Understanding Commercial Truck Traffic Through Downtown Bozeman

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GLOSSARY OF ABBREVIATIONS

AADT	Average Annual Daily Traffic
GPS	Global Positioning System
MAP-21	Moving Ahead for Progress in the 21st Century Act
MDT	Montana Department of Transportation
MPH	Miles Per Hour
MT	Montana
ND	North Dakota
NHS	National Highway System
ODOT	Ohio Department of Transportation
SR	State Road
US	United States
UT	Utah
WTI	Western Transportation Institute

1. INTRODUCTION

1.1. Background

Located in southwestern Montana, Bozeman has a population of just under 40,000 (1). Downtown Bozeman is a thriving central business district that is home to over 200 stores, restaurants, and offices with over 3,000 employees. The downtown area is a community gathering place that features 50 public events each year ranging from music concerts to parades. Downtown Bozeman was designated as a historic district on the National Register of Historic Places, and contains over 794 buildings dating between the 1880's and 1930's (2).

The primary objective of this project is to gain a better understanding of the commercial truck use of the primary arterial through downtown Bozeman (Main Street/US 191). City officials and local business owners have a perception that Main Street is heavily used by commercial trucks. This project will identify the magnitude of use of Main Street by commercial trucks, as well as investigate other potential routes for these trucks.

Main Street, and two other roadways in Bozeman (7th and 19th Street), are all part of the National Highway System (NHS). All three are designated as "MAP-21 NHS Principal Arterials" (3). However, this designation is different than the National Network designation. The National Network is defined as "'the Interstate System and those portions of the Federal-aid Primary System…serving to link principal cities and densely developed portions of the States…[on] high volume route[s] utilized extensively by large vehicles for interstate commerce…[which do] not have any unusual characteristics causing current or anticipated safety problems (4).'"

According to the City of Bozeman Municipal Code, a truck route is "a way over certain streets, as designated by ordinance, over and along which trucks coming into, going out of and traveling within the city must operate" (5). The City of Bozeman has never designated any truck routes (6).

A main street, as seen by travelers, is an "abrupt change in their continuous route along a state highway" (6). This is indeed the case with Main Street in downtown Bozeman.

Three planning documents, starting as early as 1995, have identified through traffic, particularly trucks, as a concern for downtown Bozeman. Excerpts from each are presented below.

City of Bozeman Downtown Urban Renewal Plan (November 1995) (7)

Guiding Principles and Implementation Actions

> "Traffic movement and access shall be designed with the emphasis on the Downtown as a destination rather than improving the flow of through traffic" [page 5]
>
> "The health of Downtown depends on ease of access to the Downtown for whatever reason. This includes improving traffic flow which is compatible with Downtown as a destination and reducing through traffic, especially trucks." [page 7]
>
> Principle 1: Strengthen Downtown's Economic Viability
>
> > Implementation Actions:
> >
> > 8. "Take control of Main Street: eliminate through truck traffic and restore as a pedestrian friendly downtown "Main Street." [page 10]

Principle 3: Improve Safety, Security and Health of the District

Implementation Actions:

1. Improve the flow of traffic, emphasizing Downtown as a destination, and improve pedestrian access and safety, especially at intersections.

10. "Take control of Main Street: eliminate through truck traffic and restore as a pedestrian friendly downtown "Main Street." [page 11]

"Principle 4: Downtown's Accessibility Shall Be Improved

Implementation Actions:

4. Improve the flow of traffic, emphasizing Downtown as a destination, and improve pedestrian access and safety, especially at intersections.

8. "Take control of Main Street: eliminate through truck traffic and restore as a pedestrian friendly downtown "Main Street." [page 12]

Downtown Bozeman Improvement Plan (June 1998) (7)

Traffic Considerations

"Access issues include: large semi trucks, many carrying goods between the Midwest and West Coast, often shortcut I-90 and I-15 via Main Street." [page 20]

Traffic and Circulation Improvements

"The basic Main Street issue is the conflict between the local community's desire to use the street as a community asset and the State Department of Transportation's regulations for maintaining a Federal Aid Highway System truck route." [page 36]

Business and Property Owner Survey

"What is the first thing you would propose Downtown do to improve itself?

Most popular answer: "Take control of Main Street and divert truck traffic" [appendix]

"How do you feel about the state/federal highway on Main Street?"

Most popular answer: "It is detrimental to Downtown." [appendix]

Downtown Bozeman Improvement Plan (December 2009) (8)

Issues: Access and Circulation

"Main Street's truck route designation is at odds with the other functions and character of downtown's signature pedestrian street." [page 10]

Strategies: Tame the Traffic

To further reduce noise, congestion, and pedestrian and bicyclist discomfort, large through-truck traffic should be diverted around downtown on I-90. Although

Main Street is currently on the National Truck Route Network, there is a procedure through the Federal Highway Administration to alter the system [page 26].

1.2. Project Overview

The objectives of this project are to better inform the impacts of commercial trucks in the downtown Bozeman core (Figure 1). The downtown Bozeman core can be defined by the Downtown Business Improvement District (blue line in Figure 1), the Downtown Tax Improvement District (brown line in Figure 1), or the B-3 Zoning District (yellow line in Figure 1).

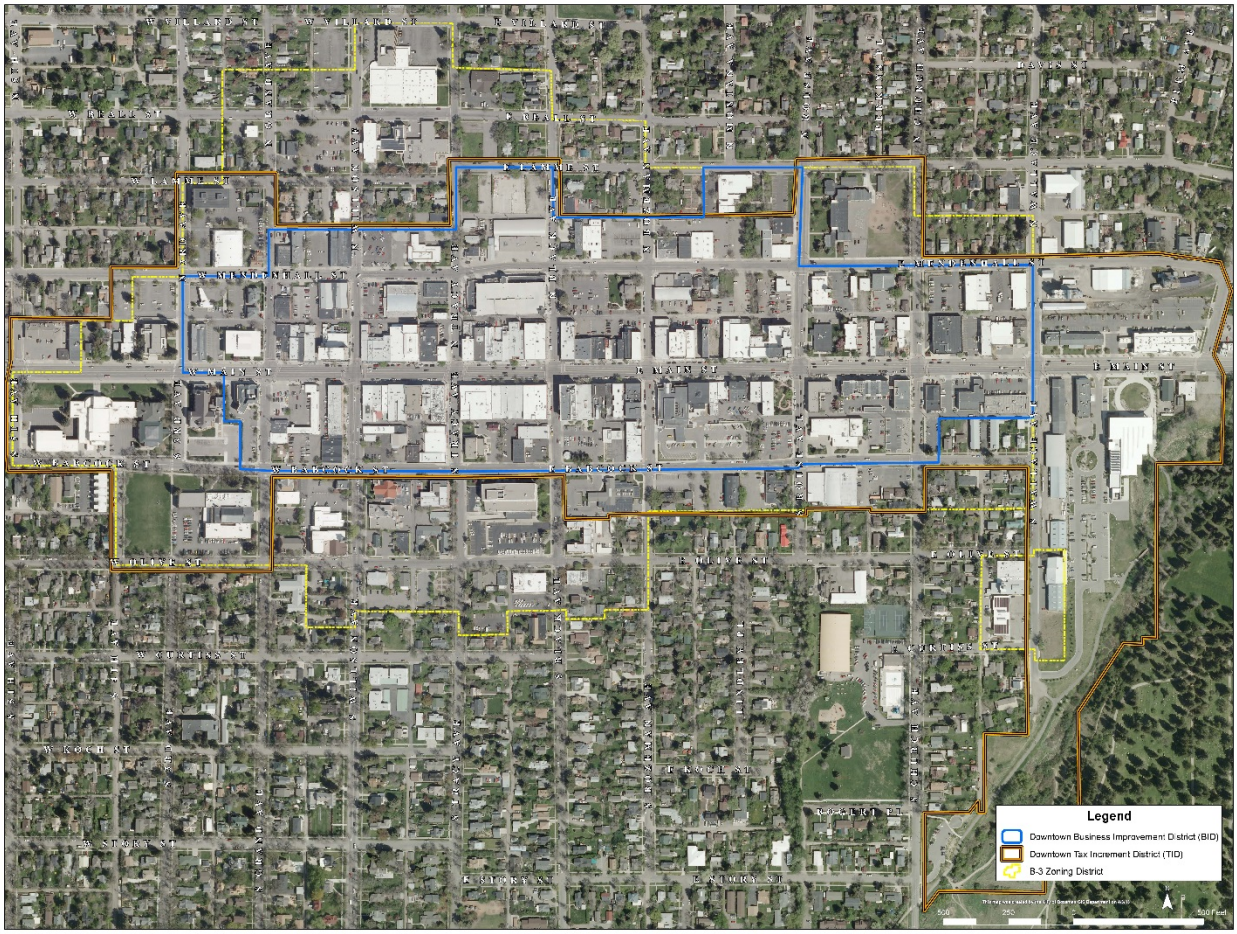

Figure 1: Downtown Bozeman Core (9)

Commercial trucks are viewed as negatively impacting the safety and pleasantness of the Main Street area, which is seeing a resurgence in commerce. Anecdotal evidence suggests that some potential users may be dissuaded from patronizing downtown due to concerns for safety. Furthermore, because there is a conscious effort to make the downtown more pedestrian-friendly (including bicycles), the sheer size of commercial trucks can be intimidating (Figure 2). Additional photos conveying the difference in size can be found in the Appendix.

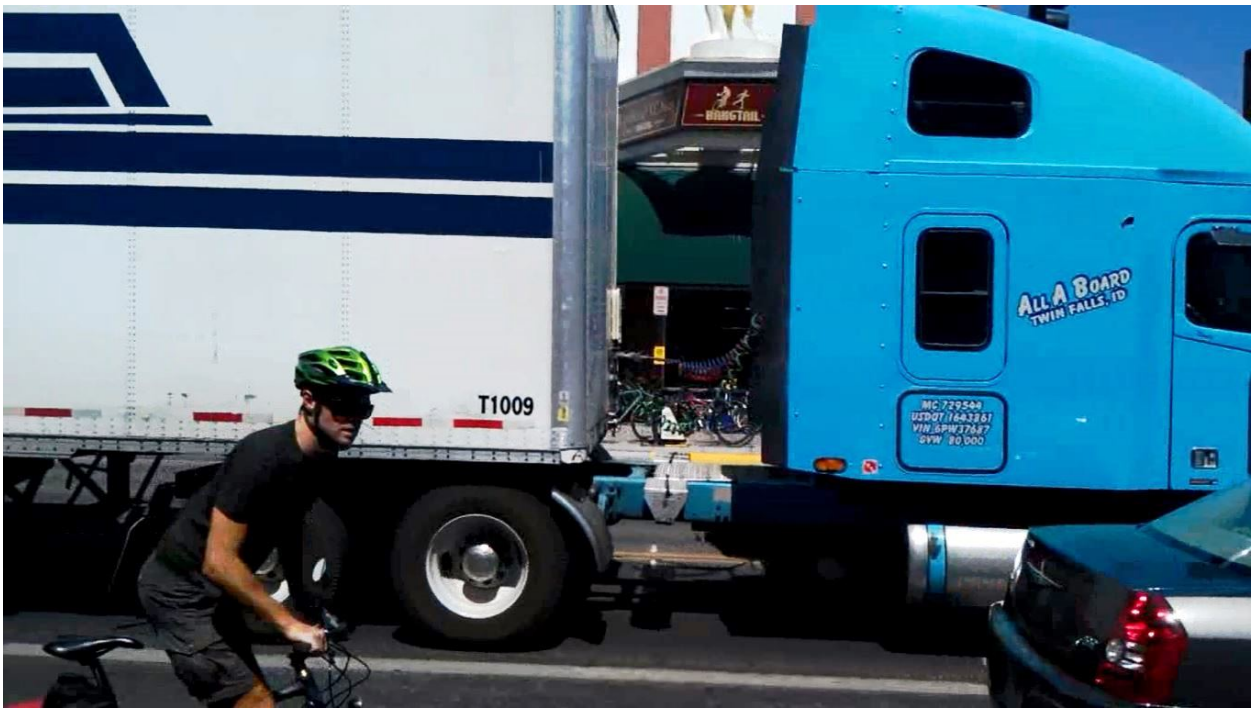

Figure 2: Main Street, Size Difference of Bicyclist and Commercial Truck
(Photo Courtesy of Downtown Bozeman Partnership)

Large trucks pose several problems for the bicycle/pedestrian oriented district of downtown Bozeman. For bicyclists, large trucks have many blind spots, which leads to safety concerns. Large trucks are loud, and that combined with their exhaust can be a nuisance to people walking or dining in the downtown area (Figure 3). The pedestrian environment of downtown Bozeman would benefit from an alternative truck route.

The remainder of the project report is organized as follows:

- Literature Review
- Methodology
- Data Collection
- Results
- Conclusion

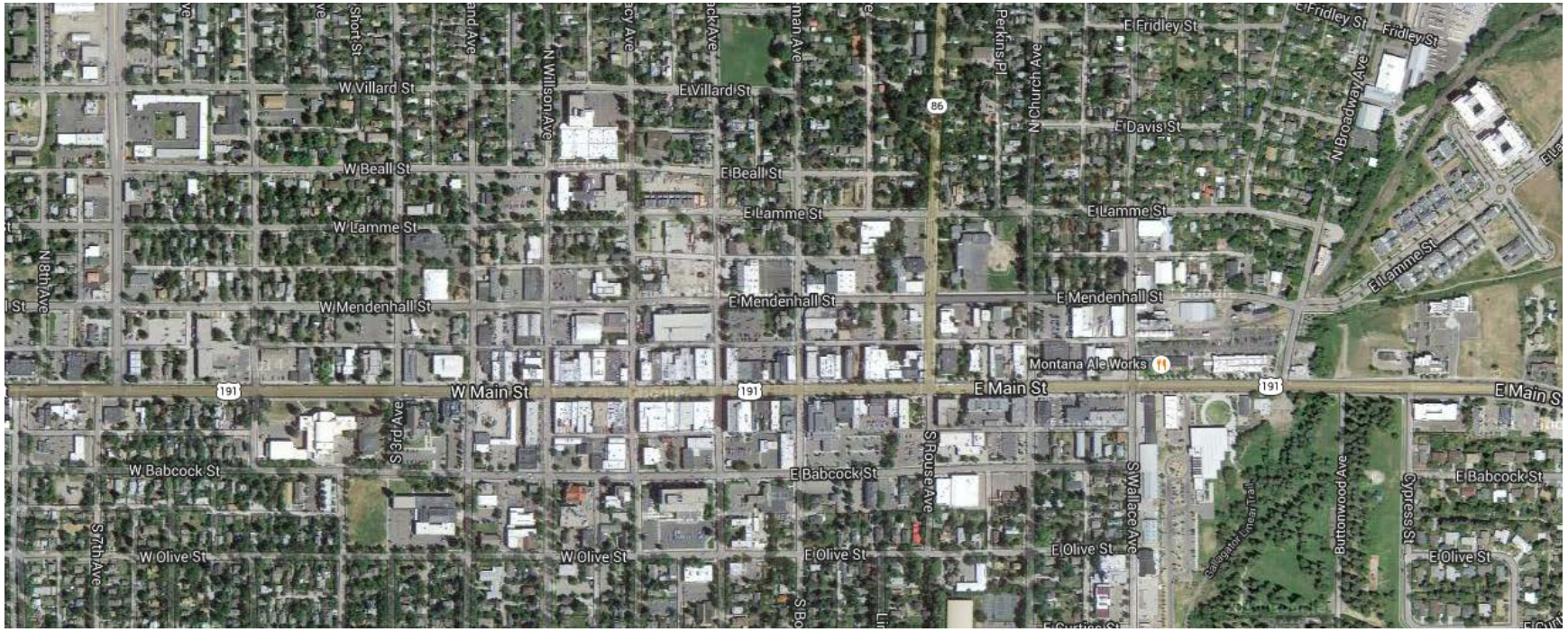

Figure 3: Main Street (US 191): Downtown Bozeman (10)

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2. LITERATURE REVIEW

The literature review is divided into five sections. The first section includes literature or sources that discuss other towns or cities that have experience with trying to re-route commercial truck traffic. These sources feature cities that appear to have similar configurations or concerns to Bozeman, Montana. The second section discusses experiences with implementing bypasses to re-route truck traffic. The third section identifies other roadways/areas, not focused on downtowns, where truck traffic was restricted. The information from these locations is featured, as it is plausible that some of the ideas employed could be considered for Bozeman, Montana. The fourth section discusses how trucks choose their routes. The fifth and final section presents some literature that addresses pedestrians in relationship to truck traffic.

2.1. Other Town Experiences with Commercial Trucks

In 2007, borough officials in Blairsville, PA discussed opportunities to attract more touring pedestrians and bicyclists. One concern discussed by the officials involved the interplay between heavy trucks and pedestrians in their downtown (11). Council members urged borough police to step up the enforcement of trucks passing through town that are violating regulations. The borough manager was working with the Pennsylvania Department of Transportation to try to restrict certain commercial trucks out of concern for damaging newly installed sidewalks and curbs.

In 2007, Street Smarts (12) investigated the feasibility of alternative routes for commercial truck traffic in the Gwinnett Village Community Improvement District, located in the Atlanta, Georgia area. They evaluated the magnitude of truck traffic and directional flows using a combination of traffic counts and turning movement counts. They also conducted very short driver and business surveys/interviews (three questions each). They found that Jimmy Carter Boulevard and Buford Highway had peak period (8 AM to 10 AM and 2 PM to 6 PM) truck percentages of 4-5 percent, and off-peak period truck percentages of 8-10 percent. Comparing these observed truck percentages to other nearby roadways, they concluded that the presence of truck traffic is an issue of perception as compared to reality. However, they recommended several potential remedies to draw truck traffic to other routes including: 1) a signage program, 2) roadway improvements (i.e. repaving roads, improving railroad crossings, and modifying signal timings) on the alternative routes, 3) providing maps with alternative routes to drivers.

A 2007 Saratoga Springs Downtown Transportation Plan (13) indicated that New York State law requires trucks to travel unrestricted along state routes. Furthermore, they implied that previous studies had been performed to identify alternative routes, which were unsuccessful. They indicated that while the trucks were seen as problematic and that the volume of trucks traveling through the downtown was large, the problem was too complex to address in the study.

In 2011, the Millsboro Downtown Partnership in Delaware began pressing legislators to address traffic and safety issues in the town (14). In particular, they wanted to remove truck traffic that went through downtown, including trucks carrying chickens. The partnership collected letters from residents, business owners and surrounding community members to present to the Delaware legislators to get them to acknowledge that there was a problem. The Partnership indicated that they were not looking for a bypass to be built, rather they were interested in identifying an alternative truck route.

In 2012, Columbiana, Alabama discussed the possibility of re-routing semi-truck traffic from their downtown (15). The city was interested in re-directing semi-truck traffic due to concerns over congestion and damage to sidewalks and curbs. However, leadership within the city reconsidered their proposal after they were informed that the traffic studies and analyses of roadway integrity would be costly.

In 2014, Perry, Georgia began investigating other options for trucks running through the downtown (16). It is unclear if the roadway running through downtown is part of the National Highway System. A concern identified in the article sounds similar to those expressed by the City of Bozeman, "We have shoppers coming down and people who enjoy the restaurants; and it can be a bit distracting with the sound of the heavy trucks coming through." The article indicated that the City Council and Georgia Department of Transportation would have to approve of alternative routes for the trucks, and that the local police department would be responsible to enforce those trucks use the new route.

A 2014 article related to truck traffic through Ithaca, New York, identified safety problems with trucks traveling through the municipality (17). However, this situation seems to be a different case than most because there appears to be repeated accidents with brake failures as a result of the hilly nature of the municipality. The author of the opinion piece recommended two alternative routes. Furthermore, he also indicated that it is likely that the truck that caused the most recent accident which spurred the opinion piece likely relied upon his GPS unit to identify the shortest route.

An undated article from Morgantown, West Virginia discussed resident concerns with heavy vehicles that run down their main streets (18). Primary concerns with the heavy vehicles include noise, emissions and the safety of other roadway users including pedestrians. A constitutional law professor at West Virginia University who was asked to look into what the city could do with regard to the heavy vehicles using the main streets found that while West Virginia Department of Transportation is required to maintain the facilities, the city can regulate traffic on them.

2.2. Bypasses to Relieve Downtowns of Commercial Trucks

In several cases, municipalities have gone through the process to identify and construct a bypass and subsequently remove the street running through the downtown from the National Highway System.

Oconomowoc, Wisconsin, is an example of this option. It took 46 years from when the bypass was originally proposed for the $32 million construction project to be completed in 2007 (19). Motivations behind the project include congestion in the downtown, concerns about the truck traffic and pedestrian safety, and crashes along the downtown corridor. After the completion of the bypass, the route through downtown was removed from designation as a National Highway System roadway. However, results from a study performed indicated that congestion was not reduced as significantly as expected. The city had hoped that reducing the traffic, particularly truck traffic, would result in a greater amount of foot traffic shopping and dining in the downtown area.

In 2012, Decatur, Illinois successfully removed truck traffic from several streets that run through downtown (20). Several of these streets had been designated as part of US 51. Now, US 51 is located along a bypass on the west side of the city; the Illinois Department of Transportation

helped to post signs identifying the desired route around the downtown. The city was interested in removing truck traffic from the downtown roadways to enable sidewalk dining and encourage pedestrian traffic. The article reported that trucking is an integral part of the Decatur economy.

The Borough of Columbia, in Pennsylvania sought to reduce the number of vehicles traveling through downtown by constructing a bypass (21). A bid was accepted for the project in 2014 at $11.9 million. They expected benefits including revitalizing the historic downtown, reducing the vibrations on historic structures, reducing accidents between trucks and other vehicles and pedestrians, and removing air and noise pollution from the downtown.

2.3. Examples of Restricting Commercial Trucks on Non-Downtown Routes

An article from 2010 discusses detouring commercial trucks from an interstate running through downtown Cleveland to a bypass interstate (22). The detours were enacted while bridge repairs were made along the downtown route. Restrictions to keep heavy trucks from using the eastbound lanes of US Interstate 90 East have been lifted, but truckers continue to use the detour. The Ohio DOT (ODOT) retained the "No Trucks 90 East" signs, even after the span was deemed safe for heavy trucks. ODOT did not want to advertise that the bridge was open to trucks because they found that the traffic of the downtown route flowed smoother.

Commercial truck traffic restrictions have been lifted after a two-year highway construction project on US Highway 191 going to Big Sky, Montana, according to a 2011 article (23). Commercial truckers reportedly accounted for approximately 9.42% of Highway 191 traffic, which was roughly the same percentage as existed before the 2008-2010 construction restriction. During the course of the construction project, trucks were being rerouted to Highway 287 through Ennis. Commercial trucks were temporarily prohibited from this stretch of highway during the construction. However, a Montana Department of Transportation representative indicated that for all federal aid highways, like Highway 191, it is a violation of both state and federal laws to indefinitely restrict truck traffic.

In 2013, efforts to remedy an ongoing problem with trucks traveling through, and sometimes getting lost in, residential areas of West Rutland, Vermont have been made (24). Town officials, law enforcement, trucking companies, and local businesses have been focusing on enforcement of weight limits on roads and bridges, hoping it will deter truck traffic. Comments have been made that truckers are using the shortest or fastest route and that they have been following global positioning systems (GPS) that do not take them through the right place. GPS does not seem to differentiate between civilian routes and trucking routes. Signs have been posted to guide the trucks on non-local routes; however, the article reports that trucks drivers overlook these signs, following instead the GPS instructions.

2.4. Truck Route Selection

A 2002 study by Pivo et al. (25) investigated commercial truck driver perspectives. While the focus of the study was on urban goods delivery, it is unique because it provides insight into the challenges that commercial truck drivers face. For the study, four structured interviews of four to six truck drivers from the Seattle, Washington area. were conducted. The authors grouped the comments into the following eight categories: 1) curb space issues, 2) alleys, 3) loading docks, 4) congestion, 5) co-existing with other modes, 6) zoning and design, 7) technology, and 8) changes in the industry. Some of the findings related to intermodal interactions and periods of use are

interesting for the present study. First, the authors found that curb space was utilized in the fashion shown in Figure 4, which was from a 1985 study. For pedestrians, truck drivers understood that "people make the urban center vibrant and interesting." The interviewees did not see wider sidewalks at street crossings as competition. Additionally, they proposed "all-way pedestrian-only" traffic signal phases that would be offset by an all-vehicle phase. The drivers indicated their desire to physically separate motorized vehicles from pedestrians. Regarding bicyclists, drivers were primarily concerned with "erratic and unpredictable behavior" of this user group.

A. San Francisco Curb Space Use Observed by Habib (1985)

Figure 4: Freight Utilization (25)

In 2005, Knorring et al. (26) developed a logistic regression model to predict the percentage of trucks that would use a bypass route as a function of the perceived speed on the downtown route. The downtown and bypass routes considered were interstates. They used the revealed preference method. Based on the results, they concluded that truck drivers are first and foremost time minimizers. They also concluded that truck drivers make route decisions based on past experience on the route, time of day, current traffic conditions, and knowledge of the route.

In 2008, Pan and Khattak performed a study to gain a better understanding of what may motivate commercial trucks to divert from their routes (27). Commercial trucks have a lower tendency to divert as compared with the average motorist. They investigated how providing dynamic traveler information to commercial and non-commercial motorists would impact whether they would divert from their route when 1) travelers can observe the incident, 2) commercial truck percentages increase, 3) commercial and non-commercial drivers divert at equal rates, and 4) the value of time for commercial drivers is greater. The authors used a behavioral route diversion model to simulate the results. They found one of the most significant factors to be whether or not drivers were able to observe the congestion. This factor cancels out the other factors. They also found significant benefits can be achieved if commercial drivers divert from the route.

In 2013, Camargo and Tok (28) investigated the use of GPS tracking device data to identify commercial vehicle routes using data from California. Historically, routes have been determined through a combination of surveys and traffic counts. They concluded that the models they developed can be applied to regional freight models.

2.5. Pedestrians

In 2003, Gårder (29) reviewed pedestrian crash data in Maine from 1994-1998 to understand how travel speeds and location characteristics affect the crash numbers. In addition to investigating the behavioral and crash statistics, he employed European pedestrian crash prediction models to compare the expected number of crashes to the observed number of crashes. Gårder found that high speeds and wide roads are correlated with a greater number of crashes. Additionally, he recommended that preventative measures be more directed to arterials and major collectors as compared to central business districts. One interesting statement that Gårder made pertaining to this study was, "long-distance travelers and long-haul freight operators will get frustrated if they frequently have to interact with slow-moving pedestrians…our National Highway System (NHS) should have alternative routes bypassing towns and villages."

3. METHODOLOGY

The objective of this research was to determine the magnitude of truck traffic that is traveling through Main Street. Two video trailers were deployed along US 191 facing east. The trailer located on the median across from the East Main St. / Haggerty Ln. intersection was equipped with an Econolite Autoscope Solo camera with black and white imaging. The other trailer, just west of the 19th St. / West Main St. intersection, was equipped with an Econolite Solo Pro II camera with color imaging. The cameras and other equipment were powered by a large battery supply with backup solar panel charging.

The two trailers began recording around 12:30pm (Mountain Daylight Time) Thursday, September 4, 2014 and stopped recording around 11:00am (Mountain Daylight Time) Monday, September 15, 2014. Overall, approximately 264 hours of footage was recorded, but of that, only about 88 hours is usable (due to lighting restrictions). From this footage, truck counts were produced during daylight hours (8am-8pm) from Friday, September 5th 2014 to Friday, September 12th 2014 with the following time intervals:

- 12am-8am (trucks not counted)
- Hourly from 8am-8pm (trucks counted)
- 8pm-12am (trucks not counted)

A “through truck” is said to be a large commercial truck that crosses from East Main St. to West Main St. in a reasonable amount of time without any stops or detours. Generally, trucks that go through downtown Bozeman are heading east on I-90 where they exit at US 191/Main Street. They stay on Main Street/US 191 to Four Corners, where they continue on towards Ennis or south towards West Yellowstone. For this study, the number of “through trucks” over this period of time was recorded by matching stills of the trucks from the footage taken from both cameras.

This study was only interested in large trucks or trucks that have an impact on the road space. The “large trucks” in this context are often called “eighteen wheelers.” Figure 5 provides anexample of the types of trucks that were being counted.

Figure 5: A large eastbound "through truck" passing through West Main Street

Many other "through trucks" did not meet the description and were captured but not recorded in the truck counts. Figure 6 provides a good example of one of these trucks. General terms that would be used to describe trucks not counted are recreational vehicles, dump trucks, and trucks bearing the Pepsi logo (Pepsi has a distributor in Bozeman so these trucks were not considered to be "through" trucks).

Figure 6: Example of a small "through truck" not counted in this study

4. DATA COLLECTION

Several pieces of data were collected for this study. The first three sections, "Level of use by commercial trucks," "Travel times for alternative routes," and "How do commercial truckers select their routes" were specifically identified in the statement of work as needed data. The additional sections, "Average annual daily traffic" and "Crash data" were additional data collected to facilitate further analysis.

4.1. Level of use by commercial trucks

Two video trailers were deployed along Main Street from Friday, September 5, 2014 to Friday, September 12, 2014. The video trailers were deployed on the medians located just south of the E. Main St. /Haggerty Ln. and directly across from the W. Main St. /N. 20th Ave. intersections. Section 4.4 contains tables of the collected data from the video trailers.

Figure 7: East Main Trailer Location

Figure 8: Video Trailer Facing East Main Off-Ramp

Figure 9: West Main/19th Trailer Location

Figure 10: Video Trailer Facing West Main/19th Intersection

Although the trailers were able to collect data twenty-four hours a day, trucks were only counted from 8am to 8pm, in hour blocks due to low-lighting. In addition, trucks were counted from 8am to 8pm because it is anticipated that these are the primary times during which trucks would interact with the largest proportion of pedestrians and other traffic on Main Street.

4.2. Travel times for alternative routes

This project investigated the level of use of Main Street by commercial truckers. In addition, to determine the feasibility of alternative routes, time trials were performed. There are four potential routes that a commercial truck may take to get from east of Bozeman to Four Corners (US 191 South):

1) From I-90/US 191 to US 191/SR 85 ("Main Street Route" - red)
2) From I-90/US 191 to 7th Street to US 191/SR 85 ("7th Avenue Route" - green)
3) From I-90/US 191 to 19th Avenue to US 191/SR 85 ("19th Avenue Route" - yellow)
4) From I-90/US 191 to SR 85 to US 191/SR 85 ("Jackrabbit Route" - blue).

These route options are shown in Figure 11.

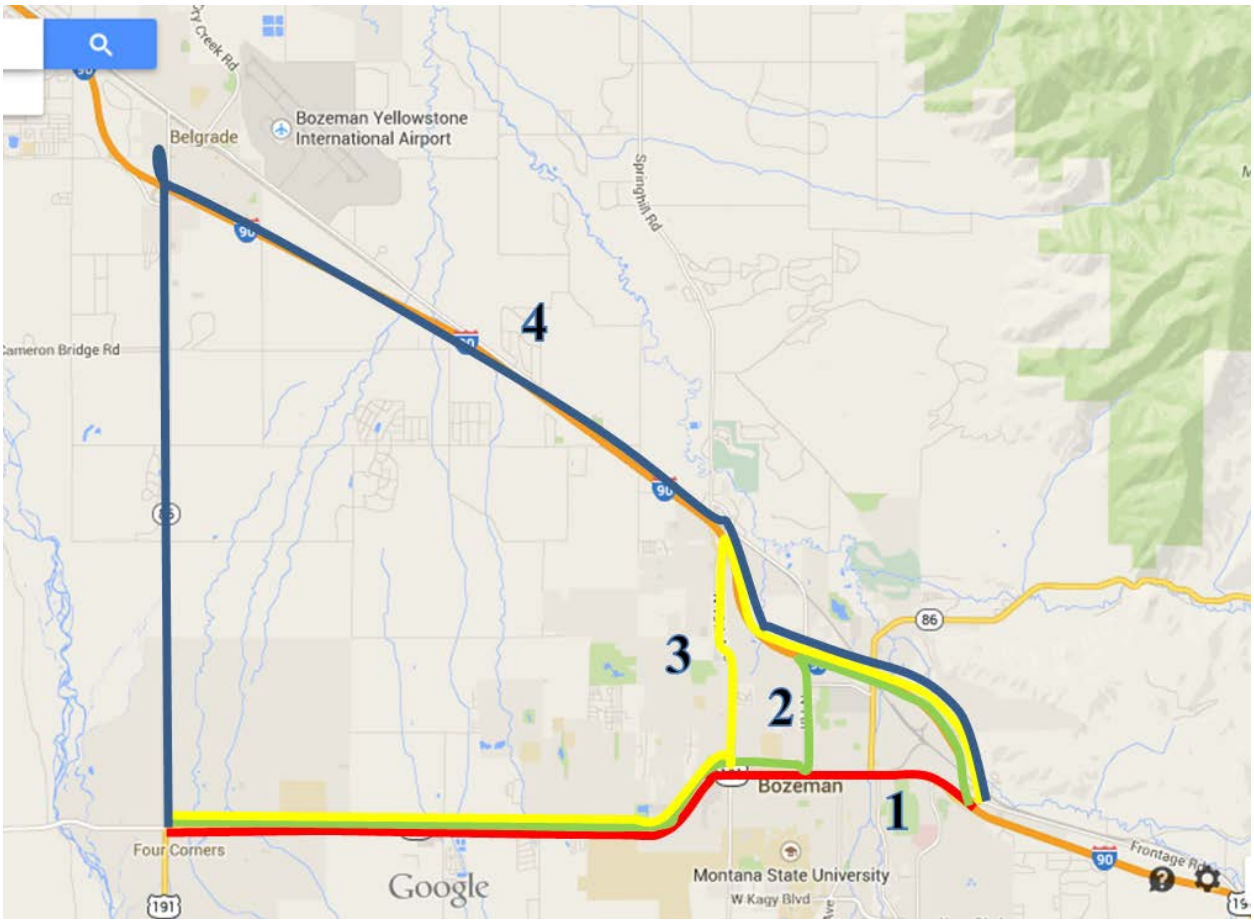

Figure 11: Alternative Routes

Table 1 shows the number of traffic control devices, the length, and the time taken through each of the four routes in question. These values were recorded during a single time-trial, and will vary depending upon traffic volumes, weather, road construction, etc. Times may also vary depending upon how many "red lights" are encountered, and it is noted herein that the current "Main Street Route" has the most traffic control devices (traffic lights) of all of the potential routes.

Table 1: Alternative Route Data

Route	# Traffic Control Devices	Length (miles)	Time (minutes)
#1-Red	24	8.7	20
#2 – Green	19	10.8	17
#3 – Yellow	17	12.9	15
#4 - Blue	5	18	17

4.2.1 Descriptions of Routes

Route 1 (Figure 12) from I-90/US 191 to US 191/SR 85 is the shortest of the four when measured by distance, but takes the longest to traverse. Overall, the route is mostly straight without any hard turns. This is appealing to truck drivers, especially when they are transporting more than a single trailer. While this route is about 2.1 miles shorter than the next shortest route, the fuel spent on this route would be the same (or even more) than the other options. A truck will have to pass through 24 traffic control devices on this route and a considerable amount of fuel is spent while idling at stoplights. Traffic is often congested through Main Street as a result of the lack of left turn lanes and because of delay often experienced when signal lights are present along a roadway. Vehicles get backed up when someone needs to make a left turn and large trucks cannot swerve in and out of lanes to avoid this.

The speed limit through downtown Bozeman is 25 MPH, increasing to 35 MPH at roughly 15th Avenue, and then 45 MPH and eventually 55 MPH as you get closer to Four Corners. The parking spaces along Main Street in Downtown Bozeman are typically fully utilized from about 9:00 am to 6:00 pm, which leads to little room to maneuver through traffic and increases the chance of collision.

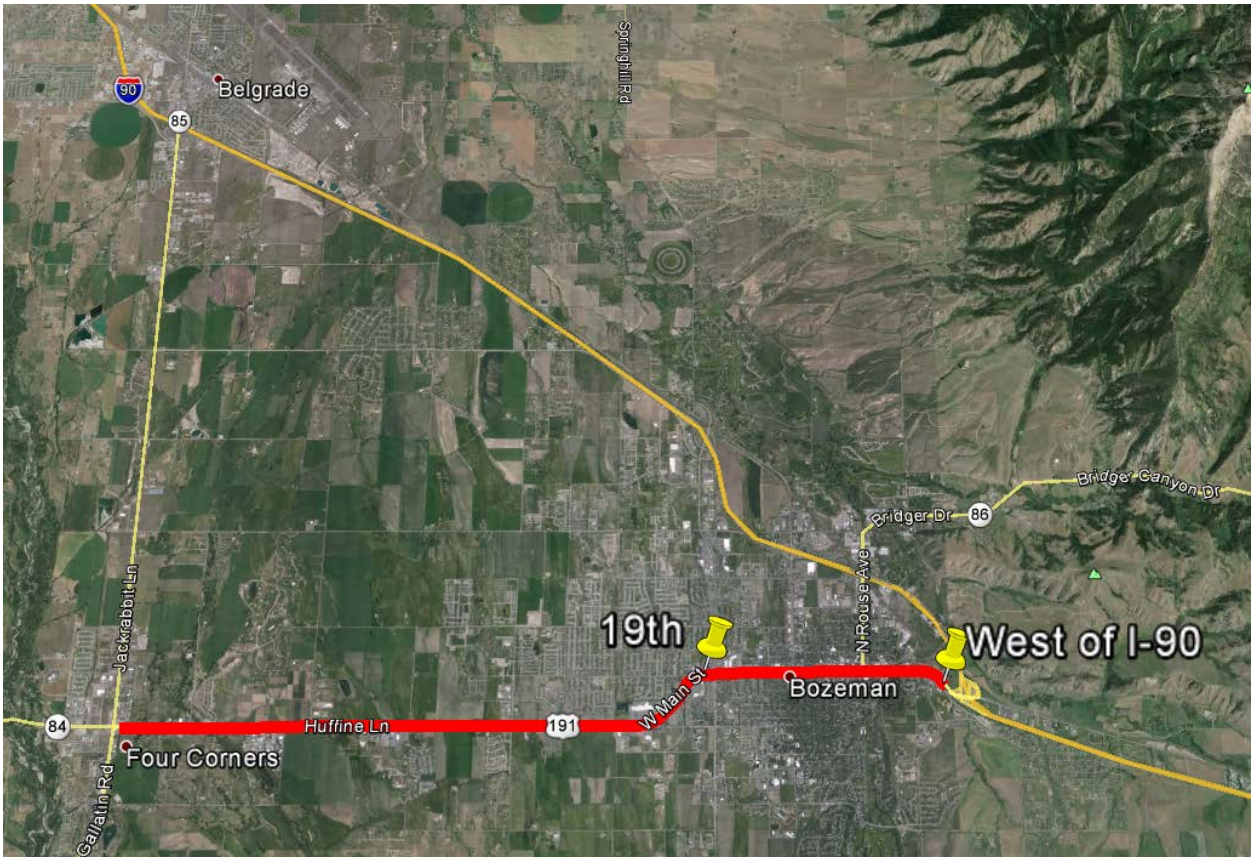

Figure 12: Route 1 (I-90/US 191 to US 191/SR 85)

Route 2 (Figure 13) is from I-90/US 191 to 7th Street to US 191/SR 85 and is about 10.8 miles in length. This route is longer than the first option, but passes through fewer traffic control devices, which makes for a shorter travel time. While this route bypasses the Downtown area, the one concern with this route is the sharp turn from 7th Street to US 191/Main Street. This intersection is a "T intersection" and it may be difficult for trucks to make that turn. This route is definitely faster than the first option, but it comes with the challenge of a potentially difficult turn.

The speed limit during the I-90 portion of this route is 75 MPH, while it slows down to 35 MPH on the northern portion of 7th St. and down to 25 MPH just past the 7th Avenue/Aspen St. intersection. As the first section of this route is on the highway, the shoulders are fairly wide and appealing for large trucks to pull over. Similar to the first route, there is still some traffic congestion to drive through, but it is not challenging compared to driving through downtown Bozeman.

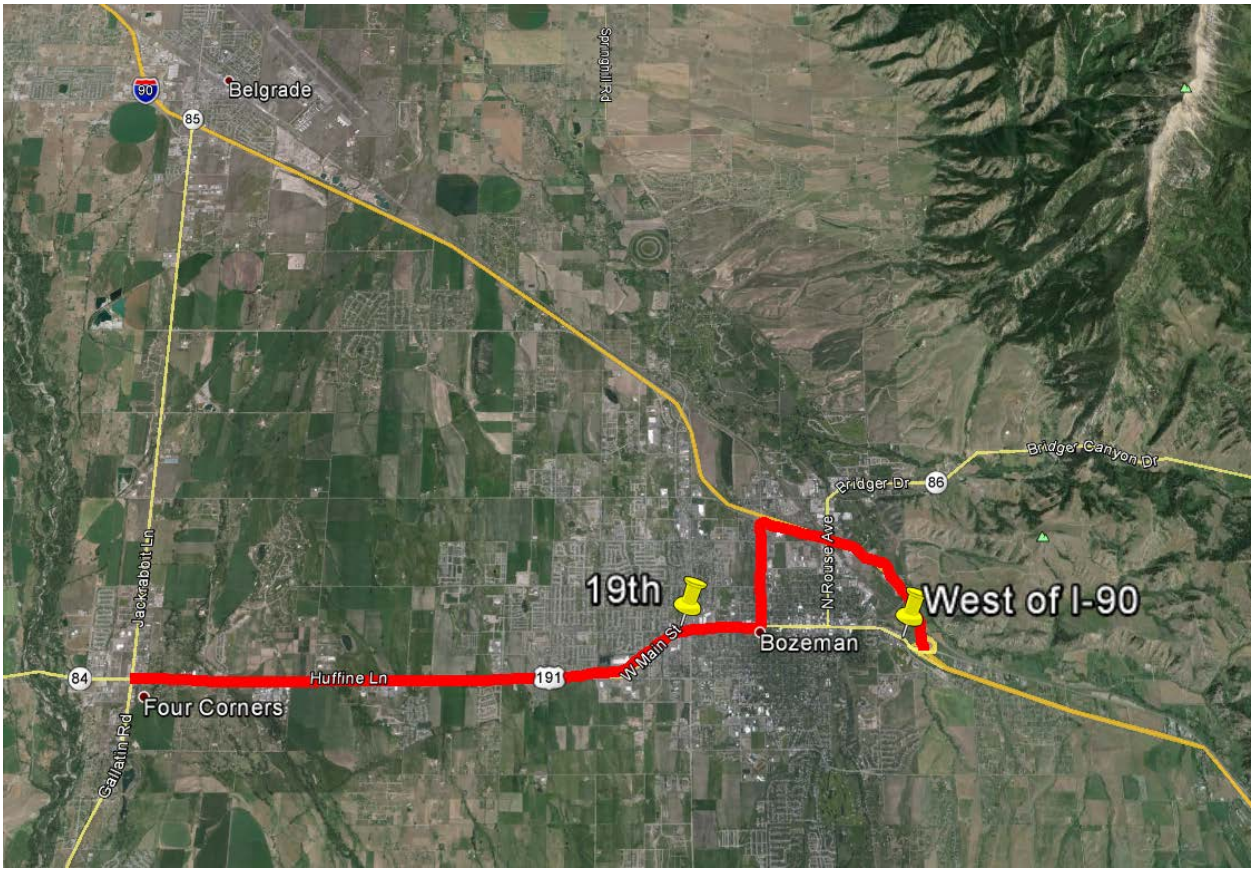

Figure 13: Route 2 (I-90/US 191 to 7th Street to US 191/SR 85)

Route 3 (Figure 14) is from I-90/US 191 to 19th Ave. to US 191/SR 85. With a combination of only 17 traffic control devices and spending more time on I-90 than the other two routes, this route is the quickest of the four, representing a 2 minute time savings over Routes 3 & 4, and a time savings of five minutes (25% reduction) over Route 1 (the US191/Main Street). There is a slight upslope and tight turn at the intersection of 19th Avenue and US 191. There is a dedicated turn lane, perhaps making this turn less troublesome than the turn at 7th Avenue & Main Street (US 191). This route's length is about 12.9 miles, but a driver can make up for the distance with faster speeds and fewer traffic control devices than Route 1.

During the I-90 portion of this route the speed limit is 75 MPH, but fluctuates from 25-55 MPH for the rest of the route. A considerable portion of this route has large shoulders that make it easy to pull over. The road does not transition into tight shoulders until after crossing Durston Road. From the 19th St. /Main St. intersection and on, Route 3 is similar to Routes 1 & 2. Another appealing feature of this route is the truck stop positioned on 19th Street immediately after exiting I-90 at the 19th Avenue exit (Exit 305).

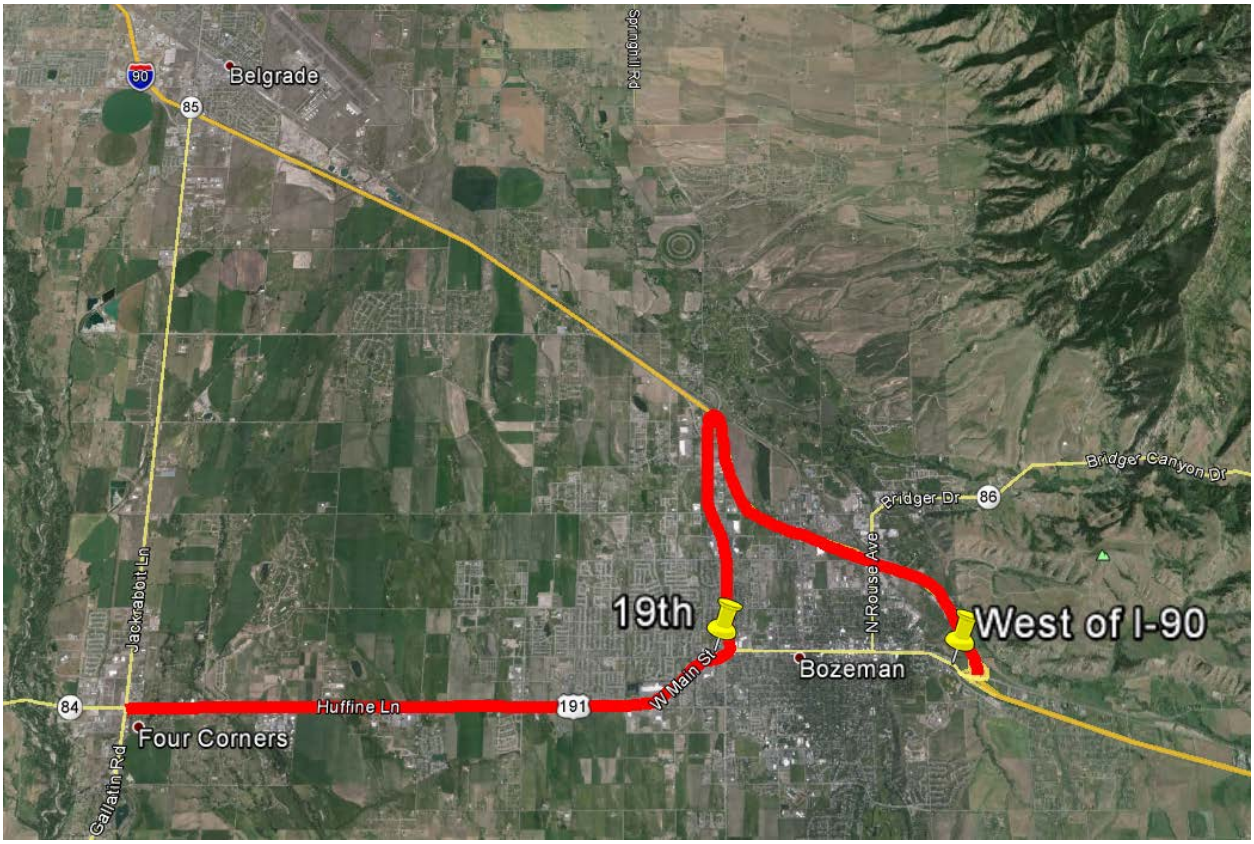

Figure 14: Route 3 (I-90/US 191 t 19th Avenue to US 191/SR 85)

Route 4 (Figure 15) is from I-90/US 191 to SR 85 to US 191/SR 85. This route is the longest in distance at 18 miles but only takes 17 minutes to complete, and is faster than the shortest option (Route 1), primarily due to the fact that it uses roads with higher speed limits and has the fewest traffic control devices. The route only takes one turn at the Jackrabbit Lane exit on I-90 (Exit 298) and the driver can average approximately 60 mph for the duration of this trip. As an added bonus, this route only passes through five traffic control devices. This allows for a smaller percentage of time potentially spent idling at a stoplight.

The speed limit is 75 MPH while on I-90, transitioning to 60 MPH after the SR 85 (Jackrabbit Lane) exit to Four Corners. Commercial truck drivers have plenty of room to pull over during the duration of this route as there are wide shoulders on much of Jackrabbit lane. The most important benefit of taking this route is the ability to stay on a highway with minimal traffic congestion and high design standards, thereby reducing the risk of collision. It should also be noted that Route 4 is the only option that does not pass through the intersection of Main Street and 19th Avenue, which is the busiest intersection in Bozeman.

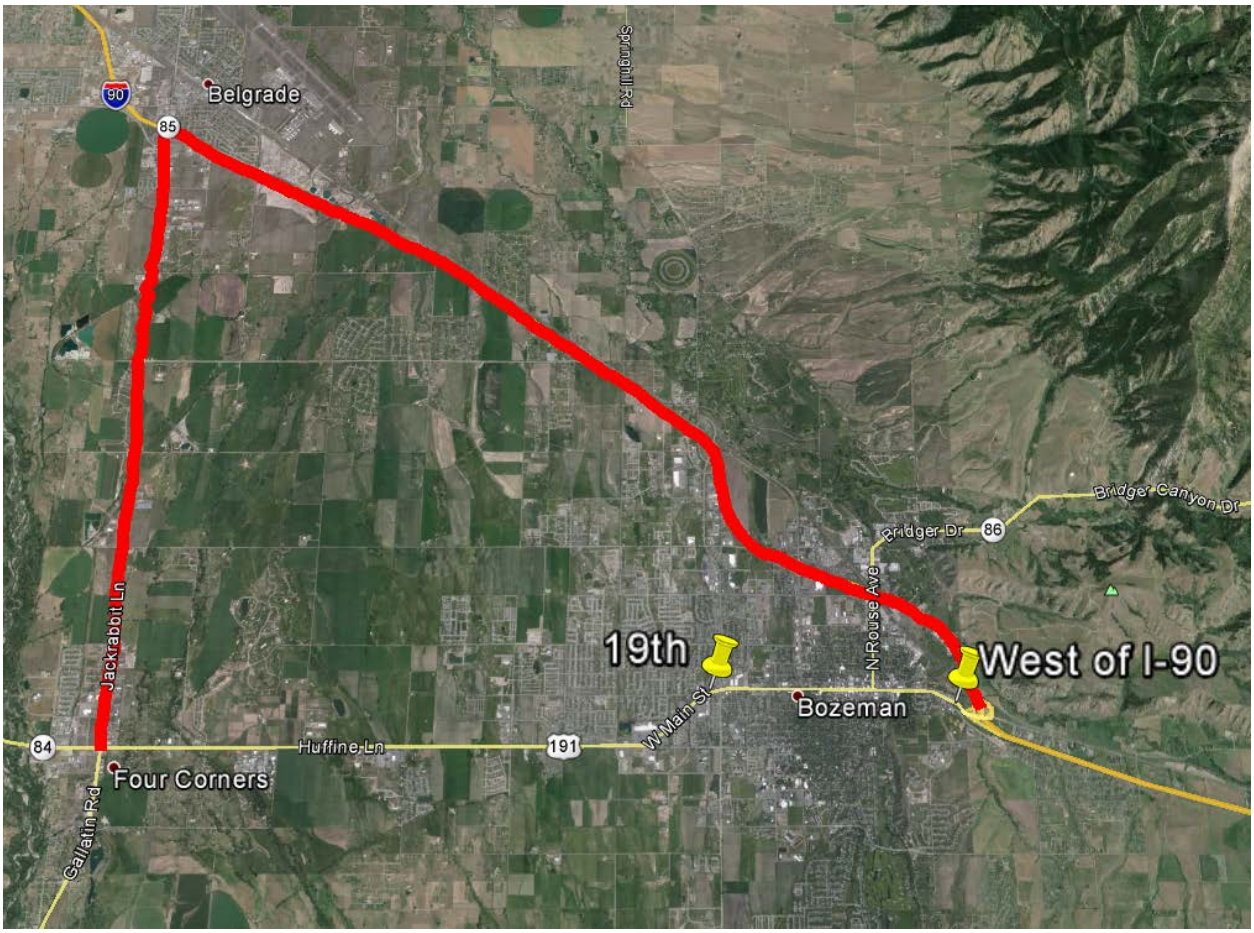

Figure 15: Route 4 (I-90/US 191 to SR 85 to US 191/SR 85)

4.3. How do commercial truckers select their routes?

The routes that a truck driver chooses are influenced by dispatch, if it is a company truck. However, if they are Owner-Operators, they choose their route. Typically, the shortest route that uses the least amount of fuel is chosen. Therefore, a route may be chosen even if it has lower speed limits if there are fewer mountain passes (August 7, 2014; Barry "Spook" Stang, Executive Vice President of the Motor Carriers of Montana).

A route decision could vary depending on intrastate and interstate trucking routes. More often than not, an operator will select the shortest and most fuel efficient route regardless of the time taken to travel. This means that commercial trucks on a delivery from Bismarck, North Dakota to Salt Lake City, Utah could travel the same route through US 191 as "local" deliveries from Bozeman, Montana to Big Sky, Montana.

4.4. Average annual daily traffic

The Montana Department of Transportation (MDT) collects average annual daily traffic counts along Main Street. Figure 16 shows the locations of these counts and Table 2 presents the

counts. The cells shown in grey are actual counts. Those cells shown in white are estimated counts.

Figure 16: AADT Traffic Counts (30)

Table 2: AADT Traffic Counts

	A	B	C	D	E	F	G	H	I	J
2013	22,790	18,910	20,780	22,410	18,810	14,990	12,470	12,360	11,610	7,250
2012	22,450	18,630	20,470	22,080	18,530	14,770	12,290	12,180	11,440	8,130
2011	23,050	21,110	17,890	18,280	15,980	13,270	10,890	12,550	11,920	8,050
2010	23,050	21,110	17,890	18,280	15,980	13,270	10,890	12,550	11,920	7,400
2009	23,220	18,370	17,930	18,390	15,790	13,770	12,750	12,530	11,160	7,640

While MDT does collect percentage truck information, it is not collected in this corridor due to heavy traffic. Instead, they use formulas to calculate it. Table 3 presents the estimated percentage truck information for each of the traffic count locations identified in Figure 16.

Table 3: Estimated Percent Commercial Vehicles

	A	B	C	D	E	F	G	H	I	J
% Commercial Vehicles	2.0	1.6	1.4	1.3	1.6	2.0	2.4	2.4	2.6	4.1

4.5. Large Through Truck Counts

Table 4 presents the number of large trucks that were categorized as "through" trucks. Figure 17 shows a graphic depiction of this data. Figure 18 through Figure 25 show the through truck counts for each day by hour of the day. Table 5 presents the number of through and total number of trucks counted. Figure 26 presents the number of through trucks in graphical format.

Table 4: Commercial "Through" Truck Counts

	Fri (9/5)	Sat (9/6)	Sun (9/7)	Mon (9/8)	Tue (9/9)	Wed (9/10)	Thu (9/11)	Fri (9/12)
8am – 9am	3	3	2	2	2	5	3	1
9am – 10am	2	2	4	7	2	4	5	2
10am – 11am	4	2	2	5	5	4	3	3
11am – 12pm	1	5	2	7	3	2	1	5
12 pm – 1pm	4	6	3	3	3	1	2	6
1pm – 2pm	2	2	5	3	2	5	4	2
2 pm – 3pm	4	0	1	5	7	5	7	4
3pm – 4pm	3	2	1	1	6	3	5	2
4pm – 5pm	1	3	2	0	5	4	4	1
5pm – 6pm	4	0	2	1	2	3	1	1
6pm – 7pm	2	1	1	2	2	2	1	3
7pm – 8pm	1	1	1	1	3	0	2	3

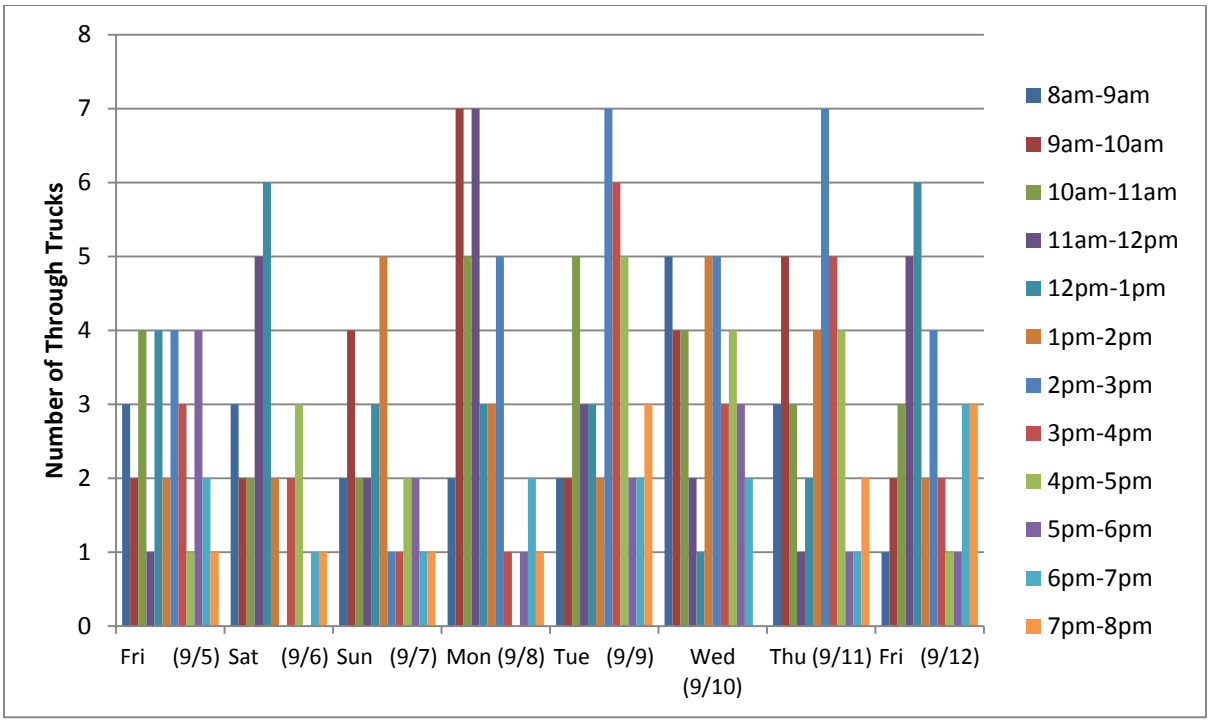

Figure 17: "Through" Truck Counts

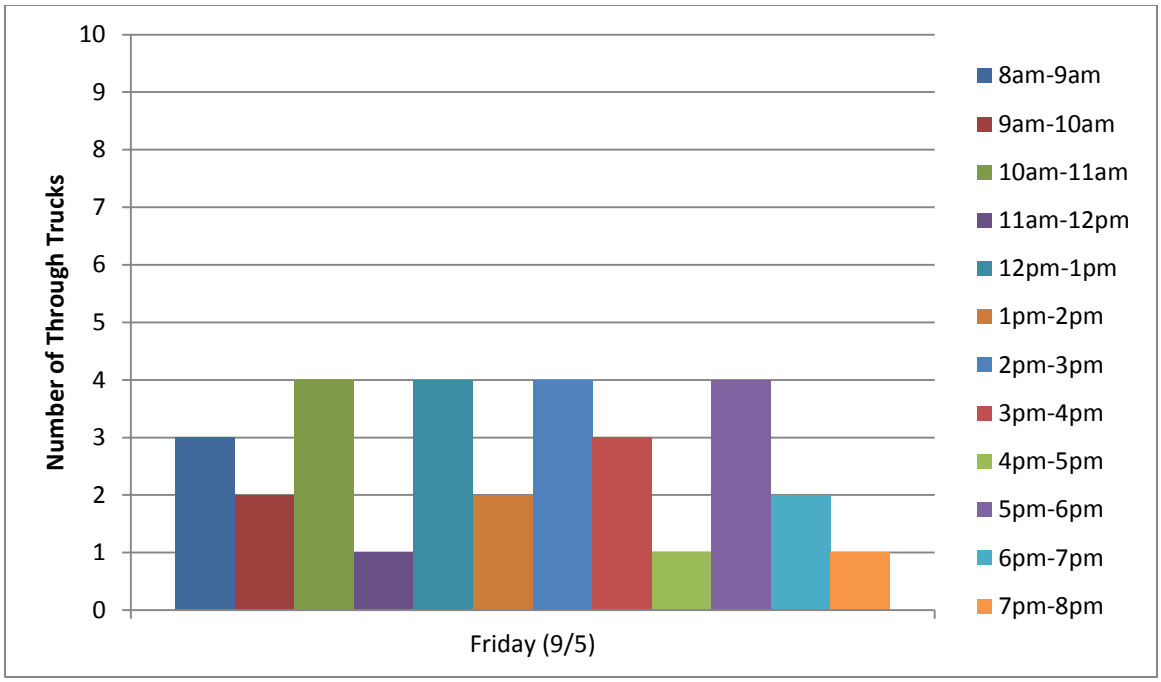

Figure 18: Through Truck Counts (Friday, September 5, 2014)

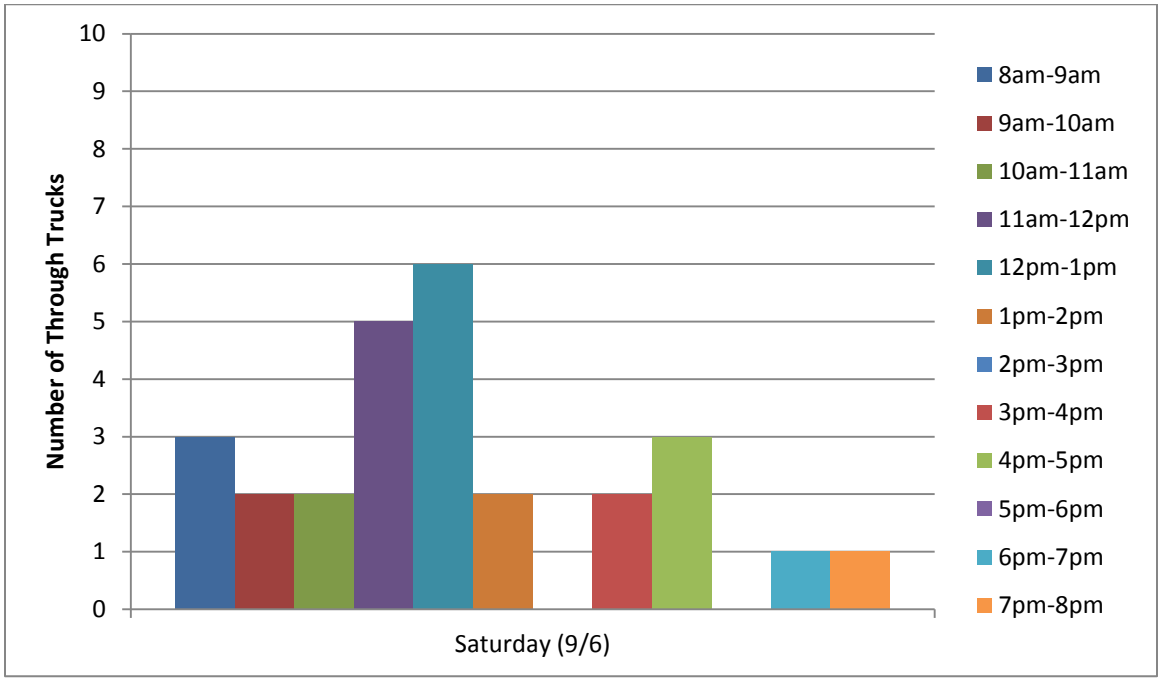

Figure 19: Through Truck Counts (Saturday, September 6, 2014)

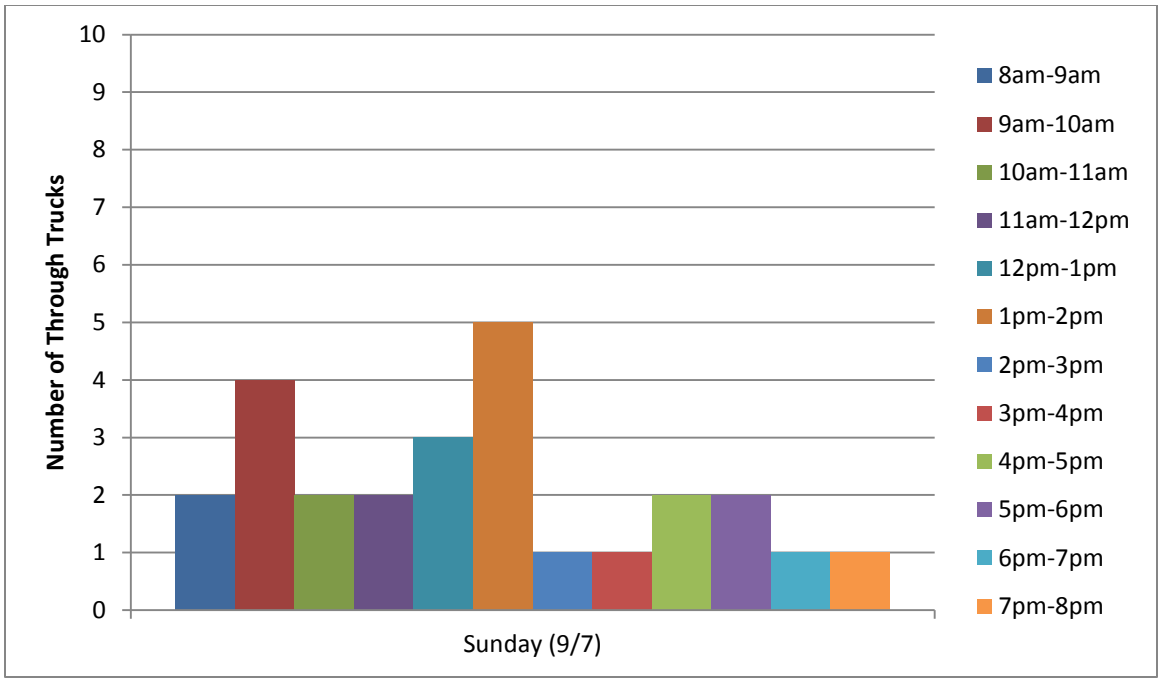

Figure 20: Through Truck Counts (Sunday, September 7, 2014)

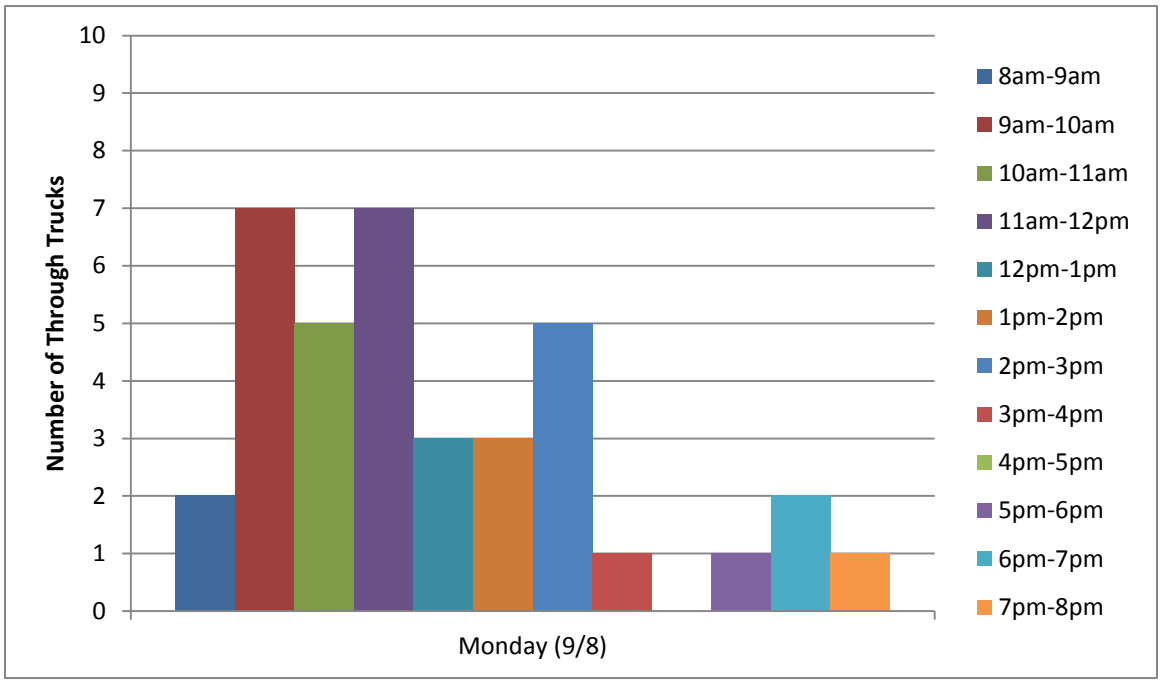

Figure 21: Through Truck Counts (Monday, September 8, 2014)

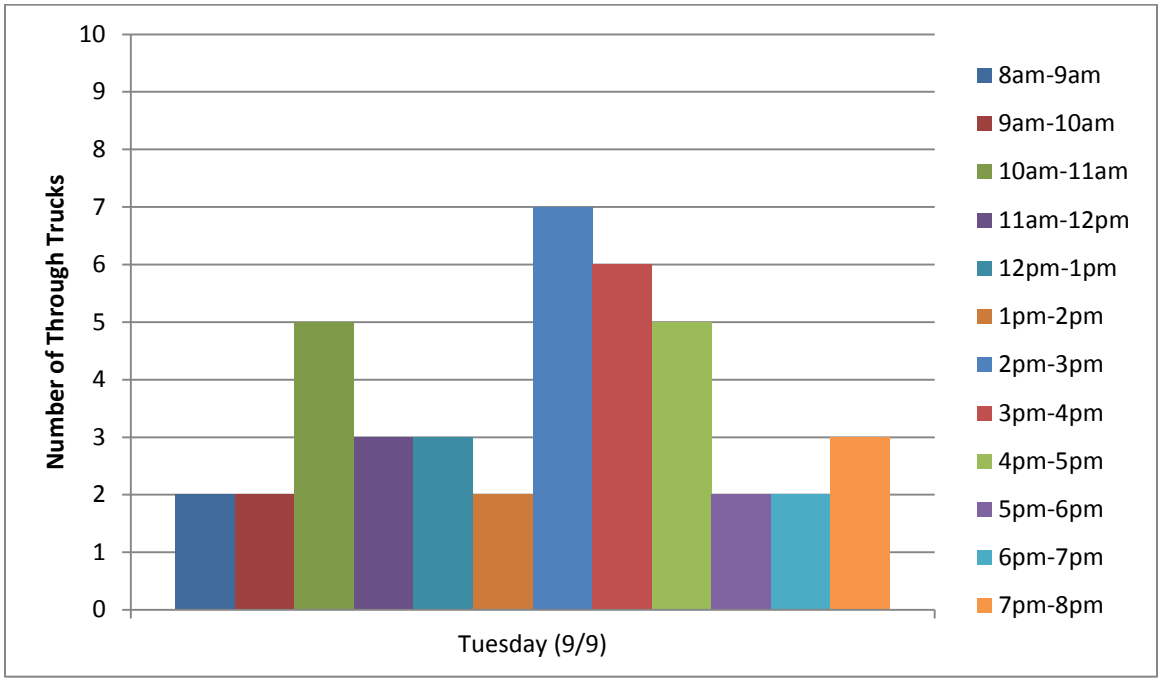

Figure 22: Through Truck Counts (Tuesday, September 9, 2014)

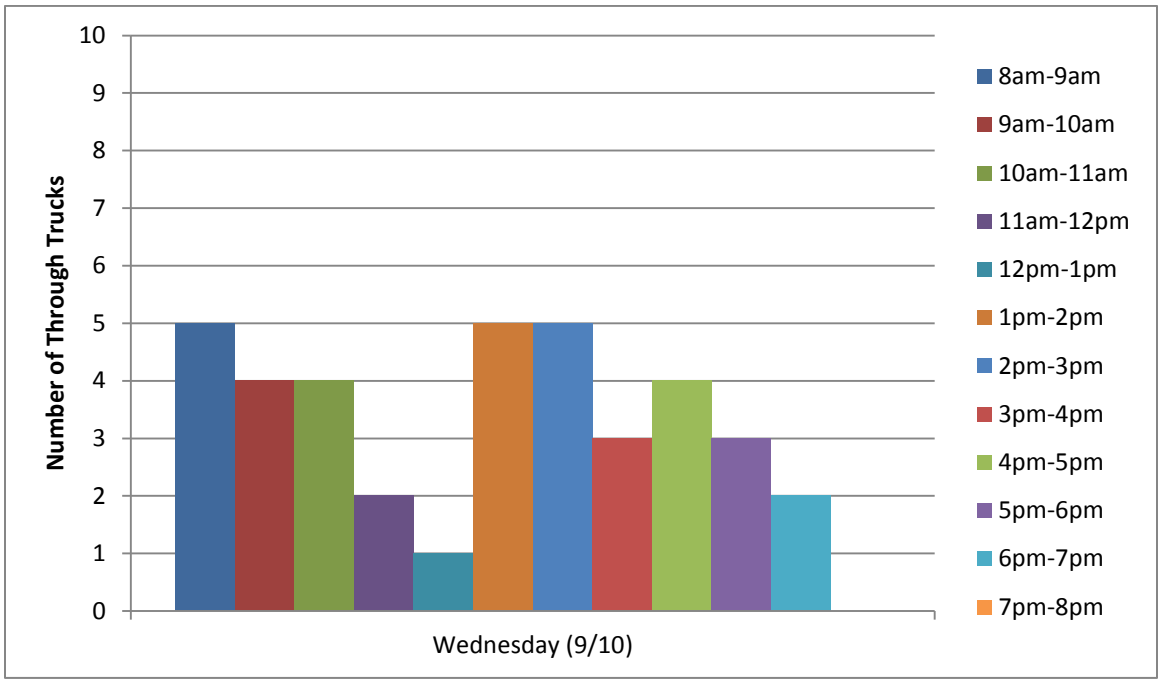

Figure 23: Through Truck Counts (Wednesday, September 10, 2014)

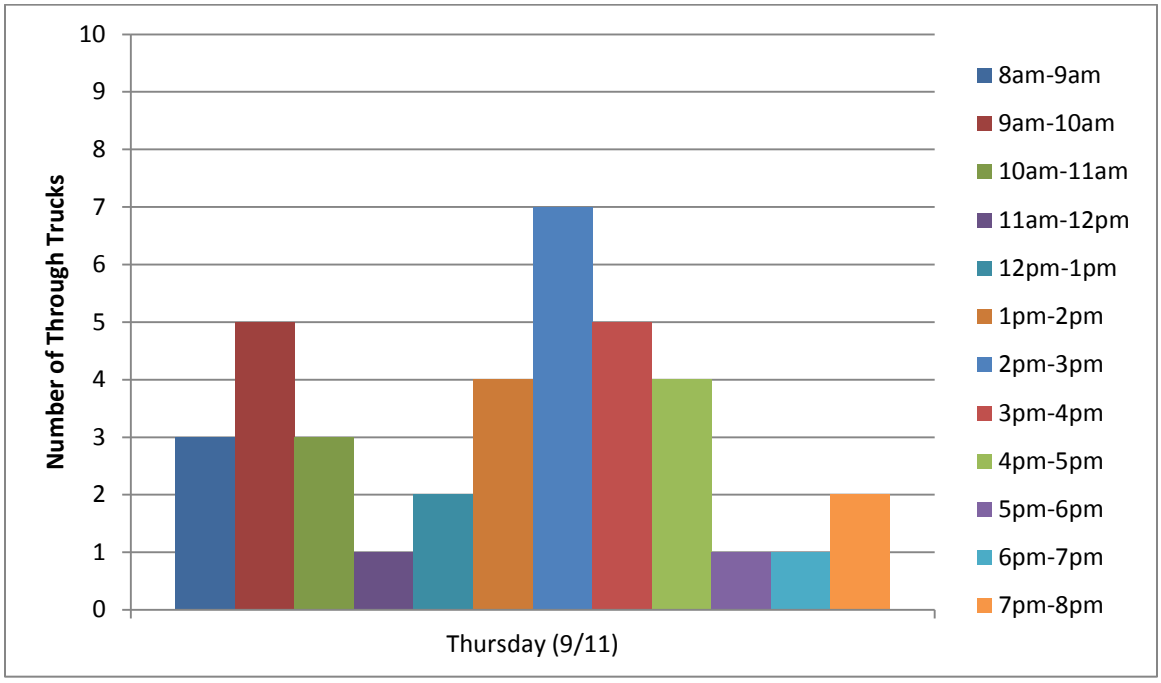

Figure 24: Through Truck Counts (Thursday, September 11, 2014)

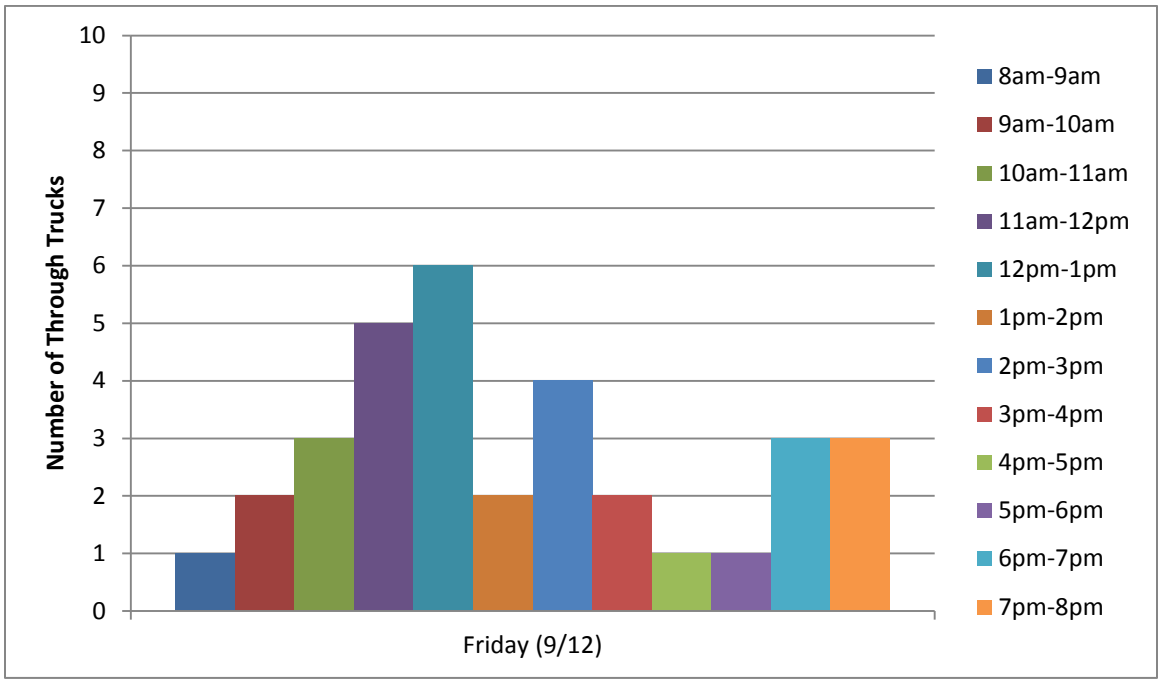

Figure 25: Through Truck Counts (Friday, September 12, 2014)

Table 5: "Through" Trucks, Total Trucks, and Proportion

	Through Trucks	Total Trucks	Percentage
Friday, 9/5/14	31	150	21
Saturday, 9/6/14	27	38	71
Sunday, 9/7/14	26	37	70
Monday, 9/8/14	37	141	26
Tuesday, 9/9/14	42	142	30
Wednesday, 9/10/14	38	108	35
Thursday, 9/11/14	38	119	31
Friday, 9/12/14	33	61	54

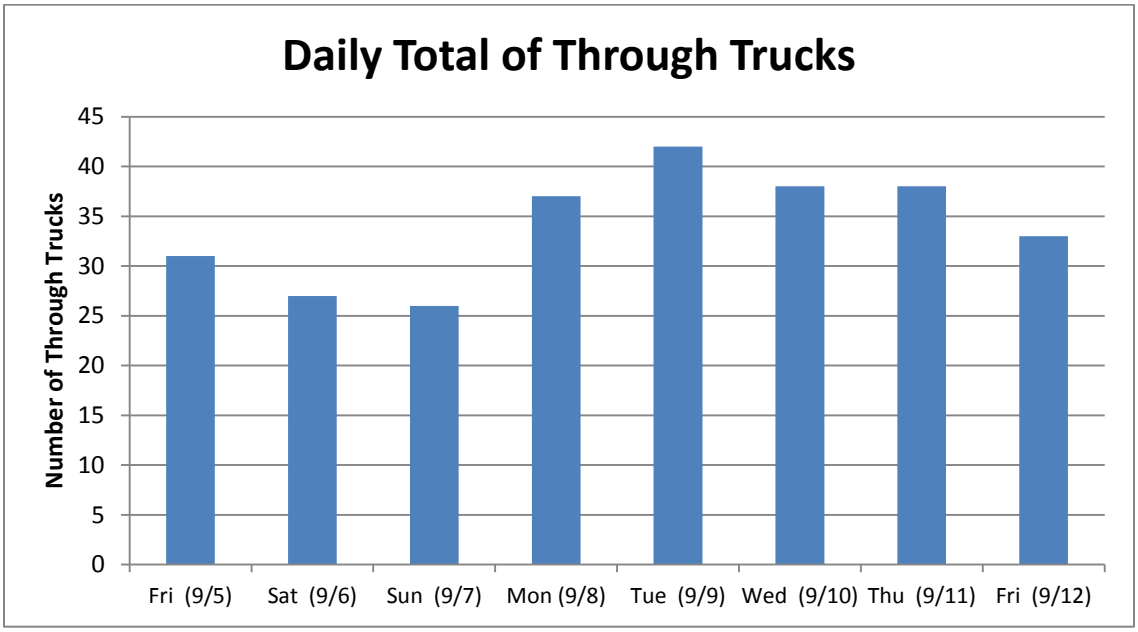

Figure 26: Total (By Day) Commercial "Through" Truck Counts

4.6. Sound

As noted earlier in this document, in addition to being physically larger than other vehicles typically on Main Street, large trucks (semis or 18-wheelers) can also be louder than other vehicles. On Thursday, March 19, 2015, sound readings were taken using the application Sound Meter at the corner of Main Street and Bozeman at approximately 1:15pm. This information provides a general understanding of the difference in sound levels when considering several generalized traffic demographics. Vehicle speed, orientation, and the presence of neighboring buildings can all effect how sound is perceived. In addition, the sound generated by an accelerating and/or decelerating vehicle will be different than when the vehicle is at a constant speed, and will be different dependent upon the type of vehicle. Even with good signal timing, it is likely that given the number of traffic control devices in Downtown Bozeman, there is a greater possibility for vehicles, including large trucks, to be either accelerating or decelerating.

As far as noise levels, when no traffic was passing the observer, the sound readings ranged between 58 and 61 decibels. When the traffic only consisted of pick-up trucks and passenger vehicles, the sound readings ranged from 69 to 75 decibels. When three large trucks passed the observer, on three different occasions, the sound ranged from 82 to 85 decibels. These results show that these large trucks increased the sound levels between 7 to 16 decibels. This represents an increase in noise levels of 9.3 percent to 23.2 percent.

5. RESULTS

Based on the data collected, a larger number of through trucks traverse Main Street on weekdays than on weekends (Figure 26); however, the proportion of through trucks is lower during the week (Table 5). Based on our data, the largest spike in through trucks during a weekday occurs from 2 to 3pm as observed with the camera at East Main (see Figure 18 to Figure 25). Furthermore, Tuesday, Wednesday and Thursday both have two peak periods. However, it appears that the peak periods occur earlier on Wednesday (granted this is from a single observation). Friday, Saturday, and Sunday, on the other hand, generally have only one peak period.

Ideally, we would have been able to observe the license plate information from each truck. However, the videos did not allow this type of detailed information to be collected (see Figure 5 and Figure 6).

As shown in Table 5, excluding the proportion from September 12, 2014, the average proportion of through truck traffic is 29%. Therefore, considering the locations where the cameras were deployed, it appears that approximately 70% of the truck traffic passing the trailer that was set up on East Main near I-90 does not travel all the way to 19th Street (becoming a "through truck").

Based on the eight days of data collected for this study, an average of thirty-four through trucks travel through Main Street daily in a westbound direction, with approximately 240 through trucks traversing Main Street in one week. However, there was a substantially greater number of trucks (132) observed by the trailer near the interstate than counted by the trailer near 19th Street. This would imply that these other trucks are somehow diverging locally, rather than traversing completely through Main Street. The destination of these trucks is unknown. This latter number (132 trucks) is similar in the context of the proportion of trucks estimated by MDT (149 trucks).

Also, it is important to note that this study did not try and differentiate between interstate or intrastate vehicles. Interstate commerce is defined to be any trade, traffic, or transportation performed between a place in a state and a place outside of such state (31). Intrastate commerce is defined to be any trade, traffic, or transportation performed exclusively in the business's domicile state. These definitions are important to note for the sake of this study as trucks associated with both forms of commerce were counted and recorded equally, and because it is expected that whether the truck is transporting materials from Billings to Big Sky (intrastate) or Bismarck to Idaho Falls (interstate), they would use the same route.

6. CONCLUSIONS

Based on the results of this study, it is recommended that commercial truck drivers use Route 3 (I-90/US 191 to 19th Ave. to US 191/SR 85) or Route 4 (I-90/US 191 to SR 85 to US 191/SR 85) for travel west on I-90 to US 191 South. All alternatives (Routes 2, 3, and 4) provide travel time savings over Route 1 (Main Street/US 191) and take trucks out of Downtown Bozeman. While Route 3 is slightly faster than Route 2 & 4, Routes 2 & 3 travel through the intersection of Main Street & 19th Avenue, which is the busiest intersection in Bozeman. Therefore, there is the potential for variations in travel times, as trucks may have to wait/queue longer at that intersection. Route 4 would be the best option for drivers seeking to reduce fuel consumption, as although being the longest route, has the lowest number of traffic control devices and the highest average speed.

There is an existing perception that a high volume of commercial truck drivers choose the route through downtown Bozeman because it is shorter and therefore takes less time to travel. However, as shown by the data collected in this study, this route takes the most time of all four routes. There are trade-offs between all four routes, but Routes 3 and 4 are more beneficial to both the drivers and the pedestrians of Bozeman. While the number of trucks our study found using Main Street appears to be consistent with MDT's numbers, our study indicated a smaller proportion are using Main Street as a through route. Regardless, the City of Bozeman must determine whether re-routing this proportion of trucks would have benefits for enhancing the downtown environment. In addition, it would be valuable to determine if the other trucks (categorized as "non-through" in this study) are traversing the majority of the route of concern (i.e. to 7th Street), or if they are diverging prior to the main pedestrian area of Main Street.

In general, the study supports the concept of creating a "truck route" for US 191 South that would use either Route 3 (19th Avenue Route) or Route 4 (Jackrabbit Route) as an alternative to trucks using the US 191/Main Street route. Finally, it is recommended that this issue be further addressed in the upcoming Bozeman Area Transportation Plan process that is anticipated to begin by May of 2015.

APPENDIX

This appendix provides photos showing the scale (physical size) of large trucks as compared to other activities and vehicles in Downtown Bozeman. Figures 27 through 34 are courtesy of the Downtown Bozeman Partnership.

Figure 27: Downtown Bozeman Pedestrian Environment

Figure 28: Comparison of Pedestrian Environment and "18-Wheeler"

Figure 29: Comparison of Pedestrian Environment and "18-Wheeler," Two

Figure 30: "18-Wheeler" and Pedestrian Environment

Figure 31: Dual Trailer Truck in Downtown Bozeman

Figure 32: Truck Hauling Logs and Downtown Bozeman

Figure 33: Oversized Load in Downtown Bozeman

Figure 34: Dual Trailer in Downtown Bozeman

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