



# MARKET STREET BICYCLE/PEDESTRIAN ACCOMMODATION STUDY

Harrisburg Area Transportation Study

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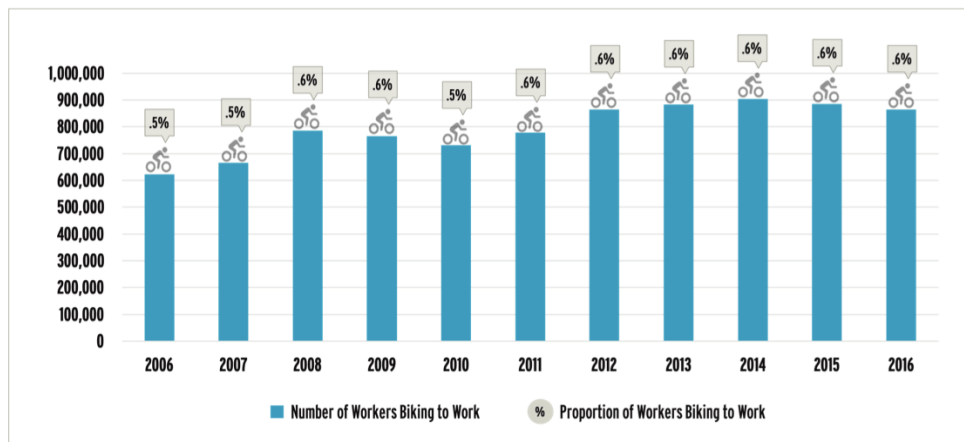
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INTRODUCTION

1.1. Overview

Biking and walking for recreation and commuting has increased over the last decade in the Harrisburg region, as well as nationwide\*. This is due in part to a national trend of millennials moving into more urban areas and using alternative transportation modes, the associated health benefits of exercise and, a greater emphasis by the City and surrounding communities to promote and invest in safer facilities for bicycle and pedestrian movement.

Number & Percent of People Biking to Work



\*Source: StreetsBlog USA National Household Travel Survey

“Improving the performance and operation of our transportation system for all modes and all users.” is one of the objectives cited in the Harrisburg Area Transportation Study’s (HATS) 2040 Regional Transportation Plan. With this goal in mind, a more coordinated effort is underway by HATS, local bike advocates, the City of Harrisburg, and PennDOT to reduce the amount of injuries and fatalities associated with walking and biking by providing a safer interface between walkers, bicyclists and vehicles.



Investments to improve bike and pedestrian accommodations have already been made within the Harrisburg region including installing additional warning signing and pavement markings at designated trail crossing points; providing designated bike lanes; and initiating public awareness programs to reduce distractions while driving.

Harrisburg Bike Share, [Bikeshare](#) a bike rental network enterprise, was implemented within the City of Harrisburg in September 2017. The service has been successful in hosting over 10,000 bike rides since its start up.

Exhibit 1.1 shows a visualization of Harrisburg Bike Share usage in 2018. Although the bike stations are only located within the City limits, many users cross the Market St. Bridge and travel to the west shore communities in Cumberland County using the Market St. segment within the study corridor as depicted by the areas highlighted in yellow on the map.

**Exhibit 1.1 Harrisburg Bike Share Usage Map**



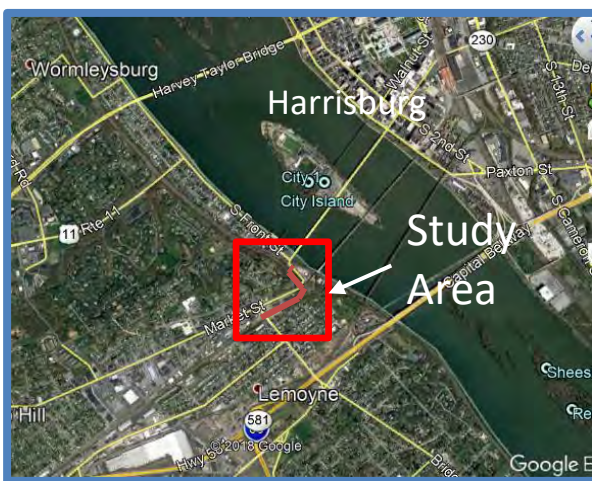
Source: Harrisburg Bike Share

The bike share program is anticipating an expansion into Cumberland County and could substantially increase the number of bicyclists travelling in the Market St. corridor in the future.

## 1.2. Study Location and Background

HATS initiated an engineering analysis to identify safety improvements for bicyclists and pedestrians who travel through a segment of the Market St. corridor in Cumberland County between the intersections of Front St. in Wormleysburg Borough and 3rd St. in Lemoyne Borough as shown in Exhibit 1.2.

**Exhibit 1.2 Study Location Map**



This approximately 2000-ft length of state highway, sometimes referred to as the “Lemoyne Bottleneck”, connects Lemoyne to the riverfront and the Market Street Bridge, which is one of only four bridges in the region linking the City of Harrisburg with west shore communities. This roadway segment provides a main commuter route into downtown Harrisburg that attracts a significant volume of vehicles (15,000 AADT). It also serves as a gateway for attending recreational events held in the City or on City Island.

This portion of Market Street is also frequented by bicyclists traveling to and from the Market St. bridge for both recreation and commuting to work. A bicycle volume count identified 26 bicyclists using the section of Market St. between the Market St. bridge and 3<sup>rd</sup> St in Lemoyne Borough within the morning, midday and evening peak travel periods.

The travel width of the corridor is constricted by the abutments of two overhead railroad bridges owned by Norfolk Southern. The corridor is identified as a portion of bike route “J” as depicted on the [PA Bike Routes Map](#).



Under existing conditions, this segment of Market St. between Lemoyne and the riverfront induces a higher level of stress for bicycle and pedestrian users due to a number of issues including: high traffic volume; curving roadway alignment; limited sight distance; absence of consistent roadway shoulder width; and the narrow width of sidewalks under the railroad bridges.

### 1.3. Study Scope

The project was developed to evaluate this segment of Market Street and identify potential improvements that can be made to provide safer movements of bicyclists and pedestrians traveling within the corridor. The project is consistent with the PennDOT Connects policy direction for improved community mobility and quality of life.

The following tasks were conducted during the analysis:

- Existing conditions assessment
- Roadside safety audit
- Traffic volume count data collection
- Bike and pedestrian movement data collection
- Crash data analysis
- Intersection analysis
- Improvement concepts

## 2 ROADSIDE SAFETY AUDIT

This section discusses the studied corridor inclusive of observations and existing deficiencies along the roadway and at the intersections and short-term improvements that could be made to address some deficiencies.

### 2.1 Existing Conditions and Deficiencies

#### Market Street and 3<sup>rd</sup> Street

Eastbound Approach



Westbound Approach



Northbound Approach



Southbound Approach



The following existing conditions and deficiencies were noted during field evaluations:

Category	Existing Conditions	Deficiencies
Speed Limit	<ul style="list-style-type: none"> <li>▪ 25-mph on all approaches</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Intersection Lighting	<ul style="list-style-type: none"> <li>▪ Intersection lighting present</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Signing	<ul style="list-style-type: none"> <li>▪ Good condition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Many of the signs on Market Street are obstructed by trees along the roadway</li> <li>▪ The pedestrian signage on the southbound approach is not compliant and not necessary for a controlled approach</li> <li>▪ The YIELD sign on the northbound approach is not needed for the channelized right turn lane</li> <li>▪ The large sign on the sidewalk along the south side of the east leg is mounted too low for a pedestrian area</li> <li>▪ There is a bicycle route sign that indicates Route J2 ends, but there is no bicycle route sign for Route J</li> </ul>
Pavement Markings	<ul style="list-style-type: none"> <li>▪ Lane use control markings in poor condition</li> </ul>	<ul style="list-style-type: none"> <li>▪ The lane use control arrows on the eastbound and westbound approaches are faded</li> </ul>
Design Vehicle Accommodations	<ul style="list-style-type: none"> <li>▪ Adequate</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Roadside Hazards	<ul style="list-style-type: none"> <li>▪ None</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Bike and Pedestrian Access	<ul style="list-style-type: none"> <li>▪ Sidewalk present along both sides of all intersection approaches</li> <li>▪ Bicyclists share the roadway with motorists</li> </ul>	<ul style="list-style-type: none"> <li>▪ The ends of the sidewalk at the driveways along the south side of the east leg do not have curb cuts</li> <li>▪ The pavement at the driveway is in poor condition and can present a tripping hazard for pedestrians</li> <li>▪ The curb ramps at the southeast corner of the intersection are not ADA compliant</li> <li>▪ There is poor sight distance between the crosswalk on the channelized right and vehicles traveling in the right lane in the northbound direction across the bridge</li> <li>▪ Where possible, a curb ramp and detectable warning surface should align with the crosswalk</li> </ul>
Traffic Control	<ul style="list-style-type: none"> <li>▪ Full-actuated traffic signal</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Sight Distance	<ul style="list-style-type: none"> <li>▪ Inadequate</li> </ul>	<ul style="list-style-type: none"> <li>▪ There is poor sight distance between motorists exiting the driveway and motorists making the northbound right</li> </ul>
Operational Concerns	<ul style="list-style-type: none"> <li>▪ Queues spill back on the south leg during the PM peak</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b>                  Many of the signs on Market Street are obstructed by trees along the roadway. This can prevent motorists from reading them. Additionally, the trees can limit sight distance for vehicles exiting the driveways along Market Street.</p> <p><b>Corrective Actions:</b>                  Remove the trees to remove the obstructions.</p>
	<p><b>Deficiencies:</b>                  There is a bicycle route sign that indicates Route J2 ends, but there is no bicycle route sign for Route J which runs along the south and east legs of the intersection.</p> <p><b>Corrective Actions:</b>                  Install a bicycle route sign on a separate post to denote the beginning of Route J.</p> 




Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> The pedestrian signage on the southbound approach is not compliant and not necessary for a controlled approach.</p> <p><b>Corrective Actions:</b> Remove the pedestrian signs.</p>
	<p><b>Deficiencies:</b> Under current conditions the YIELD sign on the northbound approach is not needed for the channelized right turn lane. Since there is an added lane, motorists turning right have no need to yield to drivers traveling along Market Street (refer to the bottom left photo).</p> <p><b>Corrective Actions:</b> Reducing the two travel lanes in the eastern direction to one lane to accommodate a bike lane will require the YIELD sign be maintained. However, the DO NOT ENTER sign mounted on the reverse side of the YIELD sign should be mounted on a separate post and located so as not to visually impair the YIELD sign.</p>



Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> Sidewalk at the driveways along the south side of the east leg do not meet ADA requirements (lack of curb cuts). The pavement at the driveway is in poor condition and can present a tripping hazard for pedestrians.</p> <p><b>Corrective Actions:</b> <b>Install ADA required curb cuts.</b></p>
	<p><b>Deficiencies:</b> The large sign on the sidewalk along the south side of the east leg is mounted too low for a pedestrian area. All signs should have a mounting height of at least 7 feet from the ground to the bottom of the sign.</p> <p><b>Corrective Actions:</b> Adjust the mounting height of the sign.</p>

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b>                      The curb ramps at the southeast corner of the intersection are not ADA compliant. There is poor sight distance between the crosswalk on the channelized right and vehicles traveling in the right lane in the northbound direction across the bridge.</p> <p><b>Corrective Actions:</b>                      Modify the curb ramps to ensure there is a level 4'x4' landing area and a compliant running slope. Refer to Chapter 6 of PennDOT Publication 13M for curb ramp design criteria.</p> <p>For the crossing on the northbound channelized right lane, remove as much foliage as possible to improve sight distance. Install crosswalk markings and a pedestrian sign (W11-2) with a downward diagonal arrow plaque below (W16-7PL) to warn motorists of the crossing.</p> <div style="text-align: center;">  <span style="font-size: 24px; margin-left: 10px;">W11-2</span> </div> <div style="text-align: center; margin-top: 10px;">  <span style="font-size: 24px; margin-left: 10px;">W16-7PL</span> </div>

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> Where possible, a curb ramp and detectable warning surface should align with the crosswalk. Note that this is acceptable in instances where a curb ramp connects to two crosswalks.</p> <p><b>Corrective Actions:</b> Modify the curb ramp and detectable warning surface to align with the crosswalk.</p>
	<p><b>Deficiencies:</b> There is inadequate sight distance when entering and exiting Market Street at the current location of this private driveway causing an unsafe condition for vehicles traveling along Market Street. Access to Market Street at this location should be eliminated since a second property access is provided to the east. Install curbing and sidewalk along Market Street along this access opening.</p> <p><b>Corrective Actions:</b> This driveway should be closed since there is insufficient sight distance.</p>
	<p><b>Deficiencies:</b> The lane use control arrows on the eastbound and westbound approaches are faded.</p> <p><b>Corrective Actions:</b> Restripe the faded lane use control arrows.</p>

Market Street and Front Street

Eastbound Approach



Westbound Approach



Southbound Approach



The following existing conditions and deficiencies were noted during field evaluations:

Category	Existing Conditions	Deficiencies
Speed Limit	<ul style="list-style-type: none"> <li>▪ 25-mph on the eastbound approach</li> <li>▪ 40-mph on the westbound approach</li> <li>▪ 35-mph on the southbound approach</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Intersection Lighting	<ul style="list-style-type: none"> <li>▪ One luminaire present on the southeast corner</li> </ul>	<ul style="list-style-type: none"> <li>▪ The crossings are not adequately illuminated</li> </ul>
Signing	<ul style="list-style-type: none"> <li>▪ Poor retroreflectivity condition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Many of the signs use Type I sheeting</li> <li>▪ The pedestrian signage on the southbound approach is not compliant and not necessary for a controlled approach</li> <li>▪ The pedestrian push button signs are not compliant</li> <li>▪ The overhead clearance sign is not compliant</li> <li>▪ The bicycle route signs on Market Street (eastbound direction) give conflicting information</li> </ul>
Pavement Markings	<ul style="list-style-type: none"> <li>▪ Transverse markings are in poor condition</li> </ul>	<ul style="list-style-type: none"> <li>▪ The stop lines and crosswalk markings at the intersection are faded and worn</li> </ul>
Design Vehicle Accommodations	<ul style="list-style-type: none"> <li>▪ Adequate</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Roadside Hazards	<ul style="list-style-type: none"> <li>▪ Hazard present</li> </ul>	<ul style="list-style-type: none"> <li>▪ The street light pole adjacent to the eastbound approach is within the clear zone</li> </ul>
Bike and Pedestrian Access	<ul style="list-style-type: none"> <li>▪ Sidewalk present along both sides of all intersection approaches</li> <li>▪ Bicyclists share the roadway with motorists</li> </ul>	<ul style="list-style-type: none"> <li>▪ The pedestrian signal heads do not have a change interval countdown display</li> <li>▪ The push button at the westbound approach is not easily accessible for pedestrians in a wheelchair or with other disabilities</li> <li>▪ Numerous sections of sidewalk along Market Street are too narrow and do not meet ADA requirements</li> <li>▪ In areas where the sidewalk is a compliant width, the concrete slabs are uneven with some sections replaced with asphalt</li> <li>▪ A section of sidewalk adjacent to the eastbound approach has a steep drop-off adjacent to it</li> </ul>
Traffic Control	<ul style="list-style-type: none"> <li>▪ Full-actuated traffic signal</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Sight Distance	<ul style="list-style-type: none"> <li>▪ Adequate</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Operational Concerns	<ul style="list-style-type: none"> <li>▪ None</li> </ul>	<ul style="list-style-type: none"> <li>▪ None</li> </ul>



Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> Many of the signs use Type I sheeting. All regulatory, warning, and guide signs with a green background should utilize Type III or higher sheeting as stated in section 2A.08 of the DoD Supplement to the MUTCD. This sheeting provides levels of retroreflectivity to ensure the signs can be seen during nighttime or low-light conditions.</p> <p>Refer to Section 2A.08 of the CA MUTCD for standards and guidance relating to maintaining minimum retroreflectivity. The Federal Highway Administration (FHWA) also provides a retroreflective sheeting guide to help identify sheeting types: <a href="https://safety.fhwa.dot.gov/roadway_dept/night_visib/sign_visib/sheetguide/">https://safety.fhwa.dot.gov/roadway_dept/night_visib/sign_visib/sheetguide/</a></p> <p><b>Corrective Actions:</b> Replace all signs with Type III sheeting or better.</p>
	<p><b>Deficiencies:</b> The pedestrian signage on the southbound approach is not compliant and not necessary for a controlled approach.</p> <p><b>Corrective Actions:</b> Remove the pedestrian signs.</p>

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b></p> <p>The pedestrian push button signs are not compliant. The pedestrian signal heads do not have a change interval countdown display. According to section 4E.07 of the MUTCD, a countdown display is required for pedestrian change intervals greater than 7 seconds. The intervals are greater than 7 seconds at this intersection due to the number of lanes.</p> <p><b>Corrective Actions:</b></p> <p>Replace the pedestrian signal heads with the examples shown below. Install a pedestrian push button sign (R10-3E) for each push button to direct pedestrians to the correct button as shown in MUTCD figure 2B-26.</p> <div style="text-align: center;"> <p>A - With countdown display</p>  <p>R10-3e</p> </div>





Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> According to section 4E.08 of the MUTCD, pedestrian push buttons should be placed within easy reach of pedestrians. The push button at the westbound approach is not easily accessible for pedestrians in a wheelchair or with other disabilities.</p> <p><b>Corrective Actions:</b> Install a longer extension arm to ensure the pedestrian push button is easily accessible.</p>
	<p><b>Deficiencies:</b> The stop lines and crosswalk markings at the intersection are faded and worn.</p> <p><b>Corrective Actions:</b> Restripe the faded stop lines and crosswalk markings.</p>


Photo	Deficiency/Corrective Action
 <p>The 'Photo' column contains three images illustrating sidewalk issues. The top image shows a narrow sidewalk with a storm drain and a concrete curb. The middle image shows a narrow sidewalk next to a stone wall. The bottom image shows a sidewalk with asphalt patches and a concrete curb.</p>	<p><b>Deficiencies:</b> Numerous sections of sidewalk along Market Street are too narrow and do not meet ADA requirements. In areas where the sidewalk is a compliant width, the concrete slabs are uneven with some sections replaced with asphalt.</p> <p><b>Corrective Actions:</b> Given that a portion of Market Street is constrained by the railroad bridges, a lane reduction is required to obtain adequate sidewalk width. Refer to the improvements in Section 4 that show an ADA compliant sidewalk network along Market Street.</p>

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> A section of sidewalk adjacent to the eastbound approach (circled in red in the bottom left photo) has a steep drop-off adjacent to it. The drop-off can cause pedestrians to lose their footing.</p> <p><b>Corrective Actions:</b> Backfill the area and ensure there is a smooth transition from the sidewalk to the gravel area adjacent to it.</p>
	<p><b>Deficiencies:</b> The street light pole adjacent to the eastbound approach is within the clear zone. Although concrete curbing is present, the FHWA has concluded that curbing has no redirection capabilities. Thus, the clear zone should only be based on volumes and speeds.</p> <p><b>Corrective Actions:</b> For a roadway with an ADT greater than 6,000 vehicles and a posted speed limit less than 40-mph, a clear zone of 16 feet is required. Relocate the pole outside of this 16-foot clear zone.</p>



Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> The overhead clearance sign is not compliant.</p> <p><b>Corrective Actions:</b> Replace the sign with the standard W12-2A sign shown below. Ensure that the sign is 78" in width and 24" in height.</p>  <p>W12-2a</p>


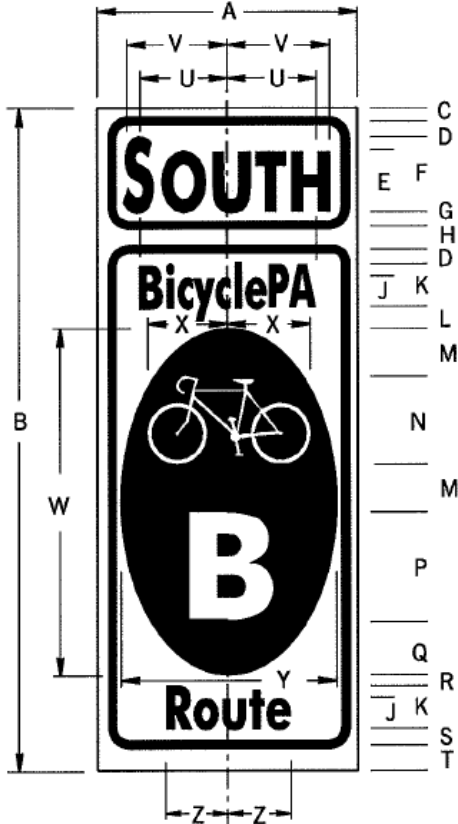

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> The bicycle route signs on Market Street (eastbound direction) can give confusing information. J Route North continues left on Front Street. J Route left is a sub-route of Bike Route J continuing in the eastern direction.</p> <p><b>Corrective Actions:</b> Replace the bicycle route sign in the bottom left photo with the standard PennDOT M1-8 sign without the direction arrow shown below.</p> 

Photo	Deficiency/Corrective Action
	<p><b>Deficiencies:</b> The crossings are not adequately illuminated. The crossing that spans across the westbound approach is only partially illuminated on one end of the crossing (as shown in the left photo). The crossing on the southbound approach is not illuminated at all. Intersection lighting increases motorist and pedestrian visibility and reduces crash potential.</p> <p><b>Corrective Actions:</b> Install luminaires to adequately illuminate the crossings. When designing lighting, the following factors should be considered; luminaire type, light source type, wattage, mounting height, and pole location. A qualified lighting engineer should evaluate intersection lighting.</p>

## 2.2 Crash History

Certain bicycle and pedestrian safety data are available through the Department of Transportation. Crash data is collected and reported to PennDOT for crashes that result in personal injury, vehicular damage that requires towing or causes property damage, and crashes that involve other modes of travel such as bicyclists or pedestrians. However, bicycle crashes that do not involve a vehicle, near misses and other less severe incidents may not be reported to PennDOT or to state or local police authority. Data that is reported to PennDOT is compiled and made available in the [Pennsylvania Crash Information Tool](#). This tool provides multiple data points about each crash allowing for analysis of the factors that contribute to crashes.

A review of the vehicle crash history over the previous 10 years for the segment of Market Street under study was performed using PennDOT crash data. The crash data is compiled by county and is not specific to local municipalities or roadway segments. A crash location map was generated to show the locations of reported crashes within the study corridor.

The location of reportable vehicle crashes involving injuries and fatalities for the segment of Market Street within the study corridor are identified as red, blue and green colored dots on the Crash Map as shown in Exhibit 2.1. The colored dots signify the location and degree of severity of the crashes i.e., fatalities, injuries and property damage.

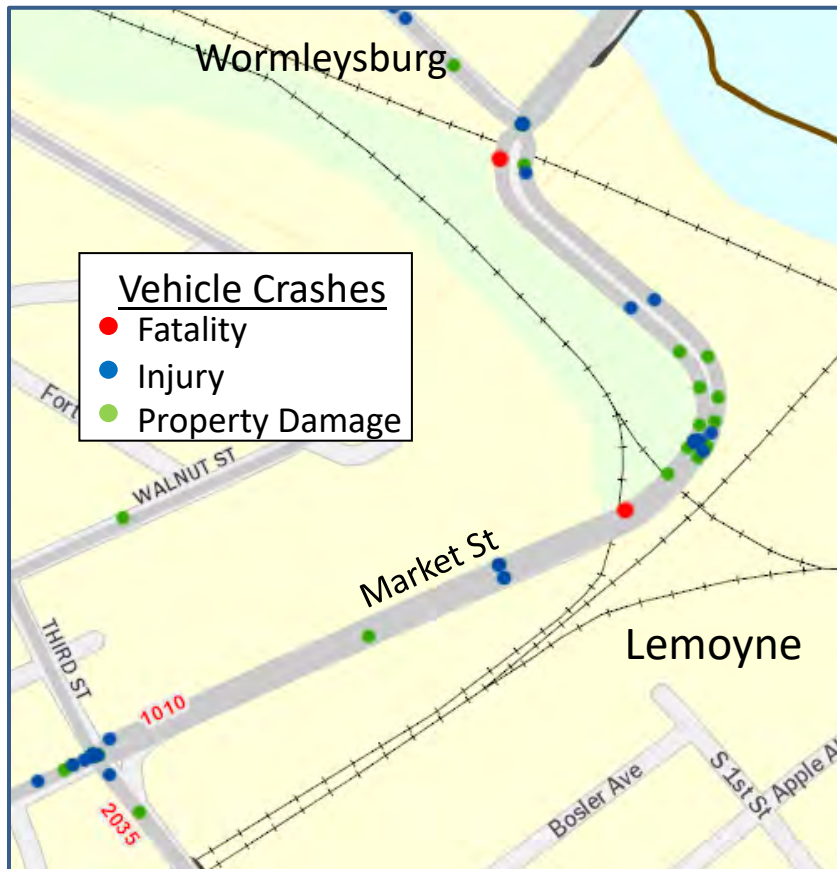


Between 2008 and 2017, the most recent year of recorded data, there were no reportable crashes involving bicyclists or pedestrians within the study corridor. However, over the 10-year period, there were approximately 33 reportable crashes along Market Street between the Market Street bridge in Wormleysburg and the intersection with 3<sup>rd</sup> Street in Lemoyne Borough as shown in Exhibit 2.1, including two vehicle crashes involving fatalities. Most of the mapped crashes occurred at the intersection endpoints of the study corridor as well as clustered along the horizontal curve at the midpoint of the roadway segment. Many of the midpoint crashes can be attributed to a combination of inclement weather and the vertical downgrade of Market St. in the eastbound direction.

Although there have been no reported crashes involving bicyclists or pedestrians, the volume of vehicle crashes within the roadway segment remains a significant safety concern for the increasing number of bikers and walkers using this portion of Market Street. As recommended in Chapter 4, installing a bike lane on both sides of the Market Street corridor will provide a safety buffer zone for both bicyclists and pedestrians helping to reduce potential conflicts with vehicles. In order to accommodate the roadway width

required to install these bike lanes, the current 2-lanes of travel in the eastbound direction of Market St. is recommended to be reduced to one travel lane. The resulting reduction in vehicle travel lanes should help to improve the safety of bike and pedestrian travel by reducing vehicle conflict points with the elimination of vehicle passing movements in the eastbound direction and by providing an increase in the distance between the vehicle travel lanes and the bicyclists/pedestrians. In addition, it is anticipated that the lane reduction will “calm” or reduce the speed of traffic in the eastbound direction.

### Exhibit 2.1 Crash Map



Source: PennDOT Crash Analysis Report



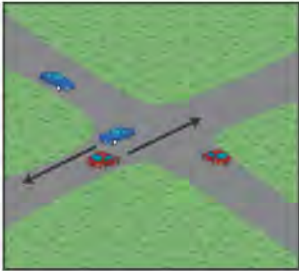
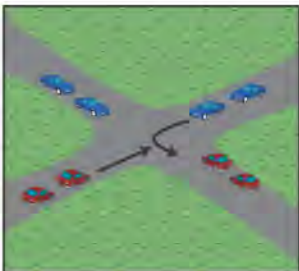
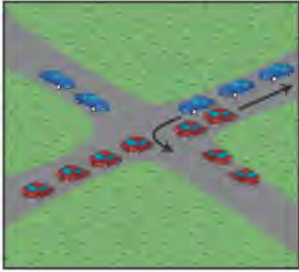
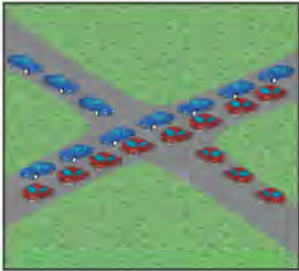
### 3 INTERSECTION OPERATIONS ANALYSIS

An operations analysis was conducted at study intersections under existing and future conditions using Synchro Traffic Analysis Software (Version 10). This section summarizes the existing, future no build, and future build (if necessary) operations for each intersection. Each table includes level of service (LOS) and 95<sup>th</sup> percentile queues for each lane group at the intersection. To get a more accurate assessment of the 95<sup>th</sup> percentile queues, SimTraffic microsimulation software was utilized. For each model, 10 runs and a 60-minute analysis period were used.

LOS describes the operational condition of an intersection and usually falls into one of six categories: A through F. LOS A represents operating conditions with relatively little traffic and no congestion, while LOS F represents relatively high traffic and unpredictable operating conditions, including high delay and driver discomfort. Generally, a facility operating at or better than LOS D is considered acceptable.

Exhibit 3.1 details and graphically shows examples and definitions of LOS A through F. The 95<sup>th</sup> percentile queue is reported because it is commonly used for determining the design length of turn lanes. Note that the amount of delay, in seconds, is shown in parentheses for movements that have a LOS F since there is no upper bound.

**Exhibit 3.1 Level of Service Definitions**

LOS	INTERSECTIONS		
	SIGNALIZED		UNSIGNALIZED
<b>A</b>	<ul style="list-style-type: none"> <li>✓ Very low delay, average less than 10.0 seconds per vehicle (spv)</li> <li>✓ Most vehicles arrive during green phase</li> <li>✓ Most vehicles do not need to stop</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delays less than 10.0 spv</li> <li>✓ Little or no delay to minor street traffic</li> </ul>
<b>B</b>	<ul style="list-style-type: none"> <li>✓ Average delay in range of 10.1-20.0 spv</li> <li>✓ More vehicles stop than LOS A</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delay in range of 10.1-15.0 spv</li> <li>✓ Short traffic delays to minor street traffic</li> </ul>
<b>C</b>	<ul style="list-style-type: none"> <li>✓ Average delay in range of 20.1-35.0 spv</li> <li>✓ Number of vehicles stopping is significant</li> <li>✓ Cycle failures may begin to appear</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delay in range of 15.1-25.0 spv</li> <li>✓ Average traffic delays to minor street traffic</li> </ul>
<b>D</b>	<ul style="list-style-type: none"> <li>✓ Average delay in range of 35.1-55.0 spv</li> <li>✓ Congestion more noticeable</li> <li>✓ Many vehicles stop</li> <li>✓ Cycle failures noticeable</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delay in range of 25.1-35.0 spv</li> <li>✓ Long traffic delays to minor street traffic</li> </ul>
<b>E</b>	<ul style="list-style-type: none"> <li>✓ Average delay in range of 55.1-80.0 spv</li> <li>✓ Cycle failures frequent</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delay in range of 35.1-50.0 spv</li> <li>✓ Very long delays to minor street traffic</li> </ul>
<b>F</b>	<ul style="list-style-type: none"> <li>✓ Average delay in excess of 80.0 spv</li> <li>✓ Delay unacceptable to most drivers</li> <li>✓ Many cycle failures</li> </ul>		<ul style="list-style-type: none"> <li>✓ Average delay in excess of 50.0 spv</li> <li>✓ Extreme delays with queuing</li> <li>✓ Congestion affects other intersections</li> <li>✓ Warrants improvement to intersection</li> </ul>

### 3.1 Existing Intersection Operating Conditions

#### Market Street and 3<sup>rd</sup> Street Peak Operations Analysis

Movement	AM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	MID Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	PM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)
EB left/thru	D / 244	246	D / 232	323	D / 210	423
EB right	A / 33	129	A / 33	135	C / 202	132
WB left	D / 224	172	E / 273	270	C / 211	336
WB thru/right	B / 101	106	C / 248	236	C / 503	368
NB left/thru	E / 200	262	D / 169	293	F / 182	513
NB right	A / 0	100	A / 0	87	A / 0	522
SB left/thru/right	C / 64	66	C / 69	82	D / 361	245
Overall	C		C		D	
Cycle Length	95 seconds		85 seconds		95 seconds	

For existing conditions, this intersection operates at an acceptable LOS for all peak periods except for the northbound left/thru movement during the PM peak.

#### Market Street and Front Street Peak Operations Analysis

Movement	AM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	MID Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	PM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)
EB left	D / 475	405	C / 218	191	D / 478	319
EB thru	B / 136	204	A / 48	89	A / 47	397
WB thru/right	B / 87	75	C / 240	211	D / 502	361
SB left	E / 434	204	D / 157	158	E / 327	309
SB right	A / 30	48	A / 24	89	A / 133	204
Overall	C		C		D	
Cycle Length	132.1 seconds		107.1 seconds		132.1 seconds	

For existing conditions, this intersection operates at an acceptable LOS for all peak periods except for the southbound left movement during the AM and PM peaks.

### 3.2 Travel Lane Reduction Analysis

The FHWA publication “Bikeway Selection Guide”, (February 2019) [Bikeway Selection Guide](#) recommends a buffered bike lane on streets within an urban/town context with a volume of over 7000 vehicles per day and a posted speed limit of 25 MPH or above where feasible. To improve bike and pedestrian safety and operations in the corridor, a 5-foot bike lane is proposed for both directions along Market Street. A 5-foot sidewalk is also proposed on sides of Market Street for pedestrian traffic. Implementing these improvements will require that a travel lane be removed from Market Street; thus, two scenarios were evaluated. The first scenario involves removing a travel lane from the westbound direction and the second scenario involves removing a travel lane from the eastbound direction.

*Note that the microsimulation software was not used to assess the westbound lane reduction scenario since the intersections do not operate at an acceptable LOS vs the eastbound lane reduction scenario.*

**Market Street and 3<sup>rd</sup> Street  
Peak Operations Analysis – Westbound Lane Reduction**

Movement	AM Peak LOS/95% Queue (ft)	MID Peak LOS/95% Queue (ft)	PM Peak LOS/95% Queue (ft)
EB left/thru	D / 261	D / 263	C / 207
EB right	A / 58	A / 43	B / 149
WB left	D / 231	D / 275	D / 348
WB thru/right	B / 103	C / 248	D / 634
NB left/thru	D / 196	D / 169	E / 138
NB right	A / 0	A / 0	A / 0
SB left/thru/right	C / 61	C / 69	C / 234
Overall	C	C	D
Cycle Length	95 seconds	85 seconds	90 seconds

This intersection operates at an acceptable LOS for all peak periods except for the eastbound approach during the AM peak period and the westbound and northbound approaches during the PM peak period. Additionally, the westbound left turn lane must be at least 525 feet to accommodate queueing. This requires that a three-lane section be maintained for at least 525 feet as well.

**Market Street and Front Street  
Peak Operations Analysis – Westbound Lane Reduction**

Movement	AM Peak LOS/95% Queue (ft)	MID Peak LOS/95% Queue (ft)	PM Peak LOS/95% Queue (ft)
EB left	D / 374	D / 265	E / 569
EB thru	B / 126	A / 40	A / 43
WB thru	C / 153	C / 369	E / 800
WB right	A / 5	A / 41	B / 165
SB left	D / 335	D / 168	E / 345
SB right	A / 22	A / 35	B / 191
Overall	C	C	D
Cycle Length	105 seconds	105 seconds	145 seconds

This intersection operates at an acceptable LOS for all peak periods except for the eastbound left, the westbound through, and the southbound left movements during the PM peak.

**Market Street and 3<sup>rd</sup> Street  
Peak Operations Analysis – Eastbound Lane Reduction**

Movement	AM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	MID Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	PM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)
EB left/thru	D / 261	259	D / 263	338	D / 214	494
EB right	A / 58	126	A / 43	137	B / 158	129
WB left	D / 231	194	D / 275	229	D / 296	383
WB thru/right	B / 103	103	C / 248	220	D / 634	423
NB left/thru	D / 196	346	D / 169	293	E / 138	305
NB right	C / 536	366	A / 1	142	A / 46	166
SB left/thru/right	C / 61	71	C / 69	82	C / 234	200
Overall	D		C		D	
Cycle Length	95 seconds		85 seconds		90 seconds	

This intersection operates at an acceptable LOS for all peak periods except for the northbound approach during the PM peak period. The eastbound lane reduction does have a slight disadvantage when compared to the westbound lane reduction during the AM peak since the northbound channelized right turn would no longer be free, but the intersection still operates at an acceptable LOS.

**Market Street and Front Street  
Peak Operations Analysis – Eastbound Lane Reduction**

Movement	AM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	MID Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)	PM Peak LOS/95% Queue (ft)	SimTraffic 95% Queue (ft)
EB left	D / 382	293	D / 243	217	D / 396	312
EB thru	B / 325	370	A / 91	152	A / 75	404
WB thru/right	B / 79	123	C / 173	167	D / 397	321
SB left	D / 335	275	C / 124	137	E / 320	286
SB right	A / 23	96	A / 27	87	A / 94	158
Overall	C		C		D	
Cycle Length	105 seconds		85 seconds		105 seconds	

For existing conditions, this intersection operates at an acceptable LOS for all peak periods except for the southbound left movement during the PM peak.

## 4 MARKET STREET IMPROVEMENT RECOMENDATIONS

Given that the results of the operations analysis indicate that removing a lane in the eastbound direction would not adversely impact level of service at either of the intersections, a conceptual design Phase 1 and Phase 2 (shown in Exhibit 4.1) was developed to illustrate the lane reduction and pedestrian/bicycle improvements.

### Bike Lanes and Pedestrian Sidewalks

Beginning at the west end of Market Street in Lemoyne, the intersection approach configurations remain unchanged from existing conditions. The northbound channelized right was reconfigured to tie into the single eastbound travel lane. The adjacent raised island should also be modified to allow for a 5-foot roadway shoulder width along Market Street to provide a safety buffer for bicyclists traveling east through the intersection.



The island reconfiguration should include the appropriate relocation of the signal pole and mast arm as well as ADA compliant curb ramps. To eliminate the risk of a collision between motorists exiting the adjacent repair shop and motorists traveling eastbound through the channelized right, the driveway at the southeast corner of the intersection is shown closed.



Example of proposed lane dimensions

Throughout the entire Market St. corridor (between 3rd Street and Front Street), 5-foot bike lanes and 5-foot sidewalks are shown on both sides of the roadway. Due to the narrow lateral clearance at the railroad bridges, some sections of sidewalk were reduced to 4-feet in width. In the eastbound direction, a buffer (variable width) is shown between the travel lane and the bike lane beginning approximately midway through the 90-degree roadway curve to Front Street.

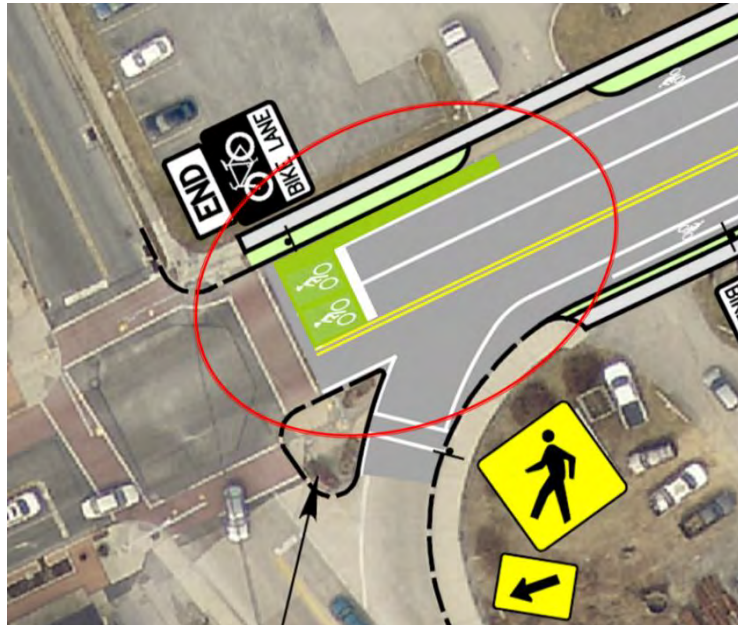
The eastbound approach of the Front Street intersection in Wormleysburg has been reduced from the original three-lane configuration to a two-lane configuration (i.e. left-turn lane to Wormleysburg and through lane to Harrisburg). To ensure that queued vehicles in the eastbound left-turn lane do not block vehicles in the through lane, 310 feet of storage is provided. The eastbound bike lane terminates at the west end of the Market Street bridge and transitions into a vehicular travel lane. The 5-foot sidewalk connects to the existing sidewalk networks on both sides of Market St.

The westbound bike lane begins at the Front Street intersection and ends at the intersection of Market and 3rd St. The two existing westbound travel lanes will remain through the entire corridor length. The westbound approach to 3rd St. will have one lane for left turn only and one through lane. The 5-foot sidewalk connects to the existing sidewalk networks on both sides of 3rd St.

### Bicycle Box

Consideration should be given to the installation of an intersection bicycle box (bike box) on Market St. at both the westbound approach to Front St. in Wormleysburg and the eastbound approach to 3rd St. in Lemoyne to allow safer left turn movements for bicycles at the intersections. A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase.

Bike box design should be in accordance with MUTCD requirements [https://mutcd.fhwa.dot.gov/resources/interim\\_approval/ia18/index.htm](https://mutcd.fhwa.dot.gov/resources/interim_approval/ia18/index.htm). Bike box design and the use of colored pavement markings is subject to current PennDOT policy and design regulations. Proper bike pavement markings should be used to identify bike routes where appropriate beyond the study corridor.



*Example of Bike Box Installation at Market and 3rd St.*



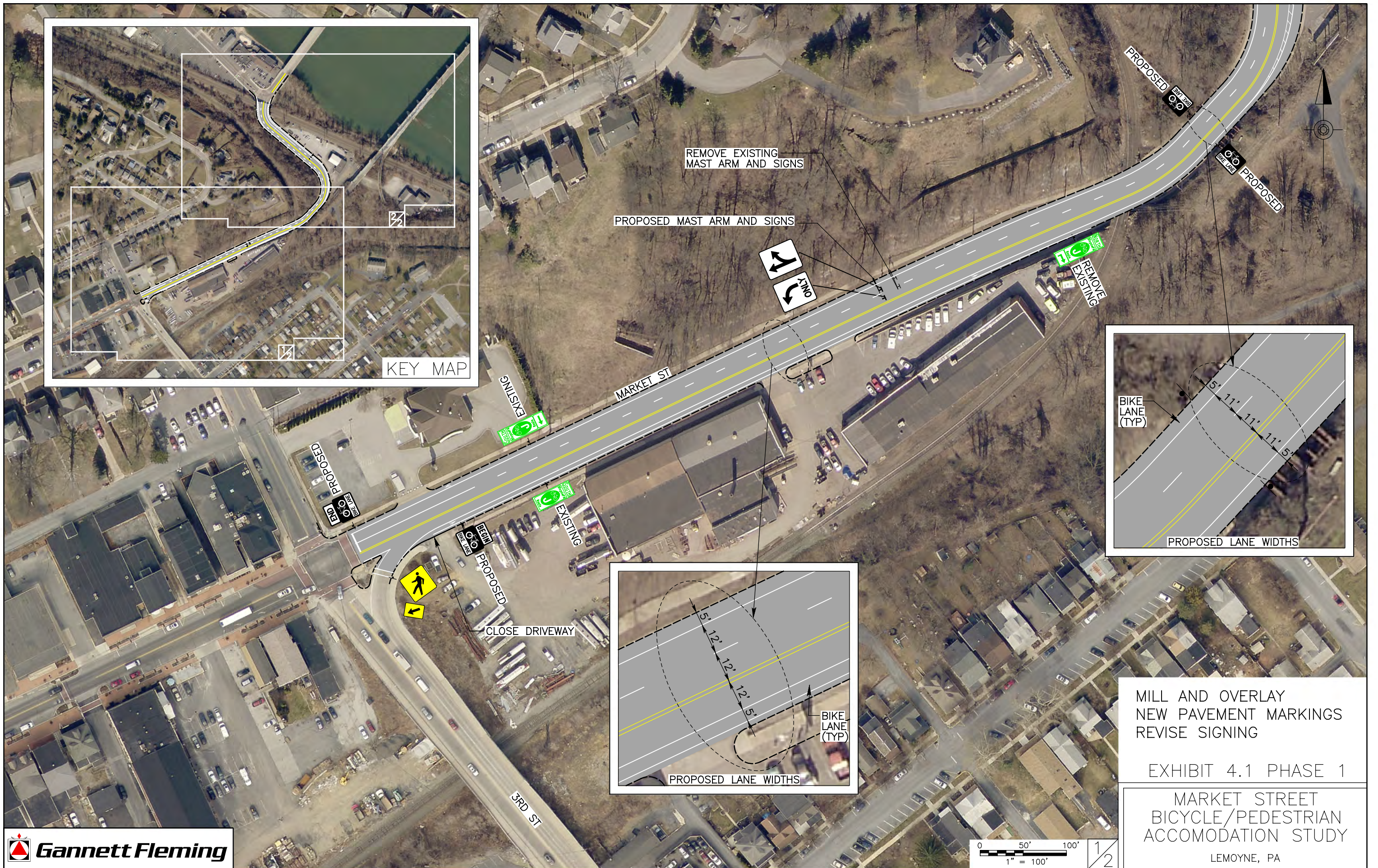
### Edge Rumble Strips

Consideration should also be given to the installation of edge rumble strips (identified by the shaded area in red) within the inside edge of the hatch-marked buffer areas adjacent to both the eastbound and westbound travel lanes on portions of Market St. These rumble strips will help to delineate the buffer area by alerting motorists through vibration when their vehicle enters the buffer area. In addition, the use of edge line rumble strips will provide a higher level of awareness for bicyclists against encroaching vehicles and will allow for the proper maintenance of the bike lane surface regarding the sweeping of debris and snow removal, otherwise difficult if a physical barrier were installed.



### Market Street Bike and Pedestrian Improvements

The proposed Market Street bike and pedestrian improvements are shown on drawings in Exhibit 4.1. The drawings are separated into two phases to allow for clarity of improvement details.



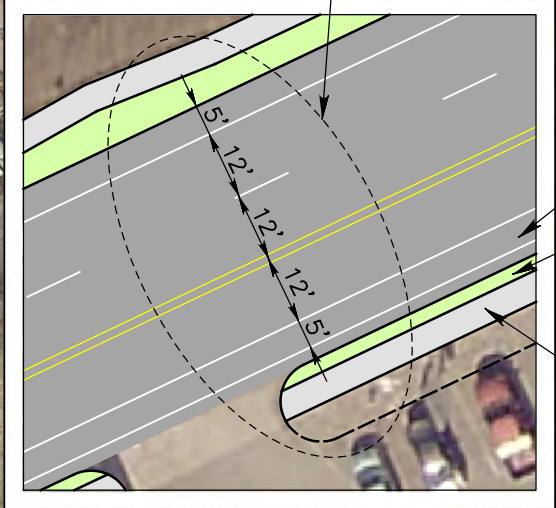
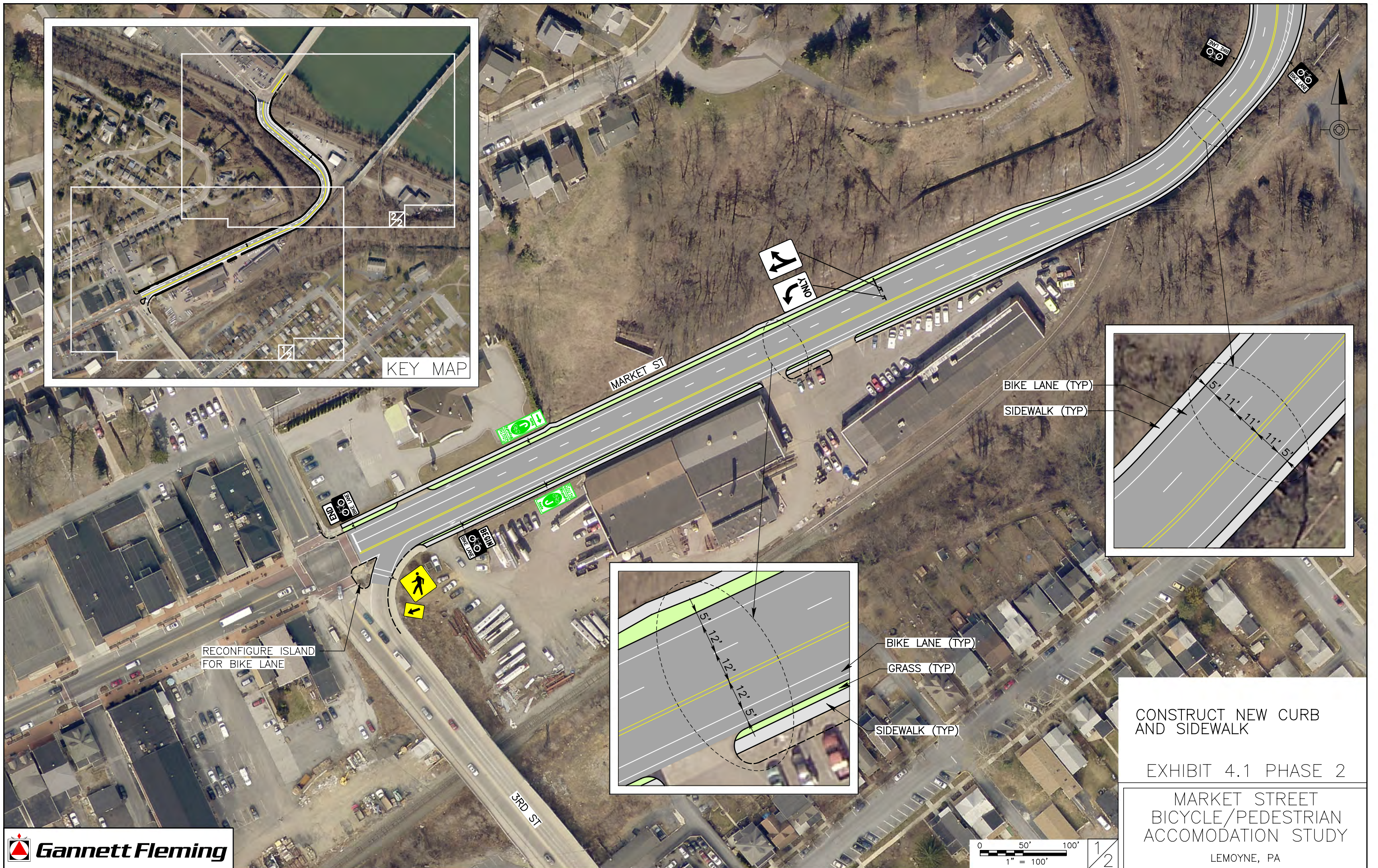
MILL AND OVERLAY  
 NEW PAVEMENT MARKINGS  
 REVISE SIGNING

EXHIBIT 4.1 PHASE 1

MARKET STREET  
 BICYCLE/PEDESTRIAN  
 ACCOMODATION STUDY

LEMOYNE, PA



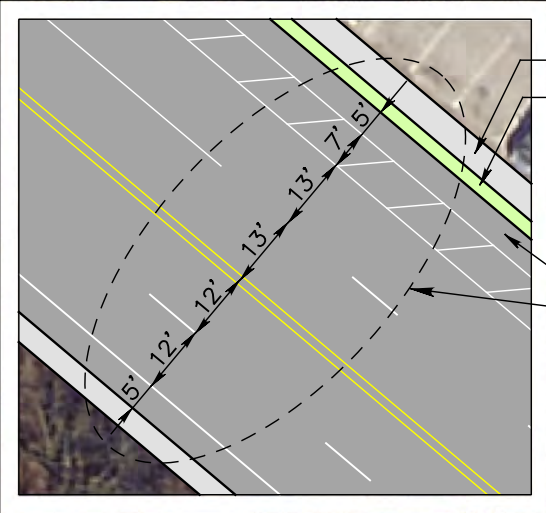
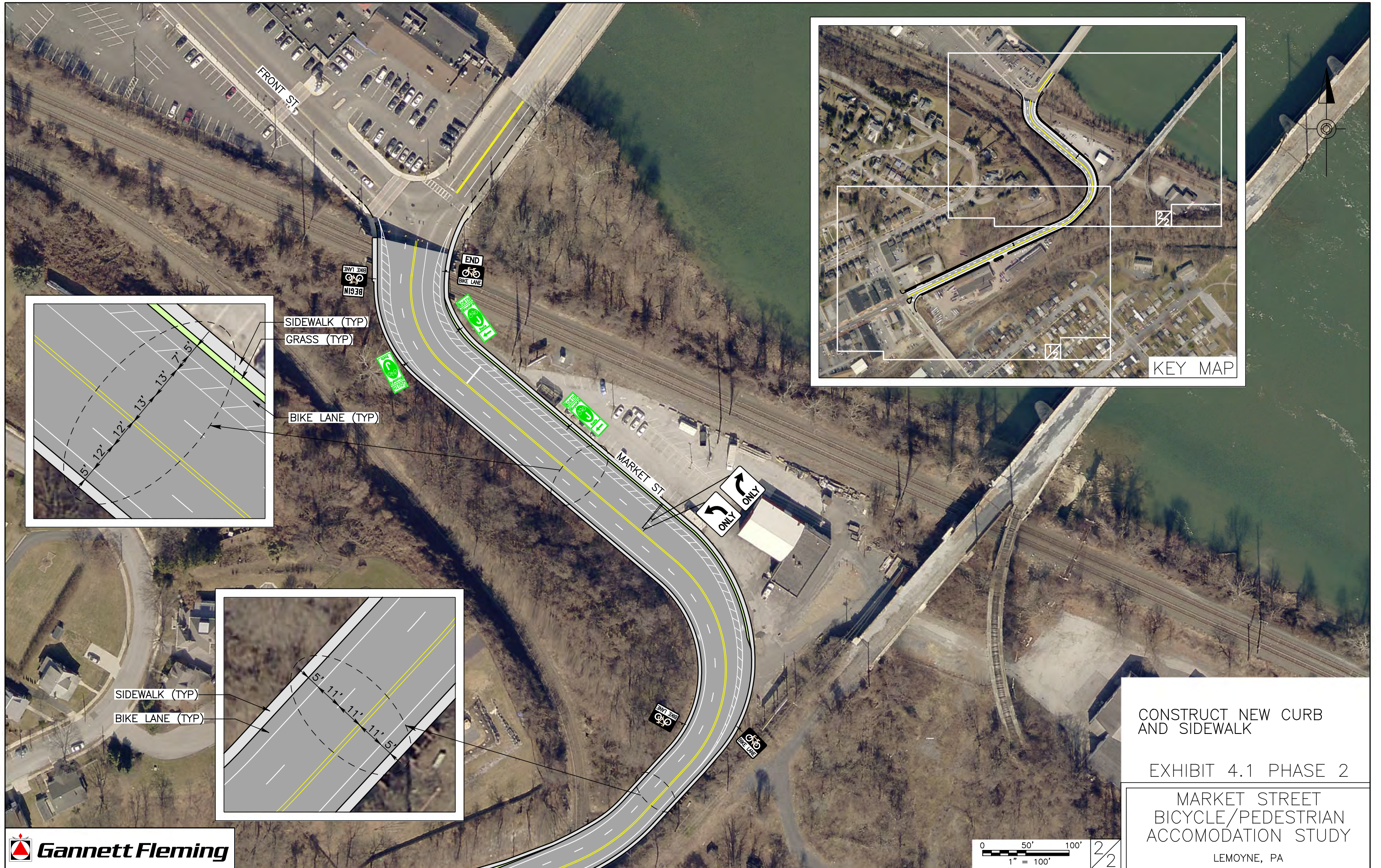


CONSTRUCT NEW CURB  
AND SIDEWALK

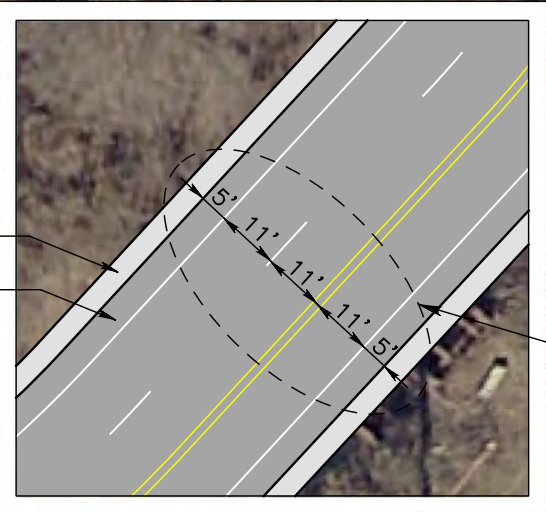
EXHIBIT 4.1 PHASE 2

MARKET STREET  
BICYCLE/PEDESTRIAN  
ACCOMODATION STUDY

LEMOYNE, PA



SIDEWALK (TYP)  
 GRASS (TYP)  
 BIKE LANE (TYP)



SIDEWALK (TYP)  
 BIKE LANE (TYP)



CONSTRUCT NEW CURB  
 AND SIDEWALK

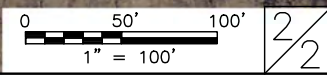
EXHIBIT 4.1 PHASE 2

MARKET STREET  
 BICYCLE/PEDESTRIAN  
 ACCOMODATION STUDY

LEMOYNE, PA



FILENAME: \$FILE\$  
 PLOTTED: \$DATE\$ \$TIME\$



2/2

## 5 COST ESTIMATES

The cost estimate for the conceptual bike and pedestrian improvements are provided below in Table 5.1 and can be implemented depending on project programming requirements and available funding.

### 5.1 Pavement Milling and Overlay, Pavement Marking and Signing, Sidewalk, Curbing Installation, and Lighting

No.	Item	Unit Cost	Quantity	Total	Unit
1	2" Pvmt Mill & Overlay			\$175,000	LS
2	New DY Centerline, 4" Paint & Beads	\$1	1900	\$1,900	LF
3	New white pvmt edge lines, 4"	\$0.5	3800	\$1,900	LF
4	New broken white line, 6"	\$0.67	475	\$300	LF
5	Gore marking buffer btwn travel lane & bike lane, 4" white	\$0.5	915	\$450	LF
6	Gore hatch marking buffer btwn travel lane & bike lane	\$4	592	\$2,350	SF
7	Bike lane legends	\$150	6	\$900	EA
8	Market and Front St. signals upgrade and timing*	\$201,800	1	\$201,800	LS
9	Lane line NB market to Wormleysburg, 4"	\$1	400	\$400	LF
10	Lane line WB Market at 3 <sup>rd</sup> St., 4"	\$1	100	\$100	LF
11	Replace ground mounted sign EB	\$67	5	\$350	EA
12	Remove Rt only on mast arm EB, adjust other LUC signs NB Market St.	\$100	7.5	\$750	EA
13	Install mast arm and directional signs WB	\$14,000	1	\$14,000	EA
14	Install bike lane signs	\$300	6	\$1,800	EA

No.	Item	Unit Cost	Quantity	Total	Unit
15	Remove and replace Sidewalk 5'	\$50	3800	\$190,000	LF
16	Removal and replace Curb	\$30	3800	\$115,000	LF
17	Drainage inlet modifications	\$20,000	10	\$20,000	EA
18	Signal Controller upgrade / interconnect	\$5,000	1	\$5,000	EA
19	Upgrade street lighting	\$5,000	6	\$30,000	EA
20	Reconstruction of raised island at Market and 3 <sup>rd</sup>	\$15,000	1	\$15,000	LS
Subtotal				\$777,000	
Design @ 20%				\$155,400	
<b>Total</b>				<b>\$932,400</b>	

*\*Ownership of signals is anticipated to transfer to municipality after upgrades complete.*

Consideration should be given to upgrading the traffic signals at Market St. and 3<sup>rd</sup> St. and 3<sup>rd</sup> St. and Hummel Ave. in Lemoyne Borough. The cost estimate for the signal upgrades are provided in Table 5.2 and can be implemented separately from the bike and pedestrian improvements depending on project programming requirements and available funding.

## 5.2 Signal Upgrade for Market St. & 3<sup>rd</sup> St. and 3<sup>rd</sup> St. & Hummel Ave Intersections

1	Market St. and 3 <sup>rd</sup> St signals upgrade and timing	\$201,700	1	\$201,700	LS
2	3 <sup>rd</sup> St and Hummel Ave. signals upgrade and timing	\$203,400	1	\$203,400	LS
Subtotal				\$405,100	
Design @20%				\$81,000	
<b>Total</b>				<b>\$486,000</b>	

Notes:

- Cost estimates are in 2019 dollars
- Total length from RR bridge to WB Market/3<sup>rd</sup> Stop Bar = 1900 LF
- Length of gore marking 915 LF – assume average hatch of 8LF X 2 F = 16SF @ 25 ft spacing (37 hatches)