changed after the construction of the overpass bridge. More trespassers entered and exited the railroad ROW further away from the crossing after construction.

Despite the negative effects on overall trespass activities, the construction of the overpass bridge had significant positive effects on high-risk trespass activities (trespassing during train events and trespassers physically interacting with a train). Trespassing during train events decreased by 84.3 percent, from 7.05 to 1.10 trespassers per train event, after construction. A riskier subset of this group (trespassers who came in physical contact with a train) experienced an even more significant reduction. The number of trespassers who came in physical contact with a train was reduced by 92.6 percent, from 1.62 to 0.12 trespassers per train event, after construction.

Lastly, the frequency of pedestrians legally entering the Collegeville corridor railroad ROW declined after the construction of the overpass bridge. Prior to construction, 55.3 percent of the

[1] Obtained from the FRA Office of Safety Analysis website: https://safetydata.fra.dot.gov/OfficeofSafety/default.aspx in March 2018.

3,509 pedestrians observed entering the Collegeville corridor railroad ROW did so legally via the at-grade crossing. In comparison, only 23.1 percent of the 1,975 pedestrians used the overpass bridge to cross the tracks.

1. Introduction

Trespassing on railroad rights-of-way (ROW) is the leading cause of rail-related deaths in the United States. In 2017 alone there were 1,080 trespass casualties, of which 575 resulted in fatal injuries, excluding known suicides.[2] This data does not include trespass at highway-rail grade crossings.

Grade separation is considered by many to represent the most effective solution to trespassing; however, it is also one of the most expensive treatments available. Additionally, without proper placement and channelization, a pedestrian overpass may be underutilized.

The John A. Volpe National Transportation Systems Center (Volpe Center) was tasked by the Federal Railroad Administration (FRA) Office of Research, Development, and Technology (RD&T) with evaluating the effects on trespassing of closing and replacing the Shuttlesworth Drive highway-rail at-grade crossing (Crossing ID 352514C) with a vehicular and pedestrian overpass bridge along a rail corridor in the Collegeville neighborhood of Birmingham, Alabama. The bridge was built to address the public safety issues for both vehicular and pedestrians due to the crossing being blocked by CSX trains.

1.1 Past Research

1.1.1 Freeway Grade Separated Crossings

Grade separated crossings are commonly used on railways; however, apparently there are no studies on their effectiveness in preventing trespassing on railroad ROWs. While several studies exist concerning the utilization of grade-separated pedestrian facilities, the vast majority of these studies concern highway overpasses rather than those used on railroads.

The Guide for the Planning, Design, and Operation of Pedestrian Facilities, published by the American Association of State Highway and Transportation Officials (AASHTO), includes the following on "Grade-Separated Crossings":

- *Grade separations can be quite expensive.*
- *May become sites for crime and vandalism and may even decrease safety if not properly located or designed.*
- *May not be utilized if perceived risk to the pedestrian of crossing at grade is not apparent or proposed route is too inconvenient.*
- *Is accessible to all users.*
- *Lighting, barriers, and railing can increase the sense of safety and security.*
- *Most beneficial where demand is moderate-to-high, large number of children are present, traffic conflicts that may emerge are unacceptable, residential neighborhoods are separated from schools by corridor*

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[2] Obtained from the FRA Office of Safety Analysis Web site: https://safetydata.fra.dot.gov/OfficeofSafety/default.aspx on March 2018

- *Grade-separated crossings will not be used based on safety alone.*

A study by Moore and Older (1965) was one of the first to examine pedestrians' behavior when choosing whether to utilize grade-separated facilities to cross highways. They indicated that the likelihood of pedestrians using a grade-separated facility is strongly tied to the ratio of the time it takes to utilize the grade-separated crossing versus the time it takes to use an alternate route. A ratio, R, was calculated by dividing the time it takes to cross using an underpass or overpass by the time it takes to cross at street level. According to their results, almost everyone will use an underpass if the ratio, R, is less than or equal to one but a ratio, R, must be equal to or less than 0.75 before almost everyone will use an overpasses. This indicates that pedestrians primarily consider convenience when making decisions regarding their route. Räsänen, Lajunen, Alticafarbay, and Aydin (2007) conducted a study in Ankara, Turkey to determine factors that influenced pedestrian use or avoid grade-separated crossings. A total of 408 individuals were surveyed at 5 pedestrian bridges. Findings showed that time saving, safety, and familiarity of the area were important factors in influencing pedestrian perceptions of bridge use. However, safety was a secondary factor when the time loss for using bridge was too large.

1.1.2 Rail Grade-Separated Crossings

Grade-separated crossings provide different planes of travel for trains and pedestrians, thus reducing the possibility of trains striking pedestrians. However, grade-separated crossings are expensive to build and underutilized if not properly designed or built. Lobb, Harre, and Suddendorf (2001) conducted a study at Henderson Railway Station in Auckland, New Zealand to determine whether education and environmental interventions are effective in promoting the use of a pedestrian overpass bridge rather than trespass by walking across the tracks. The education interventions consisted of talks, leaflets, and signs about the illegality of crossing tracks at the stations and the dangers of trespassing. Environmental interventions involved preventing illegal access to railroad ROWs by repairing holes in fences, installing new fences, and applying grease to gaps in the fences. The study made use of visual observations and surveys to gather data.

Findings showed that the proportion of pedestrians who used the overpass bridge to cross tracks increased substantially from 41 percent to 60 percent immediately after the interventions. Adults experienced a greater increase in overpass bridge use compared to children. Three months after the interventions, the increase in overpass bridge use was sustained and even slightly enhanced. Both education and environmental interventions were implemented at the same time, so the study was unable to determine whether the increase in overpass bridge use was due to one or a combination of both.

1.2 Background

The Collegeville neighborhood in Birmingham, Alabama faces significant hardships due to an adjacent railroad network. The rails not only enclose and separate the neighborhood from surrounding communities, but also bisect it laterally, providing an obstacle to individuals traveling between the two sections of the neighborhood. An added level of danger arises from the presence of idle trains, which can occupy the crossings for long periods of time while operations are performed. These trains often block one or both at-grade crossings that allow travel between north and south Collegeville. Consequently, trespassing occurs on a regular basis as residents, including children, scale active trains in order to cross the tracks.

On two occasions, emergency vehicles could not arrive to a scene on time due to the access being blocked by trains. One such incident, in May 2000, involved a firetruck blocked off by train on all sides that resulted in the death of an elderly couple.[3] Another incident occurred in 2013, when an ambulance took a long detour due to a train stopped on a crossing to reach an individual who had a seizure. Unfortunately, the ambulance did not make it in time to save the victim. To address the public safety issues with trains that blocked access to the neighborhood, late city council president Maxine Parker successfully lobbied the State and Federal Government for funding to build an overpass bridge over the railroad tracks.

The research team chose the Collegeville corridor primarily based on its scheduled improvement. As this project was already funded and planned, the team decided to evaluate the overpass from the existing project, rather than attempting to plan and construct a new structure for the purpose of this research. Although pedestrian overpasses are commonly used on railways, their effectiveness in preventing trespassing has never been studied. Additionally, while several studies exist concerning the utilization of grade-separated pedestrian facilities, the vast majority of these studies concern highway overpasses rather those used on railroads. Understanding the effect that grade separation has on trespass activity is crucial to addressing trespass-related safety issues.

1.3 Objectives

The purpose of this research was to observe changes in trespass activity following the construction of a grade separated railroad crossing in Birmingham, Alabama. Researchers collected data along a rail corridor in the Collegeville neighborhood prior to any construction taking place, and then again following the construction of a grade separated crossing. The grade separated crossing consisted of a three lane vehicle overpass (one in each direction and turning lane in-between), as well as an attached pedestrian facility with staircases on both sides of the track. Trespass activity before and after the construction of the overpass bridge was compared to determine what effect, if any, the grade separation had on trespassing.

1.4 Overall Approach

The safety benefit of the overpass bridge was demonstrated by its ability to reduce trespassing along the Collegeville rail corridor. The metrics used to evaluate the effectiveness of the overpass in reducing trespassing included: change in total number of trespassers (as a percentage of total pedestrian traffic), change in number of trespassing violations with an active locomotive on the corridor (relative to total number of train movements), and change in percentage of trains experiencing trespass activity. The change in trespass activity during train movements was weighted more heavily than general trespass activity because it represented a high-risk scenario, where the potential for injury or death was far greater.

The research team recorded trespass activity before the overpass construction to establish a baseline level for the corridor. Following the completion of the overpass, users were allowed to

[3] http://www.wvtm13.com/article/maxine-parker-bridge-expected-to-open-in-collegeville-tuesday/10016461: accessed on September 2018.

acclimate to the new environment during a "novelty" period. Data collected during this period was not analyzed, as it would not reflect normal levels of use. The novelty period was followed by the "after," or post-construction phase, during which data was collected and analyzed to evaluate the benefits of the grade separation.

1.5 Scope

The scope of this study covers railroad ROW trespassing along approximately 3,250 feet of the Collegeville rail corridor. The report does not include trespass activity at night due to a lack of lighting along the rail corridor.

1.6 Organization of the Report

This report is organized as follows:

- Section 2 presents an overview of the test site location and data collection activities.
- Section 3 describes the data analysis.
- Section 4 presents findings.
- Section 5 presents the conclusions of the study.
- Section 6 presents limitations of the study.

2. Test Site Location and Data Collection

The site chosen for this effort was the railroad ROW located adjacent to a grade crossing on Shuttlesworth Drive in the Collegeville neighborhood in Birmingham, Alabama (Crossing ID 352514C). The use of the Collegeville corridor in this study was primarily based on its scheduled improvement.

2.1 Test Site Location Characteristics

2.1.1 Collegeville, Alabama

Collegeville is a neighborhood in northern Birmingham, Alabama, and is located in Jefferson County. Figure 1 shows a map of Collegeville. As can be seen, the neighborhood is not only bisected, but also encircled by railroad tracks. The corridor, shown in red, was the one observed for trespass activities in this study.

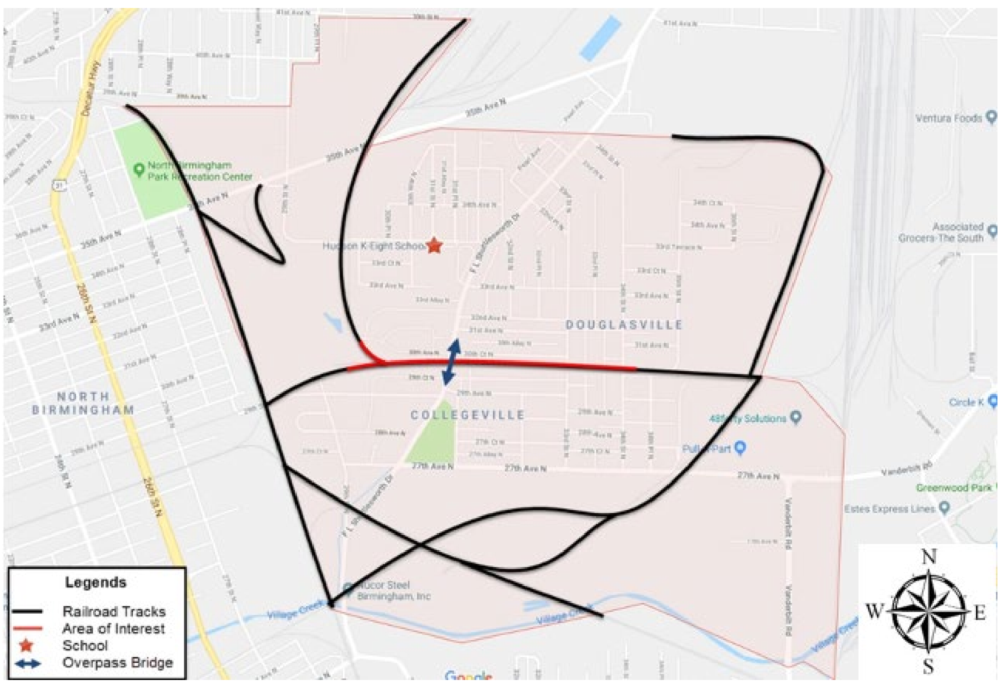

Figure 1. Map of the Neighborhood of Collegeville in Birmingham, AL

Due to the high concentration of railroad tracks in the area, trespassing is common. Pedestrians often trespass on the corridor, as there are only two at-grade crossings on the line, which are approximately 2,080 feet away from each other. Further complicating the issue is the presence of freight trains on the corridor which frequently come to a stop, blocking the grade crossings and preventing their use. For this reason, Collegeville also experiences a substantial level of high-risk trespassing, involving active locomotives operating in the same space as trespassers, and, in some cases, coming in physical contact with these individuals (who sometimes climb over or go under cars).

2.1.2 Shuttlesworth Drive Grade Crossing

This section describes the baseline site conditions before the closing of the Shuttlesworth Drive grade crossing and construction of the new overpass bridge. Shuttlesworth Drive runs in a north-south direction and is the only through street that connects Collegeville to the rest of the city. The Shuttlesworth Drive grade crossing (352514C) selected for this study is located at milepost 389.27 in the Birmingham Mineral subdivision. There is one active railroad track that intersects Shuttlesworth Drive and runs in an east-west direction. According to the DOT Highway-Rail Crossing Inventory database, the estimated annual average daily traffic (AADT) at this crossing was 3,170 in 2014, with a posted speed limit of 35 mph. The crossing is on the CSX rail line and has only freight (CSX) trains that pass through the crossing at speeds ranging from 5 to 10 mph. During the two data collection periods for this study, an average of six trains passed though the crossing daily. The crossing was equipped with four sets of mast-mounted flashers and two crossbucks. Figure 2 shows an aerial view of the Collegeville corridor that was monitored for trespass activities.

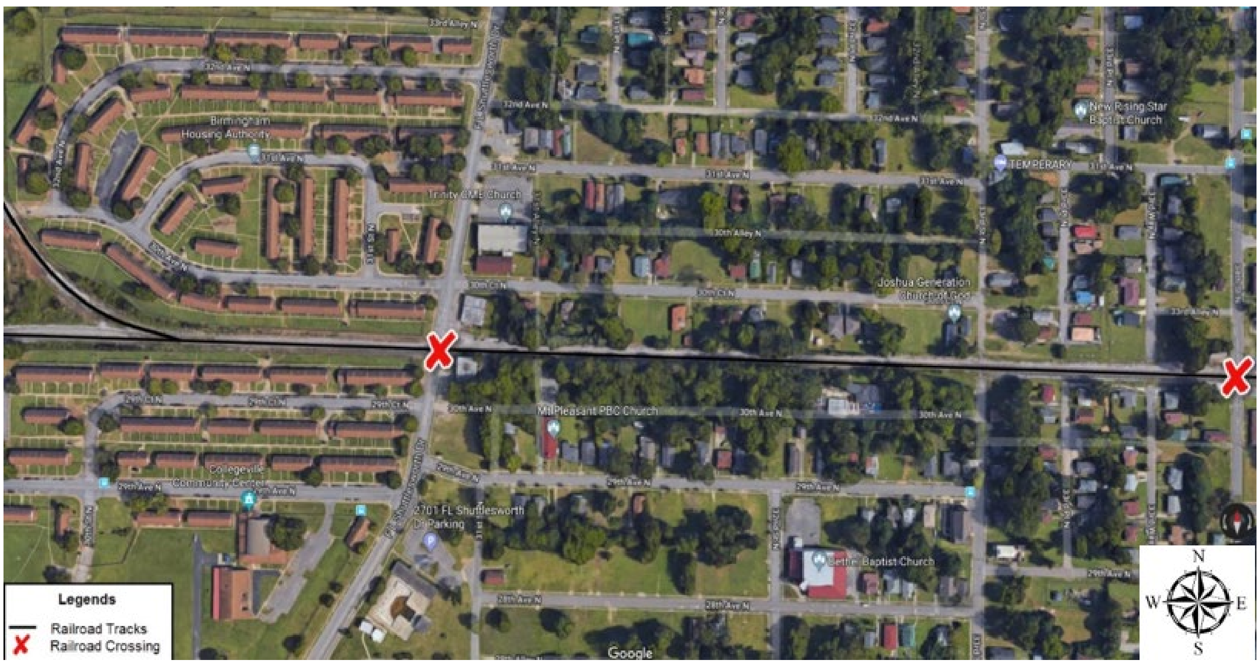

Figure 2. Aerial View of the Collegeville Corridor

West Side of the Crossing

There is one lane of traffic and a sidewalk that intersect the Shuttlesworth Drive crossing. To the west side of the crossing, there is a public housing complex consisting of approximately 400 units. The housing complex is bisected by CSX tracks that run through the middle of the entire width of the housing complex, spanning approximately 1,100 feet. Although both sides of the housing complex that border the railroad tracks are fenced off, there are holes in the fence that trespassing pedestrians use to loiter on the railroad ROW or use as shortcuts to get to the other side of the complex or to the middle school located approximately 1,200 feet to the north of the crossing. Many school children with backpacks were observed crossing the tracks through these holes or climbing over the fence. Figure 3 shows the Google Street View of the west side of the crossing.

Figure 3. Google Street View of the West Side of the Shuttlesworth Drive Crossing

East Side of the Crossing

The area monitored for trespass activities on the east side of the Shuttlesworth Drive crossing spans approximately 2,000 feet from the grade crossing to the 34th Street grade crossing. There is one lane of traffic and a sidewalk that intersect the crossing. Immediately adjacent to the crossing, there is a grocery store on the northeast corner and a commercial building on the southeast corner, followed by residential homes that dot both sides of the tracks along the ROW up to the 34th street crossing. Between these two crossings, but closer to the 34th street crossing, are three dead-end streets that lead up to the tracks. Researchers observed a significant number of trespassing pedestrians using these locations as shortcuts to travel to the other side of the tracks. This entire ROW is not fenced. Figure 4 shows the Google Street View of the east side of the Shuttlesworth Drive crossing.

Figure 4. Google Street View of the East Side of the Shuttlesworth Drive Crossing

2.1.3 Maxine Herring Parker Bridge

This section describes the site conditions after the closing of the Shuttlesworth Drive grade crossing and opening of the new overpass bridge. The bridge is named after the late city council president Maxine Herring Parker, who lobbied for funding to build this bridge. Bridge construction started in early 2015 and was officially opened to traffic on June 13, 2017. This was a collaborative Federal State, City, and local government project.

The bridge is an overpass over railroad tracks and connects Shuttlesworth Drive from 29th Avenue North to 32nd Avenue North. There are three lanes of traffic for motorists (one lane of traffic in each direction and a turning lane in the middle) and a sidewalk for pedestrians over the bridge. The sidewalk is located only on the west side of the bridge and is separated from motor vehicle traffic by a concrete barrier. The sidewalk can be accessed via a staircase located on both sides of the railroad tracks or via the existing sidewalk from 29th Avenue or 32nd Avenue. As part of the overpass bridge construction, the Shuttlesworth Drive grade crossing was closed and a chain link fence installed on both sides of the tracks that connects to the existing public housing complex fence and spans approximately 300 feet to the east.

The site conditions to the west of the overpass bridge remain similar to the baseline conditions. However, the site conditions experienced significant changes from the baseline conditions to the east of the overpass bridge. The two neighborhood stores located adjacent to the crossing were demolished and a church located approximately 150 feet to the north of the crossing was relocated. As discussed earlier, a new chain link fence was installed after the closing of the crossing and it spans approximately 300 feet to the east of the closed crossing. Figure 5 shows the overpass bridge over the closed crossing. Images of the railroad ROW to the west and to the east of the overpass bridge are shown in Figure 6 and Figure 7, respectively.

Figure 5. Maxine Herring Parker Bridge

Figure 6. Railroad ROW to West of the Overpass Bridge

Figure 7. Railroad ROW to East of the Overpass Bridge

2.2 Data Collection

A video-based data collection system consisting of a solar panel, a camera, and a digital video recorder (along with supporting hardware contained in a utility box) was used to collect video of pedestrians trespassing on the railroad ROW along the Collegeville corridor. Three separate systems were mounted on a utility pole to monitor the study area. Figure 8 shows pictures of the data collection system installed at the Shuttlesworth Drive grade crossing during the baseline data collection period.

Figure 8. Baseline Video Data Collection Systems in Collegeville, AL

For the baseline data collection period, the three video data collection systems were all mounted on a utility pole located approximately 40 feet to the east of the crossing, as shown in Figure 9. As can be seen, the cameras were directed in three different directions: one facing west toward the Housing Authority complex (red shading), one focused directly on the crossing (green shading), and the other facing east toward the 34th street (yellow shading). The video data collection system was installed on May 16, 2014 and removed on July 3, 2014.

Figure 9. Camera Placement at Shuttlesworth Drive Grade Crossing during Baseline Period

The same video data collection systems were used to collect trespass activities after the construction of the new overpass bridge. However, they were mounted approximately 150 feet to the east of the crossing on a utility pole and adjacent to the new fence because the original utility pole used during the baseline data collection period was removed during the construction of the new bridge. Figure 10 shows the video data collection systems used during the post-construction period. As can be seen, two solar panels, two utility boxes, and a camera pointed at the closed crossing (green circle) were mounted on a utility pole, and two cameras (red circle) that monitored east and west of the new bridge were mounted on the new fence. The video data collection systems were installed on September 27, 2017 and remained operational at the time of this report.

Pedestrian usage of the overpass bridge was collected using an automated pedestrian counter. The counter was housed inside a utility box and mounted on the bridge between the two staircases. Anyone using the bridge to cross the railroad tracks was counted. The counter was installed on October 30, 2017 and remained operational through December 7, 2017. Figure 11 shows the pedestrian counter used to collect pedestrian usage of the overpass bridge.

Figure 10. Post Construction Video Data Collection Systems in Collegeville, AL

Figure 11. Pedestrian Counter

3. Data Analysis Method

The main objective of this research was to determine if there were any changes in trespass activities after the construction of the overpass bridge. It is important to note that the bridge was constructed to address the blockage of the Shuttlesworth Drive grade crossing by CSX trains during their normal operations and was not designed specifically to address trespassing issues.

To determine the effects of the overpass bridge on trespass activities in the Collegeville corridor, trespass activities were collected before and after the construction of the overpass bridge. Video data was collected for 10 hours per day from 7:00 a.m. to 5:00 p.m. for 5 weekdays before construction of the overpass bridge and then again approximately five months after its opening. Baseline data was collected between June 3 and June 23, 2014. Construction started in early 2015 and the bridge was opened on June 13, 2017. Post-installation data was collected between November 17 and November 30, 2017. In total, 100 hours of video (50 hours before and 50 hours after the construction) were analyzed to determine the effects of the overpass bridge on trespass activities.

Five weekdays for both data collection periods included one Monday, Tuesday, Wednesday, Thursday, and Friday. The researcher was not able to collect the five weekdays continuously due to precipitation and holidays that fell during the data collection periods. In addition to the trespass activities, data on pedestrian non-trespassers (pedestrians who used the grade crossing or the overpass bridge to cross tracks), trains movements, and trespassers during train movement were also collected. Table 1 shows the project phase schedule for pre-installation, post-installation, and bridge construction dates.

Table 1. Project Phase Schedule

Description	From	To	Total Days
Pre-Construction			
• Trespass Activities	6/3 – 6/5, 6/20, & 6/23/2014		5 days
• Pedestrian Non-Trespassers	6/3 – 6/5, 6/20, & 6/23/2014		5 days
• Train Movements	6/3/2014	6/16/2014	14 days
• Trespassers during Train Movements	6/3/2014	6/16/2014	14 days
Overpass Bridge Construction	Early 2015 – June 2017		
Overpass Bridge Opening Ceremony	6/13/2017		
Post-Construction			
• Trespass Activities	11/17, & 11/27 – 11/30/2017		5 days
• Pedestrian Non-Trespassers	11/17, & 11/27 – 11/30/2017		5 days
• Train Movements	11/17/2017	11/30/2017	14 days
• Trespassers during Train Movements	11/17/2017	11/30/2017	14 days

Trespassers were coded based on nine possible zones in which a trespasser could enter and exit the railroad ROW. For this study, the Collegeville rail corridor was divided into nine separate zones, each representing an area at some proximity from the crossing. Figure 12 and Figure 13 show the west and east sides of the Collegeville corridor, respectively. The area identified as Zone 5, shown in Figure 12, represents the area consisting solely of the railroad crossing at Shuttlesworth Drive. The range of numbers shown beneath the zone names refers to the distance of each zone to the edge of the crossing (Zone 5). For example, Zone 3 is the region that falls between 300 and 600 feet west of the Shuttlesworth Drive railroad crossing.

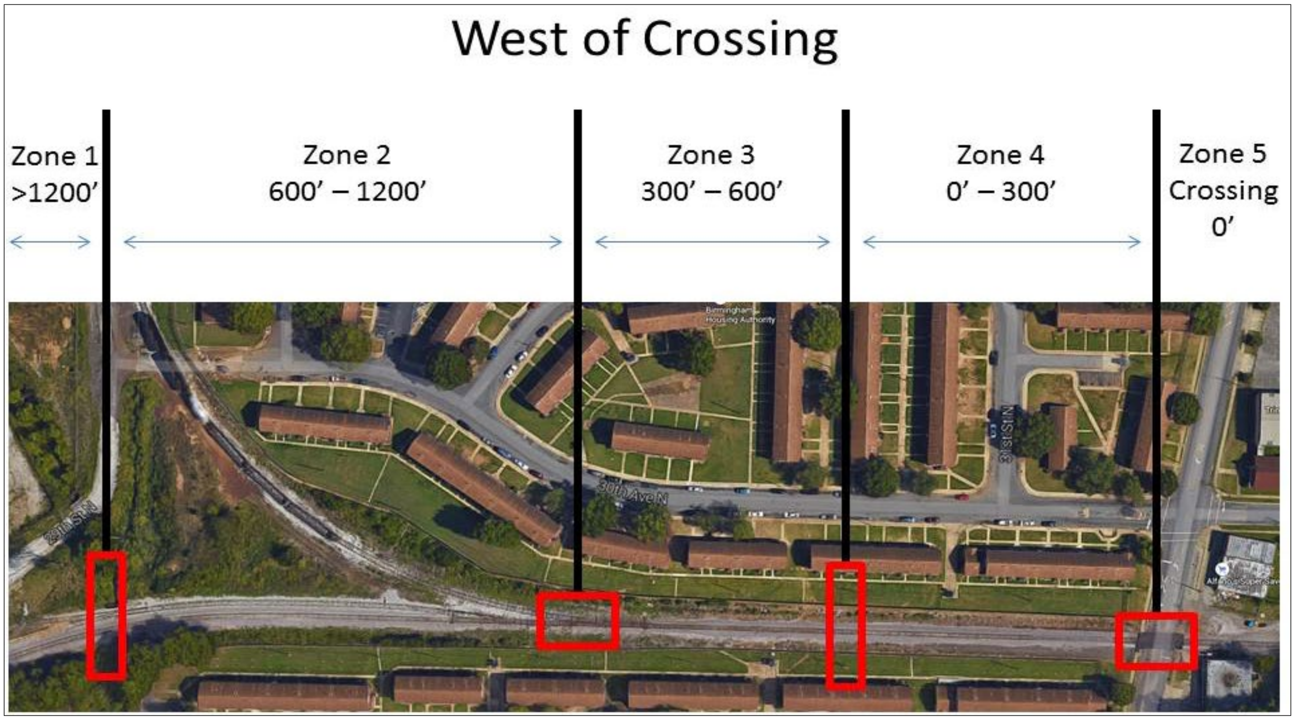

Figure 12. Zone Assignments for the Railroad ROW West of the Shuttlesworth Drive Crossing

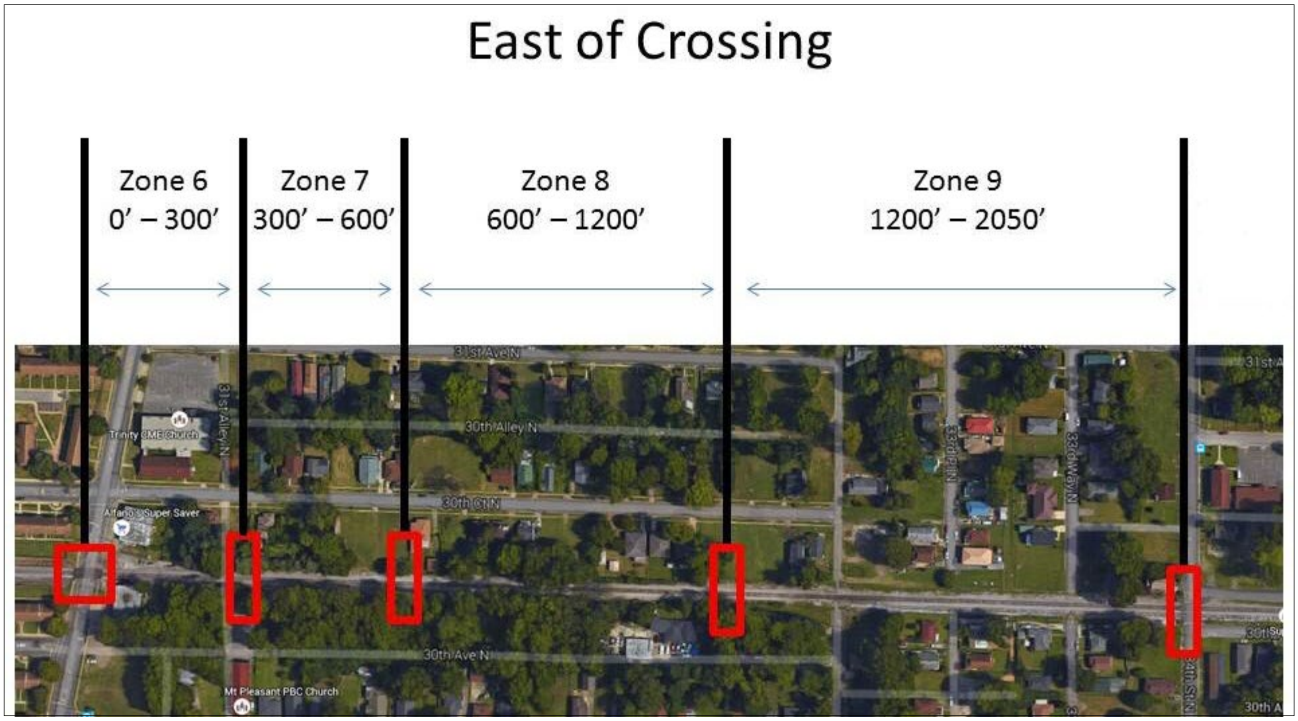

Figure 13. Zone Assignments for the Railroad ROW East of the Shuttlesworth Drive Crossing

An individual was considered a trespasser if they entered the railroad ROW regardless of whether a train was present in the corridor. At the crossing (Zone 5), an individual was considered a trespasser if they entered the crossing during an activation. Each trespasser was coded as an individual trespass event regardless of whether they trespassed as part of group or not. For each trespass event, a number of criteria, including zone entered and exited, type of activity, direction of travel, interaction with locomotives, and whether the trespasser was part of a group, was collected from the video data.

4. Results

The effects of the railroad overpass bridge on trespass activities in the Collegeville corridor was measured by comparing the frequency of pedestrians who trespassed onto the railroad ROW before and after the construction of the overpass bridge. The findings from the video analysis are discussed in the following four subsections. The first subsection discusses overall trespass activities and their movement patterns. The second subsection focuses on pedestrian usage of the crossing and overpass bridge. The third subsection covers train movements in the corridor. The fourth and final subsection focuses on trespass activities during train movements.

4.1 Trespass Activities

Trespassers were recorded based on where they entered and exited the railroad ROW using the same zone assignments shown in Figure 12 and Figure 13. Zone 1 to Zone 4 represent the area west of the crossing, Zone 5 represents the crossing, and Zone 6 to Zone 9 represent the area east of the crossing. A total of 3,089 trespassers were observed from the 100 hours of video data analyzed. Of those, 1,570 were coded prior to the construction of the overpass bridge and 1,519 were coded after the construction. Table 2 and Table 3 show the distribution of trespassers' movement as they entered and exited the railroad ROW for pre- and post-construction period, respectively. Note: Zone 7 was not covered by the video data collection system during the pre-construction period.

Table 2. Pre-Construction Trespasser Paths

		Zone Exited									
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7[1]	Zone 8	Zone 9	Total
Zone Entered	Zone 1	0 0.0%	12 0.8%	4 0.3%	1 0.1%	3 0.2%	0 0.0%	***	1 0.1%	1 0.1%	**22 1.4%**
	Zone 2	16 1.0%	98 6.2%	15 1.0%	0 0.0%	1 0.1%	0 0.0%	***	0 0.0%	0 0.0%	**130 8.3%**
	Zone 3	12 0.8%	6 0.4%	903 57.5%	4 0.3%	10 0.6%	0 0.0%	***	0 0.0%	1 0.1%	**936 59.6%**
	Zone 4	3 0.2%	1 0.1%	11 0.7%	88 5.6%	34 2.2%	0 0.0%	***	2 0.1%	0 0.0%	**139 8.9%**
	Zone 5	3 0.2%	1 0.1%	6 0.4%	21 1.3%	6 0.4%	0 0.0%	***	0 0.0%	0 0.0%	**37 2.4%**
	Zone 6	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 0.1%	***	0 0.0%	0 0.0%	**1 0.1%**
	Zone 7	***	***	***	***	***	***	***	***	***	***
	Zone 8	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	***	18 1.1%	15 1.0%	**33 2.1%**
	Zone 9	1 0.1%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	***	3 0.2%	268 17.1%	**272 17.3%**
	Total	**35 2.2%**	**118 7.5%**	**939 59.8%**	**114 7.3%**	**54 3.4%**	**1 0.1%**	***	**24 1.5%**	**285 18.2%**	**1570 100%**

Table 3. Post-Construction Trespasser Paths

		Zone Exited									
		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Total
Zone Entered	Zone 1	3 0.2%	59 3.9%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 0.1%	2 0.1%	0 0.0%	**65 4.3%**
	Zone 2	56 3.7%	843 55.5%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	3 0.2%	0 0.0%	0 0.0%	**902 59.4%**
	Zone 3	0 0.0%	17 1.1%	5 0.3%	0 0.0%	0 0.0%	0 0.0%	4 0.3%	0 0.0%	3 0.2%	**29 1.9%**
	Zone 4	0 0.0%	0 0.0%	0 0.0%	3 0.2%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	**3 0.2%**
	Zone 5	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	**0 0.0%**
	Zone 6	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	**0 0.0%**
	Zone 7	1 0.1%	0 0.0%	4 0.3%	0 0.0%	1 0.1%	1 0.1%	73 4.8%	1 0.1%	0 0.0%	**81 5.3%**
	Zone 8	1 0.1%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	1 0.1%	7 0.5%	19 1.3%	3 0.2%	**31 2.0%**
	Zone 9	2 0.1%	1 0.1%	3 0.2%	0 0.0%	0 0.0%	0 0.0%	4 0.3%	1 0.1%	397 26.1%	**408 26.9%**
	Total	**63 4.1%**	**920 60.6%**	**12 0.8%**	**3 0.2%**	**1 0.1%**	**2 0.1%**	**92 6.1%**	**23 1.5%**	**403 26.5%**	**1519 100%**

Trespass rates were compared before and after the construction of the overpass bridge to evaluate the effects of the overpass bridge on trespass activities in the Collegeville corridor. The trespass rate per 100 pedestrians entering the ROW was calculated using the following equation:

$$Trespass\ Rate = \frac{Total\ trespassers}{Total\ Pedestrains\ Entering\ the\ ROW}\ X\ 100$$

The total number of pedestrians entering the ROW was obtained by adding the total number of trespassers and pedestrian non-trespassers who legally used the at-grade crossing or the overpass bridge to cross the tracks. Subsection 4.2 discusses in detail pedestrian non-trespassers.

The trespass rate per 100 pedestrians entering the ROW increased by 72 percent, from 44.74 before to 76.91 after the closing of the Shuttlesworth Drive grade crossing and replacing it with an overpass bridge. Based on a test of proportions, the increase in trespass rate after construction was statistically significant at a 95 percent confidence level ($Z = -23.06$, p-value <0.01). Although the trespass rate increased significantly, high-risk trespassers (those trespassing during train events and trespassers physically interacting with the train) decreased significantly after the construction. This finding will be discussed in detail in subsection 4.4.

4.1.1 Entering the ROW

Figure 14 illustrates the distribution of pedestrian trespass events by location where they entered the ROW. The majority of trespassers were observed entering the ROW from the area west of the crossing for both pre- and post-construction periods (78.2 percent pre-construction and 65.8 percent post-construction). The area west of the crossing encompasses Zone 1 to Zone 4 and is where the railroad track bisects the housing complex.

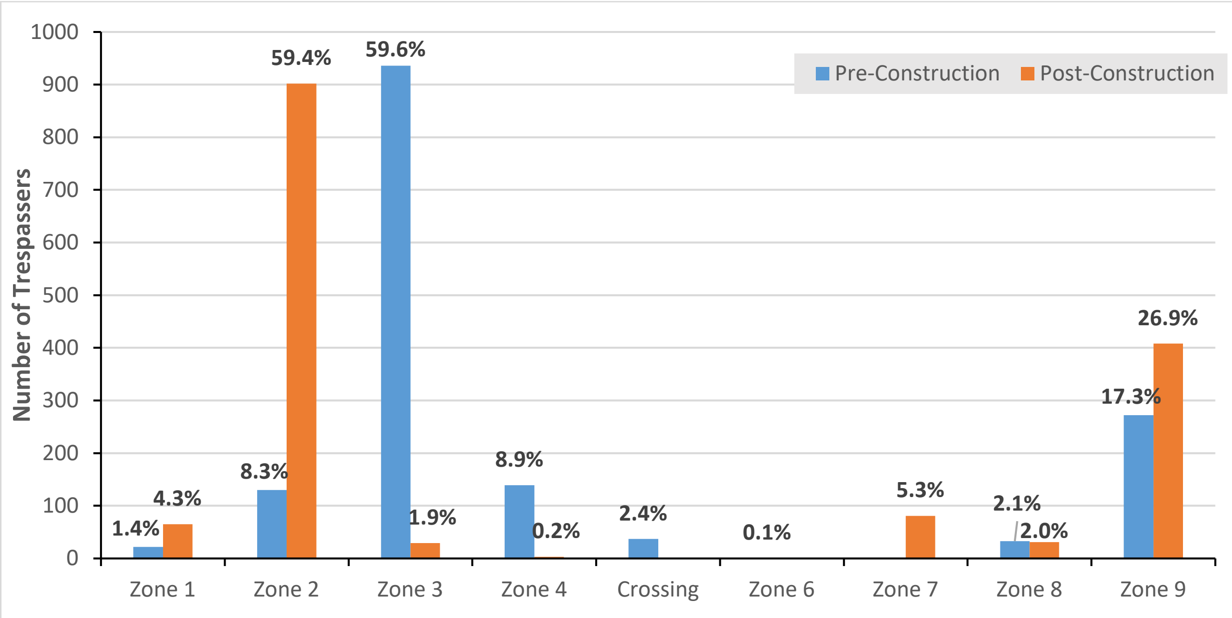

Figure 14. Where the Pedestrian Entered the Railroad ROW

Examples of pedestrians trespassing onto the ROW are shown in Figure 15 through Figure 18. In Figure 15, a trespassing pedestrian is seen exiting the ROW by climbing over the chain link fence during the post construction period. The trespasser crossed between cars of a slow-moving train in Zone 7.

Figure 15. Post-Construction Example of Pedestrian Trespassing from the Area East of the Crossing (Zone 7)

Figure 16 shows a snapshot of a pedestrian trespassing onto the railroad ROW by walking through a hole in the fence in Zone 3 south during the pre-construction period. The trespasser walked straight across the tracks and exited on the Zone 3 north side via a hole in the fence.

Figure 16. Pre-Construction Example of Pedestrian Trespassing from the Area West of the Crossing (Zone 3)

Figure 17 shows five pedestrians (3 adults and 2 toddlers) trespassing onto the railroad ROW from the south end of Zone 7 south by walking around the fence that was installed as a part of the overpass bridge construction. They walked straight across and exited the ROW by walking around the fence.

Figure 17. Post-Construction Example of Pedestrians Trespassing from the Area East of the Crossing (Zone 7)

In Figure 18, a group of pedestrians trespassed onto the railroad ROW in Zone 8 to collect scrap metal that they had thrown off a train earlier in the day. They were on railroad ROW for approximately 26 minutes collecting the scrap metal. This event occurred during the pre-construction period.

Figure 18. Pre-Construction Example of Pedestrians Trespassing from the Area East of the Crossing (Zone 9)

4.1.2 Exiting the ROW

Patterns for trespassing pedestrians exiting the ROW were similar to that of their entrance paths. The majority of trespassers were observed exiting the ROW from the area west of the crossing, for both pre- and post-construction periods (76.8 percent pre-construction and 65.7 percent post-construction). Figure 19 illustrates the distribution of pedestrians who trespassed onto the ROW by location where they exited the ROW.

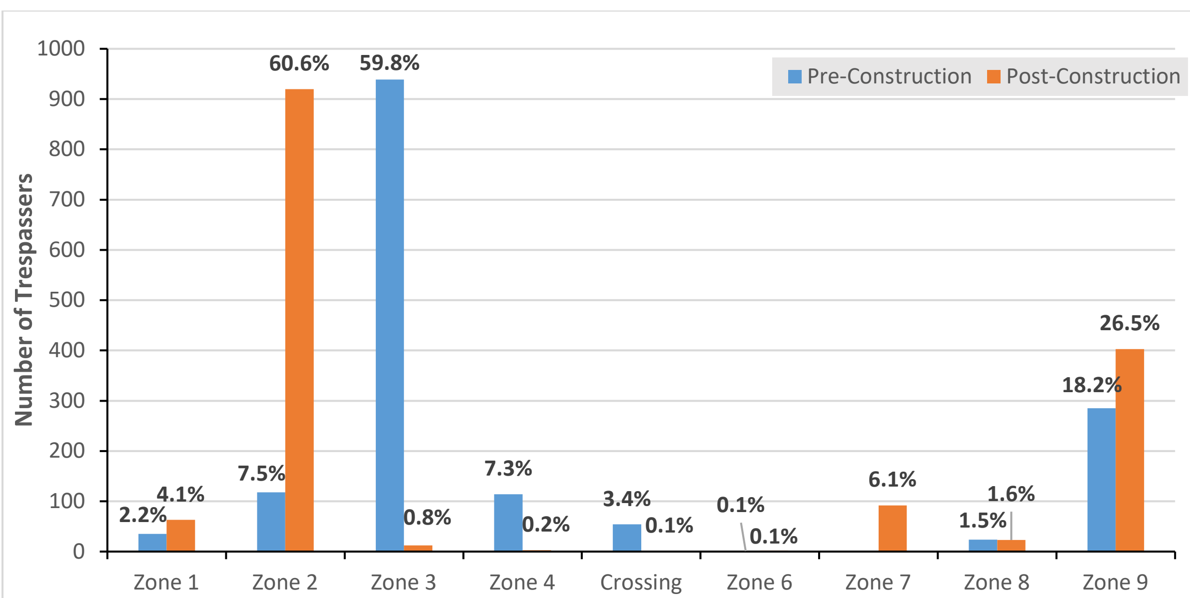

Figure 19. Where the Pedestrian Exited the Railroad ROW

4.1.3 Trespass Activities

Trespassing pedestrian activity and amount of time on the railroad ROW were recorded for each trespasser. Trespassing activity was broken up into four different categories: crossing tracks, walking along tracks, loitering on ROW, and riding a train.

- Crossing tracks: A trespasser who crossed the tracks and exited the ROW on the other side of the tracks from where they entered the railroad ROW.
- Walking along tracks: A trespasser who walked along the tracks for more than one zone and exited the ROW from the same direction as where they entered.
- Loitering on ROW: A trespasser who entered and exited the railroad ROW from the same direction and zone.
- Riding train: A trespasser who climbed on or off a moving train regardless of what zone or direction they entered or exited the ROW.

Table 4 shows the distribution of trespassers by activity and the average time on the ROW for both pre- and post-construction periods. As can be seen, a majority of trespassers were observed crossing the tracks. A chi-square test revealed a significant change in trespasser activity following construction of the overpass bridge ($\chi2 = 62.85$, df = 3, $P < 0.01$). This change was due to a 90.7 percent increase in trespassers walking along the tracks, a 70.0 percent reduction in trespassers loitering on the ROW, and an 88.5 percent reduction in trespassers riding a train.

On average, trespassers spent the most amount of time walking along the tracks, followed by loitering on ROW, riding a train, and crossing tracks. The average time on the ROW for all four types of activities declined after the construction of the overpass bridge.

Table 4. Trespasser Activity and Average Time on ROW

	Activity		Average Time on ROW	
	Pre	Post	Pre	Post
Crossing Tracks	1,390 (88.54%)	1,358 (89.40%)	0:00:35	0:00:21
Walking Along Tracks	71 (4.52%)	131 (8.62%)	0:03:40	0:03:23
Loitering on ROW	100 (6.37%)	29 (1.91%)	0:01:29	0:01:14
Riding Train	9 (0.57%)	1 (0.07%)	0:01:33	0:00:20
Total	1,570	1,519		

4.2 Pedestrian Non-Trespassers

One of the objectives of this research study was to compare pedestrian non-trespassers who used the at-grade crossing to those who used the sidewalk at the overpass bridge to cross from one side of the tracks to the other. Pedestrian non-trespasser data was collected from 7:00 a.m. to 5:00 p.m. over the same 5-day weekday period. Table 5 shows the distribution of pedestrian non-trespasser events for both pre- and post-construction periods by day of the week. As can be seen, the number of people who legally crossed the Collegeville rail corridor decreased by 76.5 percent, from 1,939 people before the construction of the overpass bridge to 456 people after the construction.

Table 5. Pedestrian Non-Trespassers by Day of Week: Before vs. After Construction

	Pre-Construction	Post-Construction
Monday	327 (16.9%)	107 (23.5%)
Tuesday	426 (22.0%)	93 (20.4%)
Wednesday	430 (22.2%)	74 (16.2%)
Thursday	418 (21.6%)	88 (19.3%)
Friday	338 (17.4%)	94 (20.6%)
Total	**1,939**	**456**

Pedestrian non-trespasser data was collected on an hourly basis. Figure 20 shows the distribution of pedestrian non-trespassers by the time of day for both pre- and post-construction periods. During the pre-construction period, pedestrians crossed the tracks via the at-grade crossing fairly consistently throughout the day. However, during the post-construction period, the use of the overpass bridge by pedestrians peaked during the morning rush hour from 9:00 a.m. to 10 a.m.

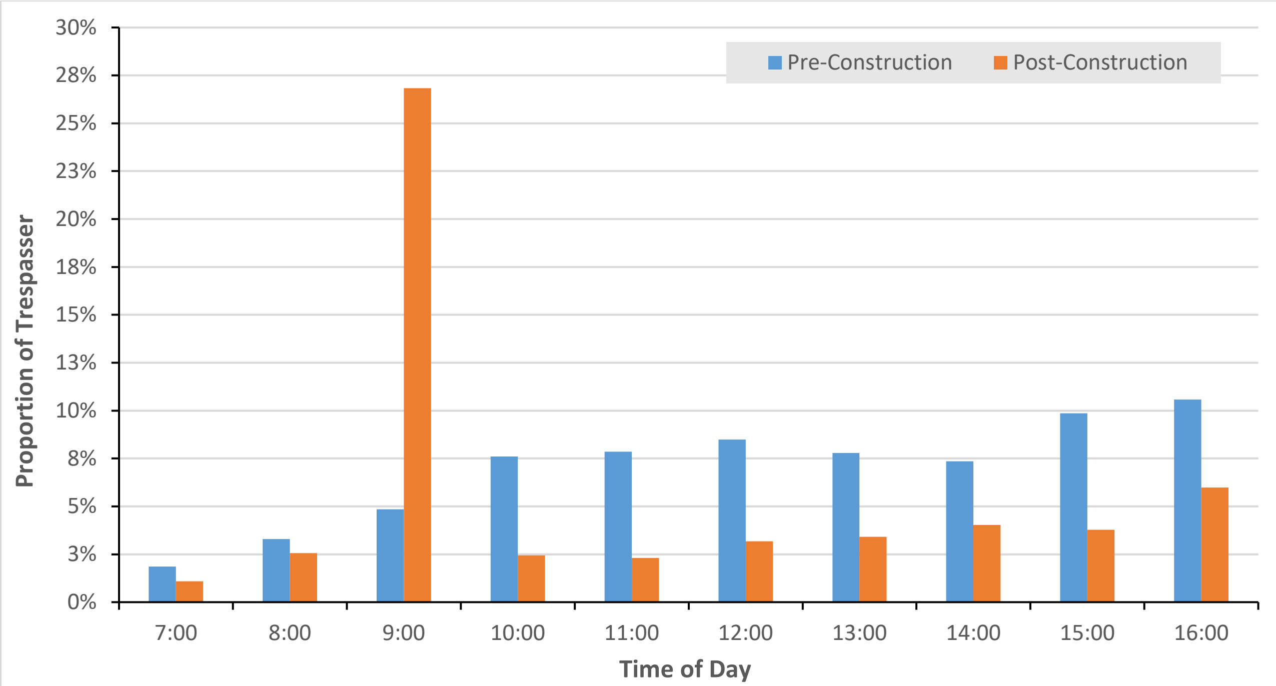

Figure 20. Proportion of Pedestrian Non-Trespassers by Time of Day (Pre-Construction n = 1,939 and Post-Construction n = 456)

4.3 Train Events

As mentioned earlier in the report, one of the main reasons for closing the Shuttlesworth Drive grade crossing and replacing it with an overpass bridge was the blockage of the crossing by CSX trains. Train events in the Collegeville corridor were collected for 14 continuous days before the construction of the bridge and then again after the construction. Table 6 shows the distribution of freight trains by day of the week. As can be seen, freight trains observed in the corridor ranged from 3 to 9 trains per day with an average of 6.2 trains per day during the pre-construction period, compared to 3 to 7 trains per day with an average of 4.8 trains per day during the post-construction period. In addition to freight trains, there were two hi-rail vehicles observed during the pre-construction period and five hi-rail vehicles observed during the post-construction period.

Table 6. Freight Train Observations by Day of Week

	Pre-Construction	Post-Construction
Monday	8 (9.2%)	8 (11.9%)
Tuesday	13 (14.9%)	12 (17.9%)
Wednesday	13 (14.9%)	13 (19.4%)
Thursday	17 (19.5%)	8 (11.9%)
Friday	15 (17.2%)	10 (14.9%)
Saturday	12 (13.8%)	6 (9.0%)
Sunday	9 (10.3%)	10 (14.9%)

	Pre-Construction	Post-Construction
Total	**87**	**67**
Average	**6.2**	**4.8**
Maximum	**9**	**7**
Minimum	**3**	**3**

Of the 87 total freight trains observed during the pre-construction period, 27 stopped and blocked the crossing, 57 travelled over the crossing without stopping and 3 were observed performing switching operations to the west of the crossing without travelling over the crossing. Of the 27 trains that stopped and blocked the crossing, 26 were travelling eastbound and one was travelling westbound. The 27 stopped trains blocked the crossing for a total of 6 hours, 38 minutes, and the blockage times ranged from as little as 1 minute, 18 seconds to as much as 52 minutes, 45 seconds. The train that blocked the crossing for over 52 minutes was an eastbound CSX that stopped on the crossing and performed a reverse operation to switch track at the interlocking to the west of the crossing. The average blockage lasted about 15 minutes.

Trespassing during train presence in the corridor presents the highest risk, as there is an elevated chance of serious injury or death. Trespassers were considered to be trespassing during train events if there was a train present anywhere in the corridor from Zone 1 to Zone 9. During the pre-construction period, 69 out of 87 (79.3 percent) freight trains operating in the corridor experienced some form of trespassing. In comparison, 28 out of 67 (41.8 percent) freight trains operating in the corridor experienced some form of trespassing during the post-construction period. That is, there was a 47.3 percent reduction in trespassing during train movements in the corridor after the construction of the overpass bridge.

4.4 Trespassing during Train Events

A total of 687 pedestrians were observed trespassing during 154 train movements in the corridor during the overall study. A total of 613 pedestrians were observed trespassing during 87 train events prior to the construction of the overpass bridge and 74 pedestrians were observed trespassing during 67 train events after the construction. Table 7 shows the distribution of the 687 trespassers during train movements by where they entered and exited the railroad ROW.

Table 7. Where the Pedestrian Entered and Exited the ROW during Train Events

	Entering the ROW		Exiting the ROW	
	Pre-Construction	Post-Construction	Pre-Construction	Post-Construction
Zone 1	9 (1.5%)	0 (0%)	14 (2.3%)	5 (6.8%)
Zone 2	15 (2.4%)	19 (25.7%)	10 (1.6%)	23 (31.1%)
Zone 3	210 (34.3%)	22 (29.7%)	207 (33.8%)	19 (25.7%)
Zone 4	31 (5.1%)	0 (0%)	18 (2.9%)	0 (0%)
Zone 5	216 (35.2%)	0 (0%)	227 (37.0%)	0 (0%)
Zone 6	8 (1.3%)	0 (0%)	13 (2.1%)	0 (0%)
Zone 7	0 (0%)	4 (5.4%)	0 (0%)	3 (4.1%)
Zone 8	0 (0%)	6 (8.1%)	0 (0%)	7 (4.1%)
Zone 9	124 (20.2%)	23 (8.1%)	124 (20.2%)	17 (9.5%)
Total	**613**	**74**	**613**	**74**

The rate of trespassers per train event was reduced by 84.3 percent, from 7.05 (613/87) trespassers per train event before construction of the overpass bridge to 1.10 (74/67) trespassers per train event after the construction. The biggest reduction was the frequency of pedestrians entering and exiting the railroad ROW from Zone 5 (crossing) after the construction.

Trespassers during train events were noted if they physically came in contact with a train. Trespassers were observed climbing onto passing or stopped trains for a variety of reasons (stealing scrap, riding trains, crossing between rail cars, etc.). Of the 613 total trespassers during the pre-construction period, 141 trespassers (23 percent) came in physical contact with a train. In comparison, 8 out of 74 (10.8 percent) trespassers came in physical contact with a train during the post-construction period. Out of the 141 trespassers involved in physical contact with a train during the pre-construction period, 91 were observed crossing the tracks by climbing onto a train and 50 were observed riding a train. About 84 percent of the 50 trespassers riding the train were involved in stealing scrap metal from rail cars. All of the trespassers involved in physical contact with a train during the post-construction period were observed crossing the tracks by climbing onto a train (no trespassers were observed stealing a scrap metal during the post-construction period).

The rate of trespassers who came in physical contact with a train per train event was reduced by 92.6 percent, from 1.62 (141/87) trespassers per train event before construction of the overpass bridge to 0.12 (8/67) trespassers per train event after the construction. This indicates that though the overpass bridge may not have been effective in reducing overall trespass activity, it was effective at reducing the most risky trespassing activity (trespassing during train events and trespassers physically interacting with a train).

Examples of trespassing pedestrians in physical interactions with a train are shown in Figure 21 and Figure 22. In Figure 21, six trespassers climbed onto a moving train from Zone 9 to steal scrap metal (threw scrap metal off the train and later came back to pick it up), and got off the train in Zone 9, approximately 2 minutes later. This event occurred during the pre-construction period.

Figure 21. Pre-Construction Example of Trespassers getting off a Moving Train in Zone 9

In Figure 22, a trespasser can be seen climbing onto a stopped train during the post-construction period. The trespasser entered the railroad ROW from Zone 7 by walking around the newly installed fence and crossed the tracks by climbing over a stopped train.

Figure 22. Post-Construction Example of a Trespasser Climbing On Board a Stopped Train in Zone 7

4.5 Summary of Findings

To evaluate the effects of closing the Shuttlesworth Drive at-grade crossing and replacing it with a railroad overpass bridge on trespass activity in the Collegeville corridor, answers to the following questions were sought:

- Does closing a highway-rail at-grade crossing and replacing it with an overpass bridge reduce the overall number of trespass activities along the rail corridor?

  Findings: Researchers observed a 72 percent increase in trespass rate, from 44.74 to 76.91 per 100 pedestrians, entering the ROW after the construction of the overpass bridge. Trespass movements also shifted after the construction of the overpass bridge. More trespassers were observed entering and exiting the railroad ROW further away from the crossing after construction.

- Does the overpass bridge significantly reduce higher-risk trespass activity (trespassing during train events and trespassers physically interacting with a train)?

  Findings: A significant reduction in trespassing during train events was observed after the construction of the overpass bridge. The rate of trespassers per train event was reduced by 84.3 percent, from 7.05 to 1.10 trespassers per train event, after construction.

  A risker subset of this group (trespassers physically interacting with a train) experienced an even more significant reduction. The number of trespassers who came in physical contact with a train was reduced by 92.6 percent, from 1.62 to 0.12 trespassers per train, event after construction.

- Did the number of pedestrians who legally crossed the tracks decline after the construction of the overpass bridge?

  Findings: Yes. Prior to the construction of the overpass bridge, 55.3 percent of the 3,509 pedestrians observed entering the Collegeville corridor ROW did so legally via the Shuttlesworth Drive at-grade crossing. However, only 23.1 percent of the 1,975 pedestrians observed entering the ROW did so via the overpass bridge after its construction.

5. Conclusions and Discussion

The objective of this research was to evaluate the effects on trespass activities of closing an at-grade crossing and replacing it with an overpass bridge along the rail corridor. The overpass bridge was designed and constructed to address the blockage of the at-grade crossing by CSX trains and not ostensibly to address trespass issues.

After closing the at-grade crossing and replacing it with an overpass bridge, more pedestrians entered the railroad ROW by trespassing rather than using the overpass bridge. The trespass rate increased by 72 percent, from 44.74 to 76.91 per 100 pedestrians entering the ROW, after the construction of the overpass bridge. Additionally, trespasser movements also changed after the construction. More trespassers entered and exited the railroad ROW further away from the crossing after construction.

Despite the negative effects on overall trespass activities, the construction of the overpass bridge had significant positive effects on high-risk trespass activities (trespassing during train events and trespassers physically interacting with a train). Trespassing during train events decreased by 84.3 percent, from 7.05 to 1.10 trespassers per train event, after construction. A risker subset of this group (trespassers physically interacting with a train) experienced an even more significant reduction. The number of trespassers who came in physical contact with a train was reduced by 92.6 percent, from 1.62 to 0.12 trespassers per train event, after construction.

Lastly, the frequency of pedestrians legally entering the Collegeville corridor railroad ROW declined after the construction of the overpass bridge. Prior to construction, 55.3 percent of the 3,509 pedestrian observed entering the ROW did so legally via the at-grade crossing. In comparison, only 23.1 percent of the 1,975 pedestrian observed after the construction used the overpass bridge to cross the tracks.

6. Potential Limitations

The use of the Collegeville corridor for this study was primarily based on its scheduled improvement. The overpass bridge was designed and constructed to address the blockage of the at-grade crossing by CSX trains rather than to address trespassing issues. The location of the bridge was selected to maintain continuity with an existing roadway and did not necessarily correspond to the area with the greatest observable foot traffic or trespass issues.

As discussed earlier in the report, the pre-construction data was collected in June 2014 and the post-construction data was collected in November 2017. During the approximately 3.5 years between the two data collection periods, the population of the Collegeville neighborhood might have changed. Also, the difference in time of year and weather conditions between the two data collection periods might have affected pedestrian decision-making about crossing the tracks.

Three pedestrian generators (two corner shops adjacent to the crossing and a church approximately 300 feet north of the crossing) were closed as part of the overpass bridge construction. This might have reduced pedestrian traffic near the overpass bridge during the post-construction period.

Another limiting factor may have been the difference in data collection methods used for collecting pedestrian usage. Pedestrian usage of the at-grade crossing was manually coded from video data, whereas pedestrian usage of the overpass bridge was collected using an automated pedestrian counter. There may have been a discrepancy in accuracy between the two methods.

It is also important to note that during the approximately 3.5 years between the data collection periods, the physical characteristics of the Collegeville corridor underwent significant changes. As a part of the overpass bridge project, the at-grade crossing was closed and a chain link fence spanning approximately 300 feet was installed to eliminate access to the closed crossing. Furthermore, access to the railroad ROW, especially to the west of the crossing, was not constant throughout the data collection periods. The locations of gaps and holes in the fence along the housing complex changed over time, as repairs were made and new holes were created.

Lastly, the site chosen for this study was unique in many ways. The housing complex to the west of the crossing is not only bisected but also encircled by railroad tracks. Due to the high concentration of railroad tracks in the area, trespassing is a common occurrence. Further complicating the issue was the stopping of CSX trains in the Collegeville corridor, blocking the at-grade crossing and preventing its use. For this reason, Collegeville also experienced a substantial level of high-risk trespassing involving active locomotives operating in the same space as trespassers, and, in some cases, trespassers coming in physical contact with trains. These unique characteristics make it difficult to translate the results of this study to other locations.

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Abbreviations and Acronyms

Abbreviation or Acronym	Name
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AL	Alabama
AL DOT	Alabama Department of Transportation
FRA	Federal Railroad Administration
RD&T	Railroad Development and Technology
ROW	Right-of-Way
DOT	U.S. Department of Transportation
Volpe Center	John A. Volpe National Transportation Systems