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DRAFT

Keokuk Main Street State Highway 218 Study

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Introduction / Project Statement

Commercial main streets are the heart of a city's social and economic life, but they also often serve as a main arterial traffic link. Balancing urban main street priorities between traffic movement, social and economic functions is a difficult task. This task is further complicated when the street serves as part of the state or national highway network. This is the case for Keokuk, Iowa, where Main Street (US 218/136) connects downtown to major shopping and industrial sites in the city as well as serving through traffic from a three-state area.

For much of the 20th century, transportation planners and engineers focused on traffic throughput as a measure of the level of service for urban streets. Though this approach minimizes delay for motorists, it often creates disconnects between streets and their adjacent land uses. Streets dominated by motor vehicles discourage lingering and window shopping in commercial districts and present challenges for urban amenities like sidewalk cafes and public meeting spaces. Such streets also disadvantage other road users, including pedestrians, cyclists, and transit users, in terms of safety and convenience. A better balance between the street as a transportation link and the adjoining urban space is vital to a vibrant downtown environment.

In addition, cities such as Keokuk that have experienced declining populations often find that traffic volumes on downtown streets have fallen below the levels that were originally used to design the streets. Keokuk's population peaked at around 16,500 residents during the 1960s, but like many Iowa communities, it experienced population decline during the latter half of the 20th century. The current population has stabilized around 10,600 residents. While the capacity of streets is routinely increased in response to forecasts of future traffic demand, they are not often redesigned to reflect new realities of lower traffic volumes that communities like Keokuk face. This combination of falling traffic volumes and the desire to relink adjacent land use to street function makes many urban arterial highways ideal candidates for a rethink of street design, such as "complete street" treatments or "rightsizing".

However, implementing complete streets designs presents challenges for localities. Major downtown streets are also often designated as state highways, and in these cases final control over design changes may be outside of local jurisdiction. For example, in Iowa, state highways fall under the jurisdiction of the Iowa Department of Transportation (Iowa DOT). Localities often lack an understanding of what types of technical assistance are available from the state department of transportation or what designs are acceptable.

The purpose of this report is to recommend context-sensitive redesign of Main Street (US 218) to increase safety and enhance its function as the commercial and social heart of the city. This can be achieved without significantly degrading its function as a major traffic thoroughfare.

The project area covered by this report is Main Street between 2nd and 14th Streets (Figure 1). Analysis and information provided here are intended to be used as the basis for a proposal to Iowa DOT to begin the conversion process. The following sections examine existing conditions within the study area and provide alternative street treatments as well as planning estimates for the recommended redesign. This includes both general recommendations for context sensitive redesign of the street right of way and identification of specific locations and treatments within downtown Keokuk. The study also provides background on the types of projects that are feasible within current Iowa DOT policy guidelines as well as resources for local officials to interface with Iowa DOT and other entities about design and funding. The report draws from case studies of successful conversions of similar downtown streets that are designated as US and State highways. Finally, next steps are provided to guide local officials in presenting a proposed redesign to Iowa DOT and building local public support.

Figure 1. Project Area - Main Street, Keokuk, Iowa.

Existing Conditions / Background

Coordination with Comprehensive Plan

Keokuk is in Lee County in southeast Iowa. The city is at the confluence of Des Moines and Mississippi Rivers and borders the state of Illinois to the east. The population of Keokuk was 10,780 in 2010. The city is bisected by Main Street (US Highway 218) from northwest to southeast through the city with US Highways 61 to the west and 136 to the south of Keokuk.

The subject of this project is Main Street (US Highway 218) from intersections with 14th Street and 2nd Streets to the north and south respectively, a distance of approximately 0.8 miles. The cross section of Main Street south of 11th Street contains two approximately 11-foot lanes in each direction, as seen in Figure 2, plus an 11-foot parking lane on each side, and curb and gutter. There are pedestrian bump-outs at the street corners between 7th Street and 3rd Street. North of 11th Street, the Main Street cross section shifts to include a two-way left-turn lane in the center of the roadway, with a parking lane only on the west side of the street as shown in Figure 3. The Main Street Corridor has historically served as the entryway into Illinois from Keokuk, Iowa across the Mississippi River where it becomes US Highway 136. Main uses consist of older commercial development on both sides of the street which house service and retail businesses. The River City Mall is located on the west side of the Main Street between intersections with 2nd Street and 4th Street.

Figure 2. A cross section of the Main Street with 4 Lanes and street parking on both sides of the street. Source: Google street map[1].

[1] Screenshot. Maps.google.com.

Figure 3. A cross section of the Main Street with 5 lanes and street parking on one side of the street. Source: Google street map.[2]

The Keokuk, Iowa 2018 Comprehensive Plan highlights areas and facilities in the city that need development and improvement[3]. One focus area is the current conditions of the roads (Pavement quality and engineering design) and the importance of wayfinding. The map below shows facilities and road segments that are in poor condition and need repair. Other than repairs, segments of Main Street, including the study area, were identified as a candidate for 3-lane conversion. Recommendations for the Main Street corridor in the comprehensive plan include reducing the number of lanes from current 4 to 3. The lane conversion would improve the viability of downtown revitalization efforts through reduction of traffic speed and noise. The comprehensive plan further highlights that priorities for repairs should be given first to roads that connect employees to industry, civic destinations, retail spaces and school campuses.

[2] Ibid.

[3] "My Keokuk: Comprehensive Plan: City of Keokuk, Iowa." Southeast Iowa Regional Planning Commission. PDF. 2018.

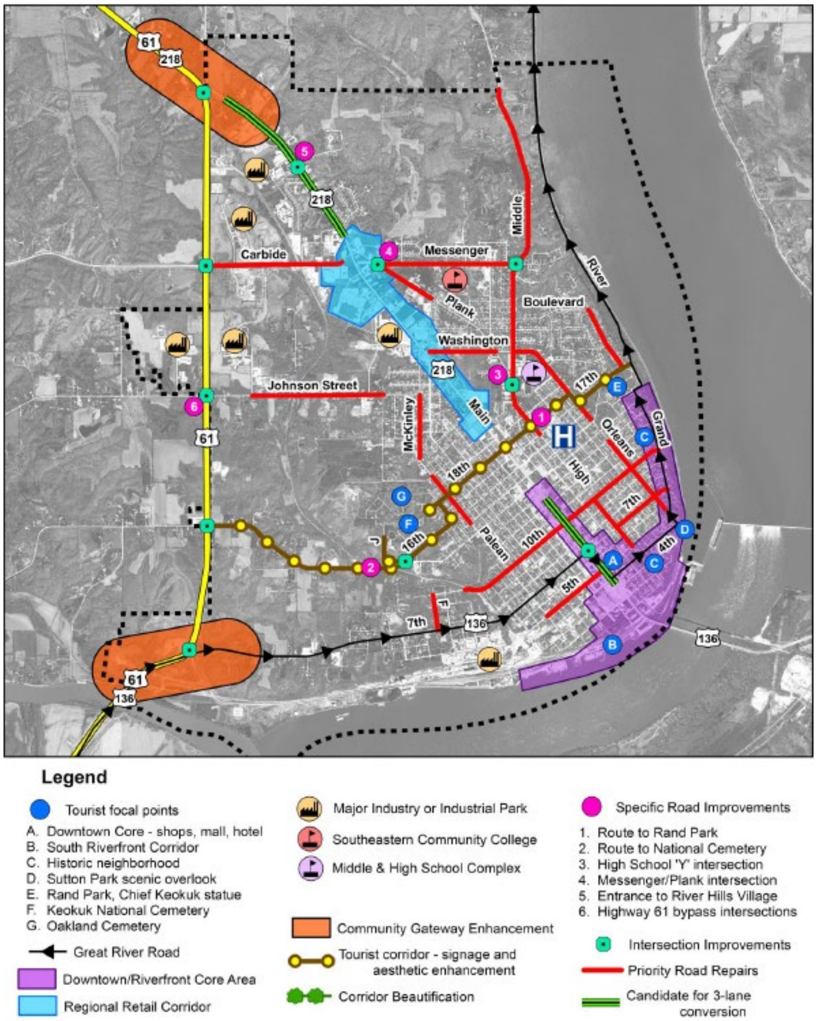

Figure 4. Map of Keokuk, Iowa.

One of the goals of the Keokuk 2018 Comprehensive Plan is that ‘Keokuk will have an efficient, quality street network’. Part of this goal is to ‘consider a lane reduction, bump-outs, and other measures for MSKI [Main Street Keokuk] within the Downton core’, to ‘improve safety, traffic flow, and economic viability of the surrounding area [and] … reduce the negative impact of through traffic on the Downtown social atmosphere’[4]. This report offers a redesign of Main Street that increases safety, increases potential for commercial activity, and maintains the Downtown core as the social hub of Keokuk.

Multi-modal Level of Service

In order to determine the effects of the conversion on traffic flow, the current level of service (LOS) for the project area was evaluated for vehicles, bicyclists, and pedestrians. Vehicle level of service, which is a measure of traffic delay, was obtained from the City of Keokuk, Iowa Traffic and Safety Study,

[4] Ibid.

completed in February of 2019 by HR Green[5]. According to the report, Main Street operates at level of service D in both directions for the AM peak, mid-day, and PM peak periods.

Bicycle and pedestrian level of service were calculated using the methods in NCHRP Report 616: Multimodal Level of Service Analysis for Urban Streets[6]. For bicycles, the LOS is C on Main Street south of the 14th Street intersection, and D both north and south of the 7th Street intersection. Current pedestrian LOS is B for all these locations.

The goal for this report is to provide recommendations that do not reduce the LOS for any mode below its current value.

Crash Data

IOWA DOT provides statewide crash data for every location using the IOWA DOT Crash Analysis Tool web application. The data include ten years of available crash data (2008-2018). The heat map (Figure 5) shows locations of all traffic crashes in the City of Keokuk. Most crashes are located on Highway 218 and IA 136 which is also part of the Main Street. Main Street between N 18th and N 2nd Streets shows the highest incidence of traffic in the downtown area. According to the crash data from IOWA DOT[7], the major causes of accidents in Keokuk include distracted driving, speed, failure to yield, running traffic signals, and crashes with animals. A previous study of Main Street calculated crash rates using approximation of the ADT[2]. The findings showed that approximately 50% of ADT occurs within the highest eight hours of the day. The total number of crashes was 69 between 2013 and 2017. Table 1 shows a breakdown of the accidents.

	Total Crashes	Fatal	Major Injury Incidents	Minor Injury Incidents	Possible/Unknown Incidents	PDO Incidents	Crashes per Million Entering Vehicles
US Hwy 218/Main Street & 2nd Street	7		1		2	4	0.26
US Hwy 218/Main Street & 3rd Street	5				2	3	0.20
US Hwy 218/Main Street & 4th Street	10			3	3	4	0.34
US Hwy 218/Main Street & 5th Street	3					3	0.12
US Hwy 218/Main Street & 6th Street	2					2	0.08
US Hwy 218/Main Street & 7th Street	7			1	1	5	0.26
US Hwy 218/Main Street & 8th Street	5			1		4	0.21
US Hwy 218/Main Street & 9th Street	2					2	0.08
US Hwy 218/Main Street & 10th Street	7			2	2	3	0.27
US Hwy 218/Main Street & 11th Street	2			1		1	0.07
US Hwy 218/Main Street & 12th Street	2					2	0.07
US Hwy 218/Main Street & 13th Street	6			1	3	2	0.20
US Hwy 218/Main Street & 14th Street	11			1	4	6	0.35
Total	**69**	**0**	**1**	**10**	**17**	**41**	**-**

Table 1. A summary of accidents in Keokuk (2013-2017) Source: HR Green

[5] HR Green, "City of Keokuk, Iowa Traffic and Safety Study." PDF. February 10, 2019.
[6] Dowling, Richard G., et al. "NCHRP report 616: Multimodal level of service analysis for urban streets." Transportation Research Board of the National Academies, Washington, DC. 2008.
[7] "Crash Data Location". Iowa Department of Transportation. https://data.iowadot.gov/datasets/crash-data-location

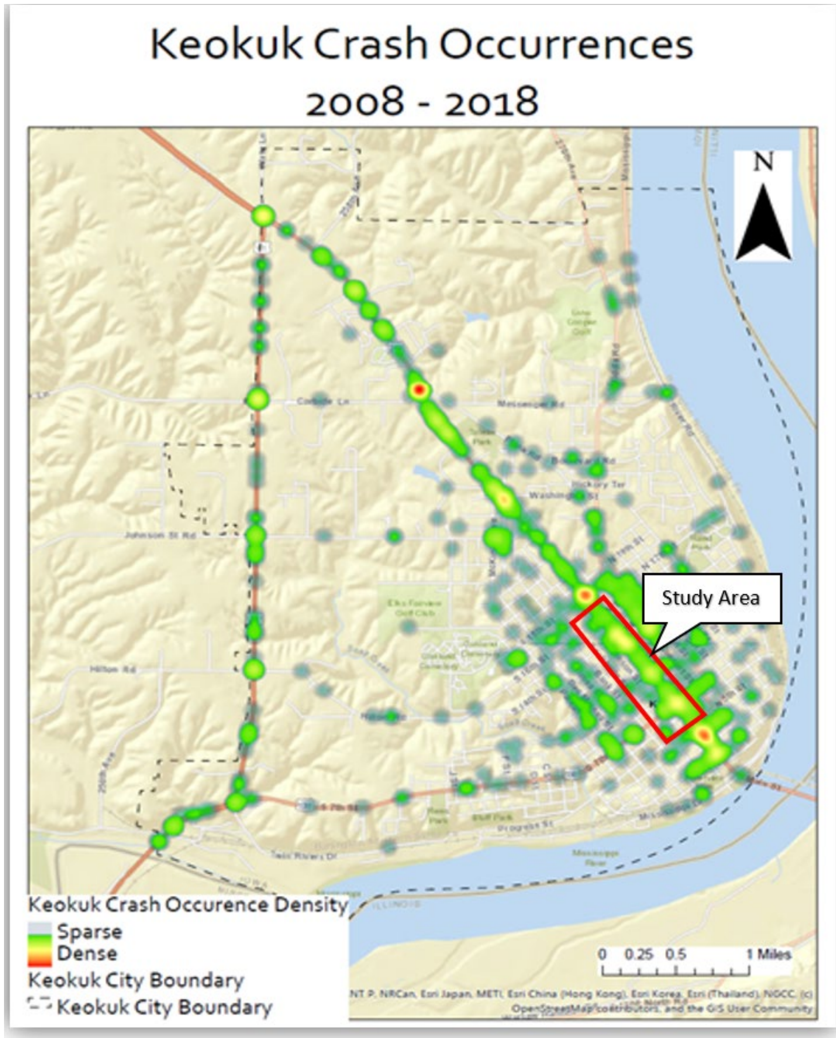

Figure 5. Map of Crash Density 2008 – 2018 in Keokuk, Iowa.

Non-motorist Crash Data

The Keokuk crash data shows incidents that involved non-motorists. There was a total of 19 crashes between 2008 and 2018 that involved non-motorists. Five of these incidences occurred on Main Street. Figure 6 shows the locations of the accidents. Pedestrian and non-motorist user safety is key in in the designing a multi-modal-use street in the downtown.

Figure 6. Map of non-motorist crashes 2008 – 2018 in Keokuk, Iowa.

Iowa DOT Guidelines

As lane conversion projects often increase safety for motorists, bicyclists, and pedestrians, Iowa DOT has developed a set of guidelines to ensure appropriate implementation. The current configuration of Main Street (Highway 218) lends itself well to automobile use but is an unpleasant environment for bicyclists and pedestrians. To generate more foot traffic and encourage different uses, Keokuk could pursue a lane conversion on Main Street from 2nd to 14th Streets.

A 4– to– 3 lane conversion consists of the removal of one travel lane to increase the efficiency and safety of a roadway. Many 4-lane roadways do not experience traffic volumes that approach their functional capacity. Reallocating the existing right-of-way space can allow municipalities to increase on-street parking or bicycle and pedestrian facilities. When implemented correctly, 4- to- 3 lane conversions can increase safety on the roadway for all users. Because of this, the Iowa DOT's office of Traffic and

Safety (TAS) developed a comprehensive list of potential locations for lane conversion in Iowa[8] . The following list contains factors that are typically analyzed as part of a lane conversion project[9]:

- Roadway function and environment
- Overall traffic volume
- Level of operational service (LOS)
- Turing volumes and patterns
- Frequent-stop and/ or slow-moving vehicles
- Weaving, speed, and queues
- Crash types and patterns
- Pedestrian and bike activity
- Right-of-way availability, cost and acquisition impacts
- General characteristics: parallel roadways, offset minor street intersections, parallel parking, corner radii, and at-grade railroad crossing

The Iowa DOT identified two sections of Highway 218 as potential candidates for a lane conversion. The first is on the north side of town and outside the scope of this report. However, Main Street from 3rd to 13th Streets has been identified as another potential candidate. This segment lies within the scope of this report and further supports the implementation of a lane conversion project.

Traffic Volume

Traffic volume is a major factor when determining the feasibility of lane conversion projects. To narrow the scope of the state-wide study, the IOWA DOT limited their analysis to 4- lane roadways with less than 18,000 AADT (Average Annual Daily Traffic). When volumes exceed 18,000, the potential for increased efficiency diminishes quickly. In addition to IOWA DOT's recommendation of a 4- to 3-lane conversion of Main Street, a Traffic Engineering Assistance Program (TEAP) study done by HR Green[10] recommends the conversion of Main Street from 4- to 3- lanes between 2nd Street and 12th Street, which 'is expected to have minimal impact to intersection operations and travel times through the corridor … [and] the added benefit of increased safety for drivers, pedestrians, and people parking downtown"[11].

Previous Studies

The abovementioned HR Green TEAP study evaluates 'existing traffic patterns, traffic signal control, and lane use geometry along the corridor … [and includes] traffic signal warrant and traffic operations analyses … [and] possible improvements to the corridor."[12] These recommendations fall into three categories: repair, reinvest, and reinvent. The first, repair, suggests repairing existing traffic signal

[8] "Statewide Screening for Potential Lane Reconfiguration." Iowa Department of Transportation. PDF. 2017. https://iowadot.gov/systems_planning/pr_guide/Safety/StatewideScreeningforPotentialLaneReconfiguration.pdf
[9] Knapp, Keith, et. al. Guidelines for the Conversion of Urban Four-Lane Undivided Roadways to Three-Lane Two-Way Left-Turn Lane Facilities. Center for Transportation Research and Education. 2001.

[10] Traffic Engineering Assistance Program. "City of Keokuk, Iowa: Traffic and Safety Study." Iowa Department of Transportation. February 10, 2019. PDF.
[11] Ibid.
[12] Ibid.

equipment at 2nd, 4th, 7th, 13th, and 14th Streets and updating the timing of the traffic signals[13]. The second, reinvest, suggests the removal of traffic signals at 5th, 6th, 8th, 9th, and 10th Streets that do not meet the 'repair' requirements, putting in 'stop control on minor streets' and 'replacing and upgrading' the remaining existing equipment as well as interconnecting the traffic signals to 'ensure good traffic progression through the corridor'[14]. Another suggestion outlines that the 'traffic signal mast arm lengths should account for a potential future 4-lane cross section to 3-lane cross section design.[15] Finally, the reinvent category suggests a 4- to 3- lane conversion of Main Street between 2nd and 12th Streets, removal of certain traffic signals, replacing and interconnecting the other traffic signals, and making 'improvements to the pedestrian experience' through curb bump-outs and added pedestrian crossings[16].

Lane Conversion Concerns / Benefits

Capacity / Efficiency

When implemented correctly, the impacts of 4- to 3- lane conversions should be minimal. Many small town main streets qualify for a lane conversion. A common concern regarding lane conversion projects is that traffic downtown will decrease, negatively impacting the economic growth of the area. Since many strong lane conversion candidates are operating below their functional capacity, average daily traffic often remains about the same. Additionally, lane conversion projects can increase pedestrian and bicycle traffic by providing better infrastructure and safety, potentially increasing economic activity due to increased foot traffic.

Another concern regarding lane conversions is that reducing the number of travel lanes will decrease efficiency and result in congestion. However, the addition of a center turn lane can help mitigate the congestion caused by turning vehicles and allow through traffic to flow more freely. A 2019 Traffic and Safety Study done by HR Green showed no decrease in level of service for a 3-lane conversion compared to the existing conditions[17].

A common concern, especially in smaller and rural communities, is that a lane conversion project will make it more difficult for large vehicles like semis and farm equipment. Often, road lane conversion projects do not affect lane width, only the number of lanes. Additionally, the engineering process should ensure that lane widths will be able to accommodate large vehicles. The weight of large vehicles is not an issue, the pavement is structurally sound. However, measures should be taken to divert heavy truck traffic away from Main Street to US 61, in order to improve safety and enhance the environment for bicyclists and pedestrians.

EMS

Perhaps the most common concern regarding lane conversions is the perceived impact that fewer travel lanes will have on emergency response times. A common perception of lane conversion projects is that because 4- to 3- lane conversions reduce the number of travel lanes, emergency response vehicles will be slower to reach their destination. Evidence of this is often anecdotal and can usually be explained by

[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.

poor engineering and design. In some cases, lane conversions have been implemented on roads where traffic volumes warrant the existing conditions. If a lane conversion project is implemented on a high-volume road, congestion may actually increase. The type of lane conversion that is implemented is also important. In some cases, the conversion that causes delayed response is not actually a typical 4- to 3-lane conversion. A simple 4- to 2- lane conversion, without a center turn lane, can cause congestion and delay response times. When an actual 4- to 3- lane conversion is engineered and implemented correctly, emergency response vehicles can utilize the center turn lane to bypass through traffic and reach their destination in a timely manner. It is crucial that lane conversion projects are planned, engineered, and implemented correctly to ensure that delays to emergency response vehicles do not occur.

Economic Impact

Another concern regarding lane conversion projects is that the new street configuration will reduce traffic volumes and have a negative economic impact on business along the street. This is generally not the case as lane conversion projects, when done correctly, do not result in large decreases of motor vehicle volume. Additionally, lane conversion projects create a more pedestrian- and bicyclist- friendly environment. Increased foot traffic along the street can have a positive impact on businesses. One example of a lane conversion project that boosted the local economy is the Indianapolis Cultural Trail. Lane conversion projects were used to create an 8-mile-long trail throughout the city. The projects helped attract $300 million of new development along the corridor[18,19] . When appropriate volume thresholds are used to implement lane conversion projects, local businesses should not suffer. As volumes do not typically decrease by more than 10% and pedestrian activity usually increases, local businesses should expect increased economic activity.

Conversion Impacts: Before / After Studies

The following sections provide information from case studies of 4- to 3- lane conversions. Though each situation is dependent on local conditions, these case studies are indicative of the changes associated with conversion projects. The impact on collisions, traffic volumes, and traffic speeds are consistent among the case studies.

Collisions

In Genesee County, Michigan, lane conversion projects have become increasingly popular. The County initially approached roadways with around 6,000 AADT. However, as the projects have become more common, roads with up to 15,000 AADT are being considered for lane conversion projects. The County conducted an analysis of crash data from 1996 – 2007 at seven lane conversion sites. On average, head-on collisions were reduced by 32% and head-on left turn collisions were reduced by 58%. In addition, rear-end collisions were reduced by 35% and rear-end left turn collisions were reduced by 36%. The Iowa Traffic and Safety Study for Keokuk showed that the highest percentage type of the 69 accidents reported between 2013-2017 were rear end (front to rear) at 38% followed by broadside (front to side)

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[18] "Road Diet Case Studies: FHWA Report No. FHWA-SA-15-052". Federal Highway Administration. Washington, D.C. PDF. https://safety.fhwa.dot.gov/road_diets/case_studies/roaddiet_cs.pdf
[19] "The Economic Benefits of Sustainable Streets." New York Department of Transportation. PDF. http://www.nyc.gov/html/dot/downloads/pdf/dot-economic-benefits-of-sustainable-streets.pdf

at 22%, and non-collision (single vehicle) at 10%. Others included sideswipe (same direction) at 10%, angle (oncoming left turn) at 9%, head on at 1%, sideswipe (opposite direction) 1%, and others 5%. The reductions in rear end, broadside, and left-turn specific collisions should be noted. The addition of a center turning lane allows for motorists to more safely cross the street. They are less susceptible to rear end collisions that occur when cars are queued in the travel lane. Reducing the number of lanes that left turner must cross from two to one had the largest reduction in collisions.

Traffic Volume

AADT, or annual average daily traffic, is a useful measurement which allows for a better understanding of the traffic levels for a given roadway. Based on an analysis of five different lane conversion projects completed by researchers at The University of Oregon, traffic decreased an average of 11.9% after the completion of the lane conversion. Pre-lane-conversion volumes ranged from 13,000 to 20,600 and post-conversion volumes from 11,500 to 18,900. It should be noted that some traffic may have been pushed onto nearby streets, but many of the cities in the report had not received complaints of unusual volumes on neighboring streets due to the lane conversion projects.

Speed Reduction

Speed reductions are largely site dependent. One study suggests that average and 85th percentile speeds, or the speed at which 85% of drivers will drive at or below under free-flowing traffic conditions, can be expected to drop by 3 to 5 miles per hour (mph). 85th percentile speeds are typically greater than the posted speed limit and reductions improve safety. Many other studies show larger reductions in speeds, especially on high volume roadways. Many smaller studies show the lane conversions have the largest impact on top-end speeders. A lane conversion project in Seattle resulted in an 80% reduction in the number of motorists traveling more than 10 mph above the posted speed limit. Due to lack of speed data in many municipalities, it is difficult to determine expected speed reductions. 85th percentile speeds and average speeds can be expected to remain relatively unchanged. The most substantial speed reduction occurs to "top-end" speeds.

Case Studies

4- to 3- lane conversions

The following case studies are highlighted because they have similar conditions to Main Street in Keokuk, Iowa. Main Street in Keokuk has an annual average daily traffic count of 6,000 – 13,600, no bike lanes, and there are safety concerns for pedestrians, bicyclists, runners, and other non-vehicle-users of the road. These case studies provide plausible options for Keokuk to consider as part of a 4- to 3- lane conversion.

San Francisco, California 25th Avenue Conversion

25th Avenue in San Francisco, California was a 4 thru traffic lane major arterial road with an average daily traffic count (ADT) of 13,000. Prior to the road conversion, the busy road did not have bike lanes or safe walking conditions, cars would park on the sidewalks, and buses would have to drive in the middle of the road in two lanes to avoid hitting parked cars. The San Francisco Municipal Transportation Agency and an air quality grant helped to pay for the conversion of 4 thru traffic lanes to two thru traffic lanes and a two-way center turn lane. This change resulted in lower ADT, an increase in use of non-car modes of transportation, improved travel times for buses, more comfortable left turns, and positive public response[20].

Seattle, Washington Stone Way N. Conversion

Stone Way N. in Seattle, Washington was a 4 thru traffic lane minor arterial road with an average daily traffic count (ADT) of 13,000. Prior to conversion, this road had out-of-date crosswalks and the street was scheduled for repaving. There were 'no dedicated left-turn lanes or explicit markings to demarcate the parking or cycling lanes' and there was a bus stop that 'faced an empty lot'[21]. The conversion was done to '[maintain] car capacity while improving safety and adding bike lanes'[22]. Four thru traffic lanes were converted to two thru traffic lanes and a two-way center turn lane and 'a bicycle lane was added to the uphill side of the street and sharrows were added to a wider travel lane on the downhill side'[23]. This change resulted in reduced ADT, safer conditions for pedestrians, lower speed driven, more cyclists, and a steady traffic capacity.

Reconfiguration Options for Main Street

Below are recommendations based on the above findings concerning existing conditions, safety concerns, IOWA DOT guidelines, concerns and benefits associated with lane conversions, before/after data, and case study research. Redesign options include multiple bicycle lane configurations, lane conversion options, and traffic safety improvements.

Infrastructure Improvement Types

The following options consist of the different right-of-way configurations that could be implemented in Keokuk. National Association of City Transportation Officials (NACTO) Urban Street Design Guide was used when applicable to determine the best practices for each type of path. The NACTO guide specifically issues recommendations for use in urban environments and is recognized as a standard by Iowa DOT.

Buffered Bike Lanes[24]

On streets with a higher traffic volume and speed limit, NACTO recommends buffered bike lanes. Buffered bike lanes consist of a painted bicycle lane, with an additional buffer of some sort between the vehicle lane and the bike lane. A buffer can simply be two painted lines with diagonal markings in between them. The buffer should contain such markings if 3 feet or wider. If a street has high truck traffic, a speed limit of 35 miles per hour or greater, and high traffic volume, alternatives to the conventional bike lane are suggested such as the buffered bike lane, left-side lanes, and cycle tracks[25].

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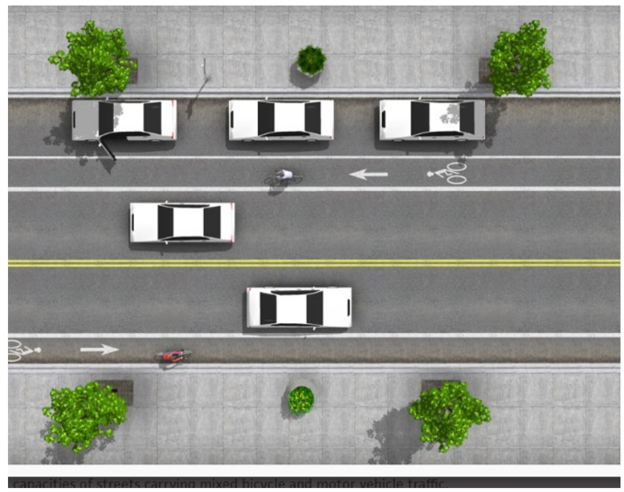
[20] Schlossberg PhD, Marc, John Rowell, Dave Amos, and Kelly Sanford. "Rethinking Streets – An Evidence-Based Guide to 25 Complete Street Transformations". PDF. 2013.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] [24] "Urban Bikeway Design Guide." National Association of City Transportation Officials, November 13, 2017. https://nacto.org/publication/urban-bikeway-design-guide/
[25] Schlossberg PhD, Marc, John Rowell, Dave Amos, and Kelly Sanford. "Rethinking Streets – An Evidence-Based Guide to 25 Complete Street Transformations". PDF. 2013.

Conventional Bike Lane

Bicycle infrastructure at its core consists of bike lanes, designated areas on the street for bicycle traffic. Conventional bike lanes are best used on streets with at least 3,000 average daily traffic and speed limits of 25 miles per hour and greater. Conventional bike lanes would perform best on arterial and collector streets in Keokuk with a higher traffic volume[26]. Conventional bike lanes are a dedicated bicycle facility which is adjacent to the vehicle travel lane and going in the same direction as motor vehicle traffic. These lanes are typically on the right side of the road between the travel land and the curb or parking lane and may be buffered if road with allows[27].



Figures 7 and 8. Bike lane examples. Source: NACTO[28]

Protected Bike Lanes

Protected bike lanes provide infrastructure exclusively for bicycles which that is physically separated from general traffic. The separation is provided through some type of barrier which could be anything from a curb, potted plants, flexible posts or parked cars. The physical protection increases the sense of safety as well as comfort level for cyclists of all levels. The presence of protected bike lanes reduces the risk of bicycle/vehicle collisions by increasing predictability of bicyclists but acting like a visual reminder of a bicyclists' right to the road. Many times, these protected bike lanes have a buffer area, the area is where planters or the flexible posts would go but also providing a door zone for motorists to get in and out of their cars without impeding cyclists[29].

[26] "Urban Bikeway Design Guide." National Association of City Transportation Officials, November 13, 2017. https://nacto.org/publication/urban-bikeway-design-guide/

[27] Ibid.

[28] Ibid.

[29] Ibid.

Figure 9. Protected bike lane example. Source: NACTO[30]

Figure 10. Protected bike lane example. Source: NACTO[31]

Sidewalks

NACTO-recommended sidewalk widths are 5 to 7 feet for residential areas and 8 to 12 feet for downtown and commercial areas. The sidewalks in Keokuk are typically 14 to 18 feet[32] and are sufficiently wide for their purpose.

Lane Widths

Vehicle travel lane width is advised to be 10 feet in urban areas and not greater than 11 feet. Lanes of 11 feet are recommended by NACTO on designated truck routes. Parking lanes should be anywhere from 7 to 9 feet in width, with exceptions of up to 15-foot-wide lane for loading zones where double parking happens. The width of travel lanes that are currently along Main Street are approximately 12 feet[33] and could be narrowed to 11 feet without impacting traffic flow.

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[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Ibid.

Bump Outs

Bump outs extend the sidewalk to be in line with the parking lane in order to increase the visibility of pedestrians as well as reducing the crossing distance of the road. Bump outs also encourage slower turning speeds by tightening the curb radius which also increase the safety of pedestrians and bicyclists.

Bicycle paths that go through intersections with bump outs must be treated so that bicycles are able to navigate through the bump outs. There are a couple of options to treat the bump outs for bicycle usage. Options include cutting through the bump out to allow for adequate space for bicycle traffic to cut through the bump out. Ramps for bicycles can also be constructed over the bump outs[34].

Intersection Safety

Intersections are points of conflict within any roadway system for motorists, bicyclists and pedestrians. One of the main ways to reduce conflict is to reduce a vehicle's speed at intersections which allows a driver to see bicyclists and pedestrians and have time to react and yield to them. Slower speeds also reduce the likelihood of severe injuries or fatalities in case of a crash. Intersections with a protected bike lane should be designed to create a slow turning movement at 10 miles-per-hour or less.

Intersections along Highway 218 need to be designed to accommodate trucks especially at the intersection of Highway 136. It is a signalized intersection which requires additional space in order to accommodate turning trucks.

Figure 11. Intersection in Keokuk, Iowa. Source: Google Maps.[35]

One option would be to have the stop line for the receiving traffic pushed back in order to allow a large truck to use a portion or the entire width of the receiving roadway which means it would encroach on the oncoming travel lane.[36]

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[34] Ibid.

[35] Screenshot. Accessed December 2, 2019. Maps.google.com

[36] "Separated Bike Lane Planning & Design Guide." Mass.gov. Accessed November 20, 2019. https://www.mass.gov/lists/separated-bike-lane-planning-design-guide

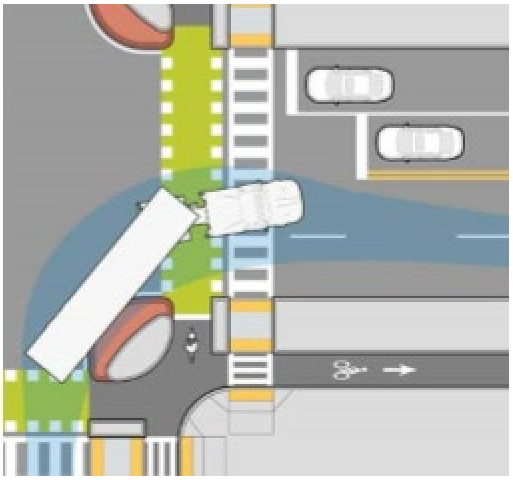


Figure 12. Intersection example. Source: Massachusetts Department of Transportation[37]

Another option would be to utilize mountable truck aprons. If the intersection has a curb radius which is too small, it often results in the rear wheels of the truck driving over the curb which also leads to an increase in maintenance issues. Mountable truck aprons reduce turning speeds for passenger vehicles but also allows for trucks to track over the area and creates a larger corner radius. These surfaces need to be visually distinct from travel lanes and sidewalks to ensure pedestrians do not stand on them. The height of the mountable area should not exceed 3 inches above the travel lanes in order to accommodate a range of trailers.

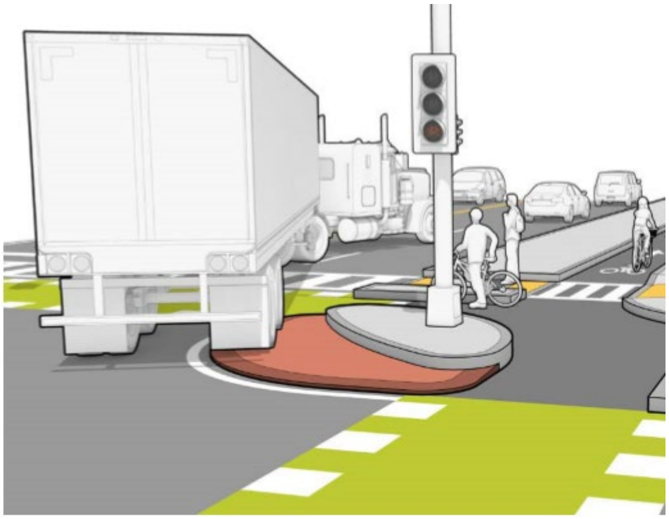


Figure 13. Truck turning at intersection. Source: Massachusetts Department of Transportation[38]

Scenarios

Based on the infrastructure reconfiguration options discussed, three scenarios are presented for the reconfiguration of Main Street. Leaving Main Street in its current condition, implementing a buffered

[37] Ibid.

[38] Ibid.

conventional bike lane, and a buffered bike lane protected by parking are considered. The street layout, widths of the lanes, and segment level of service are provided in Figures 14, 15 and 16.

Scenario 1: Leave Main Street As-Is

9’ parking

12’ travel lane (2 in each direction)

Segment Level of Service: Vehicles D, Bicyclists D, Pedestrians B

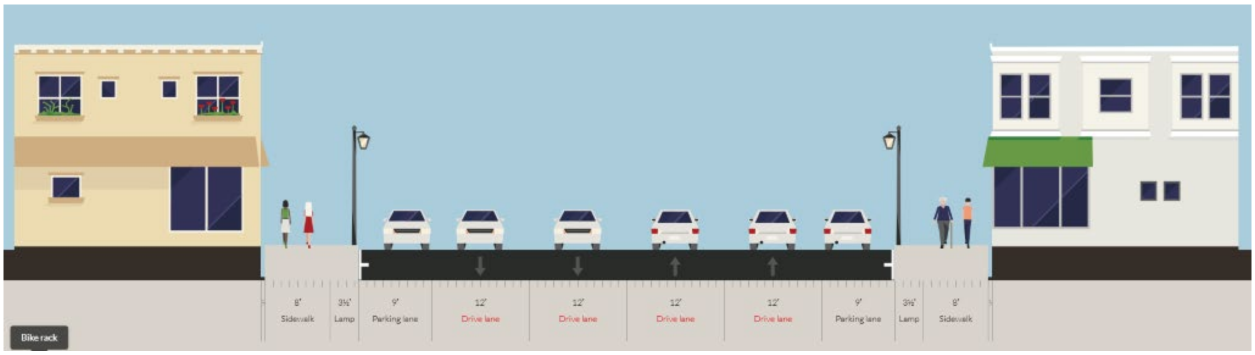


Figure 14. Main Street as-is. Source: Author.

Scenario 2: Conventional Bike Lane[39]

Travel Lanes: 11’

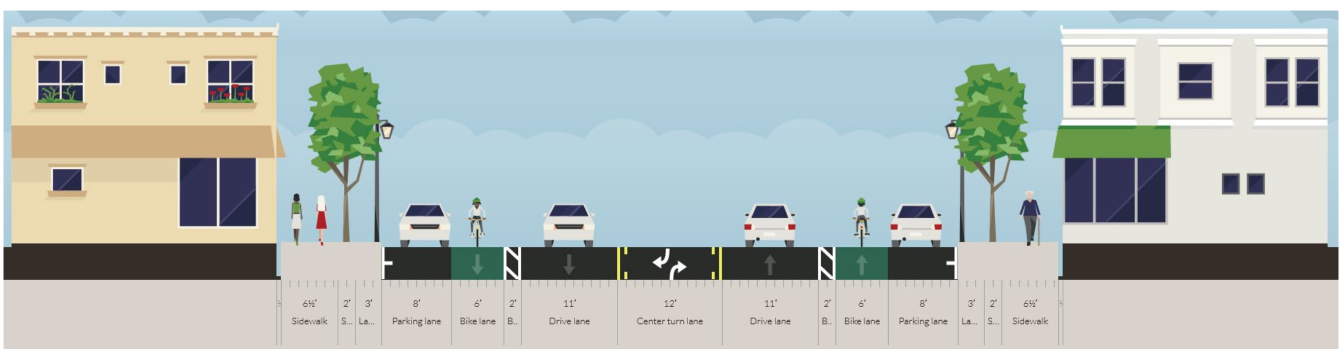
Turn Lane: 11’

Bicycle Buffer: 2’

Bicycle Lane: 6’

Parking Lane: 8’

Segment Level of Service: Vehicles D, Bicyclists C, Pedestrians A



[39] “Urban Bikeway Design Guide.” National Association of City Transportation Officials. November 13, 2017. https://nacto.org/publication/urban-bikeway-design-guide/

Figure15. Conventional bike lane scenario. Source: Author.

Scenario 3: Protected Bike Lanes[40]

Travel Lanes: 11’

Turn Lane: 11’

Bicycle Buffer: 3’

Bicycle Lane: 6’

Parking Lane: 8’

Segment Level of Service: Vehicles D, Bicyclists A, Pedestrians A

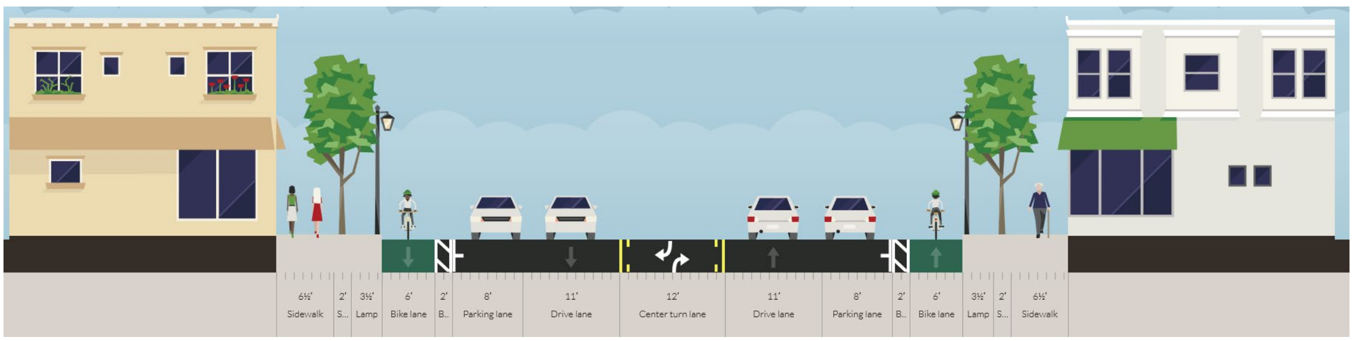


Figure 16. Protected bike lane scenario. Source: Author.

Truck Routes

When looking at potential solutions to the issues facing traffic in downtown Keokuk there are a few important factors to consider, one of them being through truck traffic on Main Street. Truck traffic is an important part of a healthy freight system and is a necessary aspect of transportation within and between cities, it is however, also a source of potential increases in congestion and crashes. In order to gauge properly the impacts of truck traffic on Keokuk, especially as it pertains to Main Street, two aspects should be observed, crash data and throughput. Crash data were already discussed in the sections above, so we will now begin to look at throughput rates for truck traffic in two of the most accident-prone intersections of Main Street, 7th and Main, and 14th and Main[41]. The turning information for single and combo trucks at both intersections are shown in Figure 17, the order is: 7th and Main single, 7th and Main combination, 14th and Main single, 14th and Main combination. The goal of the truck route would be to reduce the throughput of truck traffic in both intersections, especially between 7th and 14th. In particular, through truck traffic should be encouraged to use US 136/7th Street to access US 61, bypassing downtown. This could be achieved through a truck route designation. Information about establishing a truck route is provided in the toolkit below.

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[40] Ibid.

[41] “Iowa DOT Turning Movement Traffic Count Summary.” PDF. Iowa Department of Transportation. September 25, 2017.

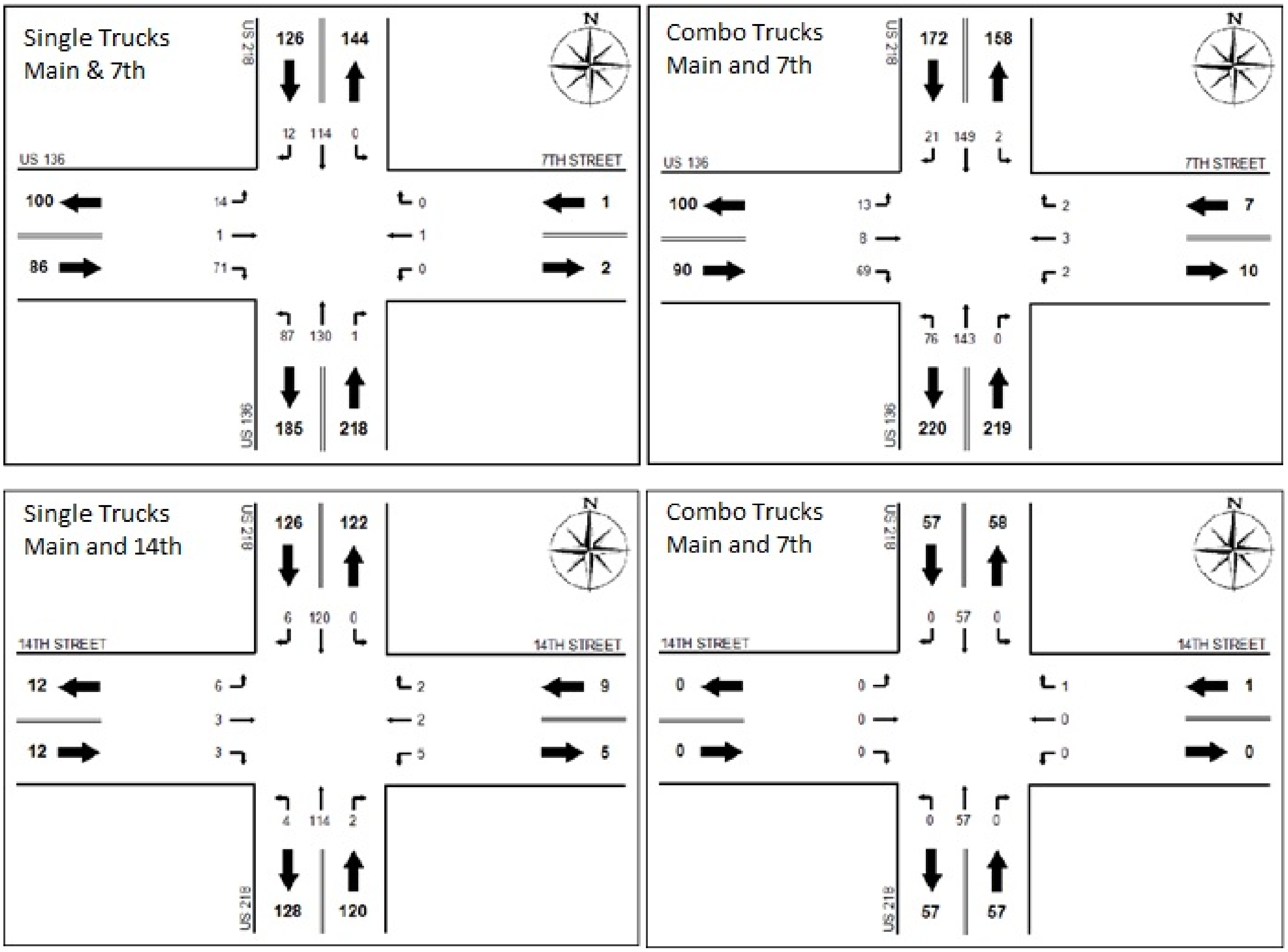

Figure 17. Iowa DOT Turning Movement Traffic Count Summary. Source: IOWA DOT.[42]

Truck Route Toolkit

While there exists no silver bullet for the creation of a truck route in Iowa there are some important documents and examples that we can look to understand the process. In this section, we will discuss the Iowa State Freight Plan[43], the Local Truck Routes: A Guide for Municipal Officials[44], and a truck route study done for Bozeman, Montana[45], and go over their methodologies to create a toolkit for deciding to implement a truck route.

The Iowa State Freight Plan, completed through the Iowa DOT to act as a guiding document for freight transportation management in Iowa, sheds light on how freight is currently handled in Iowa. This document contains all the stated goals and issues, and their suggested solutions. Additionally, it acts as a directory for helpful resources when Keokuk decides to move forward with the creation of a truck route. The IOWA DOT offers a program called Iowa Traffic Engineering Assistance Program (TEAP) which aims

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[42] "Iowa State Freight Plan." PDF. Iowa Department of Transportation. 2016.
[43] Ibid.
[44] "Local Truck Routes: A Guide for Municipal Officials." PDF. Ontario Trucking Association. December 2011.
[45]Villwock-Witte, Natalie, Justin Livingston, and David Kack. "Understanding Commercial Truck Traffic Through Downtown Bozeman." PDF. Western Transportation Institute: Montana State University. June 2015.

at assisting local Iowa communities by providing traffic engineering expertise with considerations regarding safe and effective transportation; this would include truck routes. While information is given on the creation of alternative routing for oversized and overweight truck movement, it is the default position of the state that all truck movement is allowed on highway/interstates. This, however, does not mean that it is impossible to create a truck route in Iowa.

The Local Truck Routes: A Guide for Municipal Officials which was created by the Ontario Trucking Association in 2011. While this document deals with the creation of truck routes in another country, it contains within it very similar steps to how such a process would take place in the United States. This document includes everything from what considerations need to be made before beginning the process to what localities should be prepared to do to create their truck route designations. While the specificities of the laws in this document might not apply in the United States, there is not a substantive difference between the processes in both countries.

A truck route study done for Bozeman, Montana to guide their truck route determination process is useful as a guiding document in creating the truck route toolkit. *Understanding Commercial Truck Traffic Through Downtown Bozeman*, authored in 2015, is a fantastic collection of case studies and methodologies for the considerations around, and creation of, truck routes specifically as they relate to downtowns. This document includes an extensive literature review section which covers most topics required to understand before deciding whether to create a truck route. What makes this document so applicable to the considerations being made in Keokuk is that they have a similar case as that of Keokuk. Bozeman, Montana has issues with congestion on their main thoroughfare, which is also a state highway, additionally, the suggested truck route would also divert traffic away from the main stretch and onto another set of state highways.

Recommendation: US 136 / US 61 Truck Route

This report suggests that US Highway 136 be designated as a truck route to reduce freight traffic on US 218 (Main Street). Depending on the route chosen, this would assist in reducing congestions and potentially reduce the occurrences of accidents on Main Street in downtown Keokuk. It is the opinion of the authors of this report that no substantial alterations need to be made to US 136 to accommodate the increased freight traffic. The surface of US 136 appears to be in good, working condition and the intersection of US 136 and US 61 has wide turn lanes which are more than adequate for freight transportation.

The suggested changes would be limited to some traffic movement considerations at the intersection of Johnson Street and 7th (US 136), depending on the truck route chosen, and the inclusion of some additional signage. Intersection treatments shown under Intersection Safety in this report should be considered to facilitate heavy truck turning movements, however no physical changes to the roadway are required. Examples of signage that have been used throughout the state are included in the Appendix and can be affixed to existing signage infrastructure.

As for Highway 61, there would need to be no additional modifications to existing infrastructure for it to function as the main north-south leg of the proposed truck route. The surface seemed to be in moderate condition, however, any repairs needed would be handled by the Iowa DOT. When considering the need for internal freight trips within Keokuk, meaning that the trip both originates and terminates within Keokuk, Highway 61 offers a convenient number of east-west connector roads which will allow for access back into the core of Keokuk, allowing for trips to be completed while avoiding heavy use of interior roads.

Based on Google Maps routing, travel time on the proposed truck route is only two minutes more than Main Street. This is a relatively small delay compared to total travel time for heavy trucks.

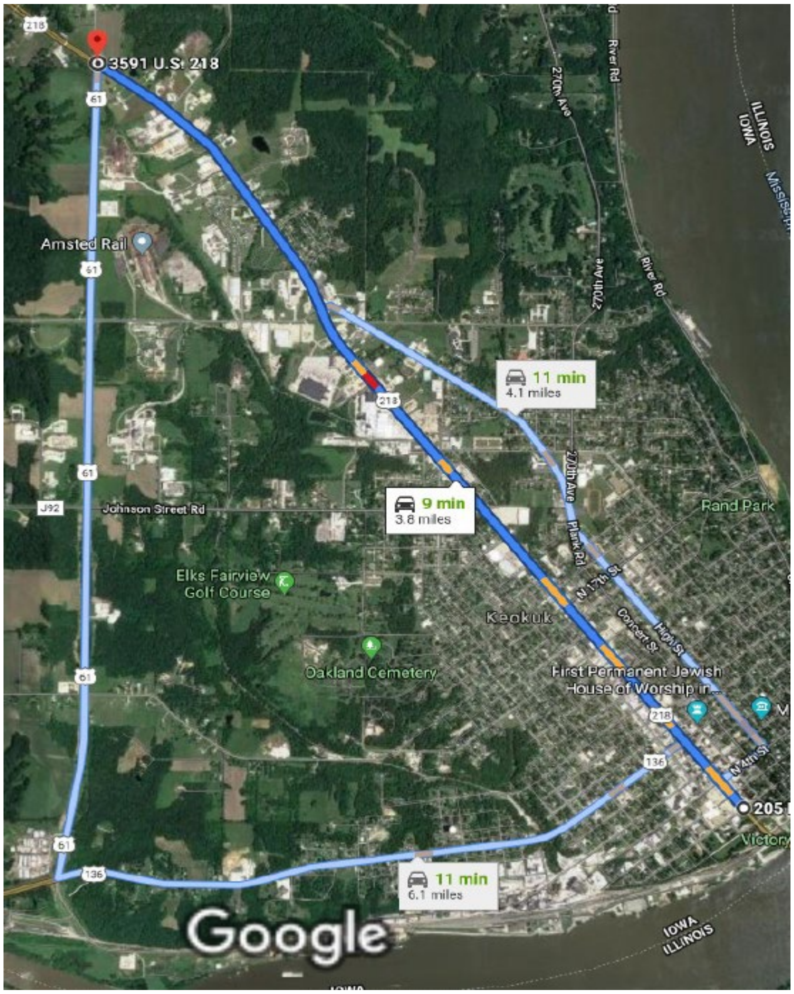

Figure 18. Truck route in Keokuk, Iowa. Source: Google Maps[46].

Recommendation Summary

Road Configuration

Treatment for bike/ped

The safest option for bicyclists and motorists alike would be to treat the street with a 4- to 3- lane conversion with protected bike lanes. This provides the safest environment for people of all ages and abilities to use the street. The protected bike lane protects the bicycle riders from vehicle traffic while making accommodations for parking and a safer configuration for motorists. Protected bicycle lanes in conjunction with a 4-to-3 lane conversion is recommended since it will be the safest option for all street users. If a protected bike lane is prohibited by cost, the next best option is a buffered bike lane without the parking protection. Installation of a mountable truck apron as well as pushing back the stop line are the recommended safety improvements for the 7th and Main Street intersection. Existing bump outs should be cut out or ramped over to allow for bicycle traffic. For new bump out construction, painted

[46] Screenshot. Accessed December 2, 2019. Maps.google.com

bump outs can be used to save on construction costs. Figure 19 shows the location of the proposed intersection redesign and where new bump outs are recommended. Figure 20 Shows an example of painted bump outs from the NACTO guide. In addition, a US136 / US 61 truck route should be established in order to reduce truck traffic on Main Street.

Figure 19. Intersection redesign for truck turning movement. Source: Google Maps and the Author.

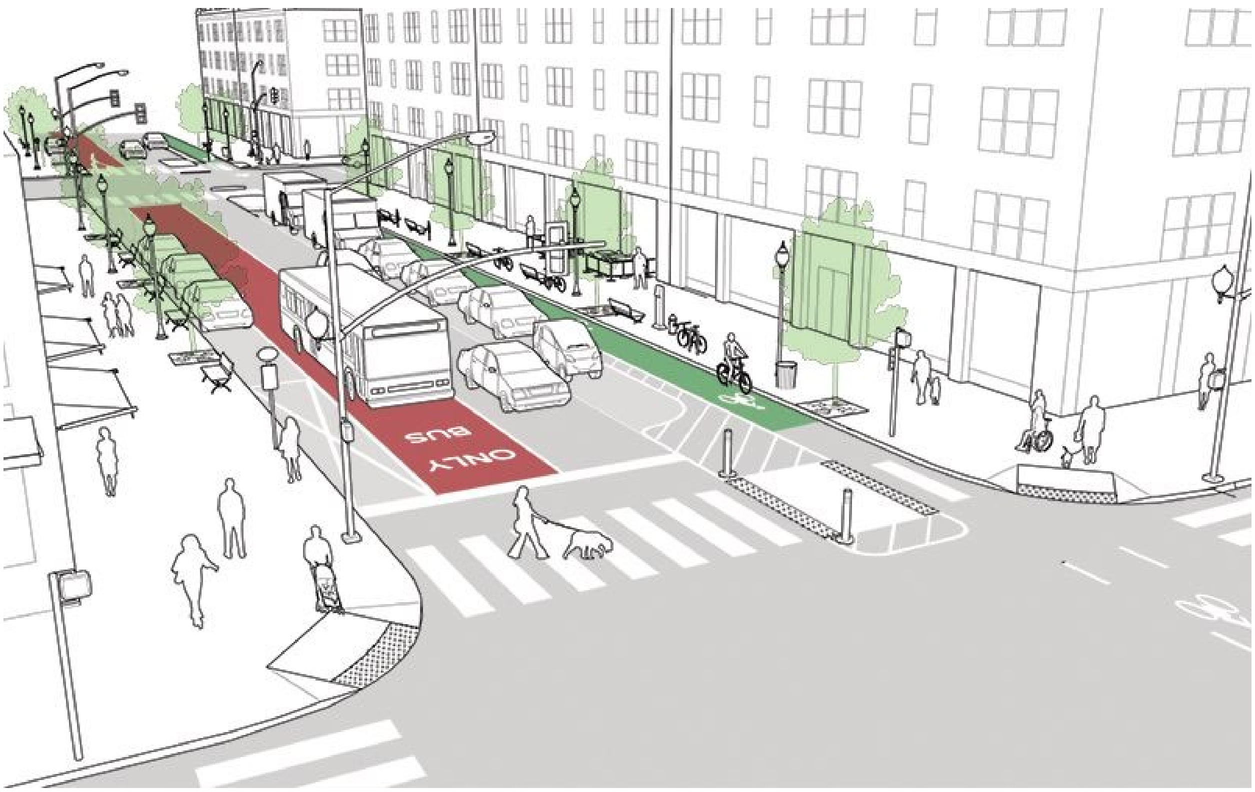

Figure 20. Interim Painted Bump Out and Crossing Design. Source: NACTO.

Implementation

Cost Estimates

Using a resource created by UNC Highway Safety Research Center in 2013 titled *Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public*, we were able to adjust average prices for the following roadway treatments to create our best cost estimates for various roadway treatments. These treatments relate primarily to any new pedestrian or cycling infrastructure that would be new features on Route 218. Additionally, bicycle infrastructure considerations were adopted from *Cost Analysis of Bicycle Facilities: Cases from cities in the Portland, OR* Region from Portland State University.

Infrastructure	Description	2013 Median[47]	2019 Adjusted Median	Unit
Curb Extension	Curb Extension/Choker/ Bulb-Outs	$10,150	$11,188	Each
Curb Ramp	Truncated Dome	$37	$41	Sq. Ft
Curb Ramp	Wheelchair Ramp	$740	$816	Each
Curb Ramp	Wheelchair Ramp	$12	$14	Sq. Ft
Crosswalk	High Visibility Crosswalk	$3,070	$3,384	Each
Crosswalk	Striped Cross	$340	$375	Each
Crosswalk	Striped Cross	$5.87	$6.47	Linear Foot
Crosswalk	Striped Cross	$6.32	$6.97	Square Foot
Flashing Beacon	Flashing Beacon	$5,170	$5,699	Each
Flashing Beacon	Rectangular Rapid Flashing Beacons (RRFB)	$14,160	$15,607	Each
Signal	Audible Pedestrian Signal	$810	$893	Each
Signal	Countdown Timer Module	$600	$662	Each
Signal	Pedestrian Signal	$980	$1,081	Each
Signal	Signal Face	$490	$540	Each
Signal	Signal Head	$570	$629	Each
Signal	Signal Pedestal	$640	$706	Each
Pavement Marking Symbol	Pedestrian Crossing	$310	$342	Each
Pavement Marking Symbol	Shared Lane/ Bicycle Marking	$160	$177	Each
Pavement Marking Symbol	School Crossing	$520	$573	Each
Curb/Gutter	Curb	$18	$20	Linear Foot
Curb/Gutter	Curb and Gutter	$20	$23	Linear Foot
Curb/Gutter	Gutter	$23	$26	Linear Foot

Table 2. Cost estimates for various infrastructure.

[47] Bushell, Max A., Bryan W. Poole, Charles V. Zegeer, Daniel A. Rodriguez "Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public" PDF. University of North Carolina Highway Safety Research Program. Oct. 2013

Category	Facility Type	2013 Estimation[48]	2019 Adjusted Estimation	Unit
Bike Lanes	Line/Stripe Removal	$0.62	$0.68	Foot
Bike Lanes	Bike Lanes	$0.83-$6.35	$0.91-$7.00	Foot
Bike Lanes	Buffered Bike Lanes	$2.00-$9.33	$2.20-$10.28	Foot
Bike Lanes	Bike Lane Stencil	$250-$270	$276-$298	Stencil

Table 3. Cost estimates for bike lanes.

Cost Estimates

There are an estimated 4,425 feet of road in the study area. Given the conversion goes through and bike lanes are installed, the lanes will be buffered lanes on both sides of the road. Protected bike lanes refer to a configuration where bike lanes are protected by parking with a buffer to prevent motorist doors from colliding with cyclists; these facilities will however require reconfiguration of existing bump-outs which we estimate to be half the cost of creating a new bump-out. On-road facilities will have a buffer as well but will not be parking protected and therefore will not interfere with any existing bump-outs. We estimated that line removal would cost the same per foot plus 15% as the estimations from Portland State University. The estimates that follow provide planning estimates for the two recommended conversions, based on costs given in Tables 2 and 3.

4-3 Lane Conversion with Protected Bike Lanes

Treatment Name	
Buffered Bike Lanes	$19,470-$90,978
Stencil for Bike Lane	$276-$298
Paint for Lane Marking	$177
Retrofitting Existing Bump-Outs	$89,504
Paint Removal for Reconfiguration	$6,920
Total Cost	**$116,347-$187,877**

4-3 Lane Conversion with Unprotected Bike Lane

Treatment Name	
Buffered Bike Lanes	$19,470-$90,978
Stencil for Bike Lane	$276-$298
Paint for Lane Marking	$177
Paint Removal for Reconfiguration	$6,920
Total Cost	**$26,843-$98,373**

[48] Weigand PhD, Lynn, Nathan McNeil, and Jennifer Dill, PhD. "Cost Analysis of Bicycle Facilities: Cases from cities in the Portland, OR Region from Portland State University." PDF. Portland State University. June 2013.

Grant Funding for Engineering Services

Funding improvement projects can often be difficult without outside assistance from higher levels of government. There are various programs offered in the state of Iowa that provide funding assistance to municipalities to help cover costs of improvements ranging from traffic safety to air quality. The following is a list of potential funding sources for both technical assistance and infrastructure redesign & repairs.

Traffic Safety Improvement Program (TSIP)[49]

TSIP is a program implemented by the Iowa DOT that provides funding for construction, purchasing of traffic safety equipment, and funding traffic safety research. Project applications must be submitted in one of three categories established by the DOT which include a site or corridor with a crash history, purchase of materials for new traffic control devices or replacement of obsolete signs and signals, or research related to public information initiatives, driver education, work zone safety, and crash data analysis. Cities and counties are both eligible to apply for this funding and awards cannot exceed $500,000 per project.

Traffic Engineering Assistance Program (TEAP)[50]

TEAP provides engineering assistance to communities that are aiming to improve safety and road operations. This includes high-crash locations, unique lane configurations, obsolete traffic control devices, school pedestrians, truck routes, parking issues, etc. Both counties and cities without a staff traffic engineer are eligible to apply. This requires no local match but does require assistance with data collection efforts by applicant staff at the request of consultants.

Revitalize Iowa's Sound Economy (RISE)[51]

RISE is aimed at promoting economic development through the construction and improvement of existing streets. Funding can be received as a grant or loan or a combination of the two. The types of projects that are granted funding in this instance fall under categories of immediate opportunity or local development.

Immediate Opportunity refers to projects that are related to non-speculative opportunity for permanent job creation or retention. Local match in this case is a minimum of 20%.

Local Development refers to projects that support local economic development but do not require immediate funding or do not meet immediate opportunity criteria. The considerations in this category include development potential, economic impact, local commitment and initiative, transportation need, and are economic need. Local match is typically around 50%.

Iowa's Transportation Alternatives Program (TAP)[52]

TAP funds programs that provide transportation alternatives such as pedestrian and bicycle facilities, enhanced mobility, community improvement activities, recreational trail projects, safe routes to school projects, etc. as a replacement for a previous federal grant program. Local governments, regional

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[49] "Guide to Transportation Funding Programs of interest to local governments and others." PDF. Iowa Department of Transportation. October 2019.
[50] Ibid.
[51] Ibid.
[52] Ibid.

transportation authorities, transit agencies, natural resource/public land agencies, tribal governments, any other regional government body with transportation or recreational trail oversight may apply for this grant funding. For this funding 20% local match is required and projects must have a direct relationship with existing or planned transportation or a relationship to one of more than 20 other qualification measures.

Iowa Clean Air Attainment Program (ICAAP)[53]

ICAAP is aimed at funding highway, street, transit, bicycle, pedestrian, and freight programs that assist in maintaining air quality by reducing auto emissions. Eligible highway and street projects must be on the federal-aid system and applications can be submitted by public entities or private entities in partnership with public entities, but the public entity will assume financial responsibility. This program requires a 20% local match. In order to qualify, projects must either reduce emissions with traffic flow improvements and provide a direct benefit to air quality, reduce vehicle miles traveled, reduce single-occupant trips, or have another transportation improvement that will improve air quality/reduce congestion.

Next Steps

Building Public Support

Iowa's department of location and environment, a sub-department of the Iowa DOT, provides two strategies for public engagement regarding transportation projects[54]. Holding public engagement activities, such as public information meetings or public hearings, ensures that the community is given the opportunity to provide ideas and comments regarding the development of the transportation related project. Additionally, there are federal and state regulations that require a public engagement process because transportation projects effect the entire community, thus public input is highly important.

The two most common forms of public engagement events are public information meetings and public hearings. Information meetings are generally held throughout the duration of the project at different stages. These meetings may also be held to inform and discuss detours, road closures, or right of way needs. A public information meeting is set up as an open forum so attendees can see visual displays and can ask questions directly to the transportation experts. Individuals in attendance are encouraged to voice their comments during the meeting. Additionally, individuals are often prompted to send written comments or submit comments online after the meeting regarding the project or detour.

Ultimately, providing a space for the public to voice concerns and thoughts is an important component of any project. A public hearing is a method of public engagement that is generally held later in the project when a document showing the environmental changes and how daily traffic will be altered throughout the duration of the project. In addition, it is useful to show and compare different project alternatives and each's influence on the surrounding environment. The public hearing involves a formal presentation made by the city staff. The formal presentation can be recorded to be saved and included in the final record. In an open forum designed engagement, which is an aspect of a public hearing,

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[53] Ibid.

[54] "Location and Environment: Public Involvement." Iowa Department of Transportation. https://iowadot.gov/ole/public-involvement/public-involvement-home

allows for attendees to ask questions directly to Keokuk city staff. Individuals are encouraged to send in written comments or post comments online regarding the current project.

Transfer of Jurisdiction

Iowa Code 306.8[55] outlines transfer of jurisdiction for roadways, and states that the road or street must be 'in adequate repair' or provide money to the appropriate entity to make repairs. Both jurisdictions (IOWA DOT and the city) must agree to the transfer and following a transfer of jurisdiction all responsibilities for the maintenance would fall on Keokuk. However, this would also mean that Keokuk would have complete control over the design of the roadway and that the conversion would be capable of occurring without requiring authorization by the Iowa DOT. Though details of transfer of jurisdiction are beyond the scope of this report, the city should give thorough consideration to the benefits and disbenefits of taking control of Main Street from the Iowa DOT.

Conclusion

There are many decisions to be made, all of which will impact the physical and functional aspects of Main Street (US 218), and how it will be used by current and future Keokuk residents. Providing legitimate consideration to roadway and traffic treatments such as transfer of jurisdiction, designated truck routes, 4- to 3- lane conversions, and provision of bike lanes will guide future development potential in the corridor. Roadway treatments of this kind have been shown to incentivize economic development and reduce the occurrence of automobile collisions with other automobiles, pedestrians, and cyclists. Creating a safer roadway environment may also help to foster stronger community bonds and a sense of character with the downtown area. The treatments recommended in this report are assembled with the goals of safety and fostering community in mind.

It is the recommendation of this report that a 4- to 3- lane conversion, which includes protected bike lanes, paired with the creation of a designated truck route is the best option to address the issues laid out in this report. While protected bike lanes are the better option when it comes to safety considerations, it is also the most expensive of the bike lane options. In the event that sufficient funds cannot be allocated, it is recommended that more conventional bike lanes be included, but that a buffer space is included between traffic and the bike lane. This can be accomplished through the use of paint, and is the most cost-efficient of the two options. In either situation, the creation of the truck route is recommended, as it will aid in reducing the potential interactions between bicyclists and heavy-truck traffic. While specific route decisions have not been made in this report, the suggested route involves diverting freight traffic to US 136, or 7th street, allowing truck traffic to be diverted to US 61 which is already designated as a business route.

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[55] "United States Code: Title 23 – Highways." OLRC Home. Office of the Law Revision Council. Accessed November 8, 2019. https://uscode.house.gov/browse/prelim@title23&edition=prelim