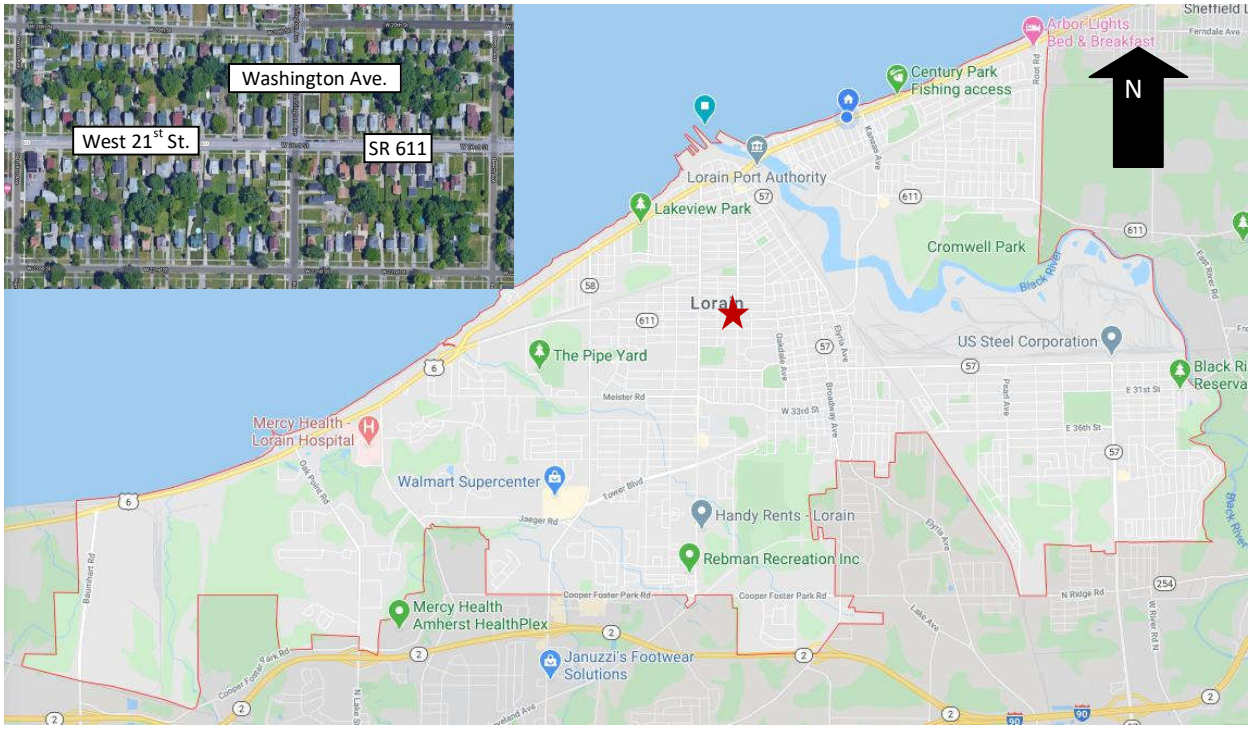

City of Lorain
Engineering Department
Intersection list:
#223 Statewide
#7 Citywide

ABBREVIATED SAFETY STUDY

CR 633 AND SR 611

(WASHINGTON AVENUE AT WEST 21ST STREET)

CITY OF LORAIN, LORAIN COUNTY

Prepared by: Veronica A Newsome, P.E. and Jessica Potter

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Background

The City of Lorain reached out for guidance at ODOT District 3 to evaluate the intersection of Washington Avenue (CR 633) and West 21st Street (SR611). The intersection of Washington Avenue (CR 633) and West 21st Street (SR611) ranked #223 statewide Urban Intersections on the 2018 Ohio Department of Transportation Highway Safety Improvement Program list and #7 citywide on the 2018 City of Lorain Safety Priority Intersection List. Please see **Appendix J** for details.

Ohio is one of the first states in the country to fully implement AASHTOWare's Safety Analyst to prioritize safety locations across Ohio. Safety Analyst uses state-of-the-art statistical methodologies to identify roadway locations with the highest potential for reducing crashes. The software system flags spot locations and road segments that have higher-than-predicted crash frequencies. It also flags locations for review based on crash severity. For further explanation on the criteria terminology, refer to the following link:
http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/Pages/Priority-Lists-Initiatives.aspx

A preliminary crash analysis using the ODOT Economic Crash Analyst Tool (ECAT) found the following statistical results based on the existing conditions and traffic volumes:

Expected Crash Frequency – 6.65crashes/year
Ratio of observed fatal and serious injuries to observed total crashes 0.00%
Percentage of the potential for safety improvement to total expected crashes
20.30%
Relative severity index $25,609
Equivalent property damage only index 3.45

As can be seen above, the study intersection currently has a potential for safety improvement of 20.30%. This means that there are approximately 20% more crashes occurring at the intersection than would be expected at a similar intersection.

Existing/Future Conditions

The Washington Avenue (CR 633) and West 21st Street (SR611) intersection is located in northern Lorain County. It is approximately 1.2 miles from US6 which runs parallel to Lake Erie and 1.3 miles from Lorain City Hall. The area is residential.

The Washington Avenue (CR633) and West 21st Street (SR611) intersection is a four-leg, signalized intersection located within the City of Lorain in Lorain County. The intersection is relatively flat grade and has adequate intersection and stopping sight distance for all approaches.

The north-south roadway (Washington Avenue) is a two-lane major collector on the north and south approaches and a 25 MPH speed limit. This roadway will be restriped in 2021 to reflect advisory bike lanes on the north approach and bike lanes on the south approach with project PID 108526 CMAQ – Washington Ave Bike lanes. Please see **Appendix E** for details.

The east-west roadway (West 21st Street) is currently undergoing a road diet to the west of Oberlin

Avenue. The speed limit is 35 MPH. Overhead lighting is present along Washington Avenue and West 21st Street.

Stop lines are offset from the intersection for vehicle turning movements. Left turn lanes are on the east (100' storage) and west (100' storage) approaches.

The east and west approaches are curb and 36' pavement width. The south approach is curbed and has 34' pavement width. The north approach is curbed and 28' pavement width. The surrounding area is urban residential.

Figure 1 North Approach

Figure 2 South Approach

Figure 3 East Approach

Figure 4 West Approach

The nearby schools create a combination of multimodal travel at this intersection. Local residents may cross at this intersection to reach nearby Elementary, Middle, and High Schools.

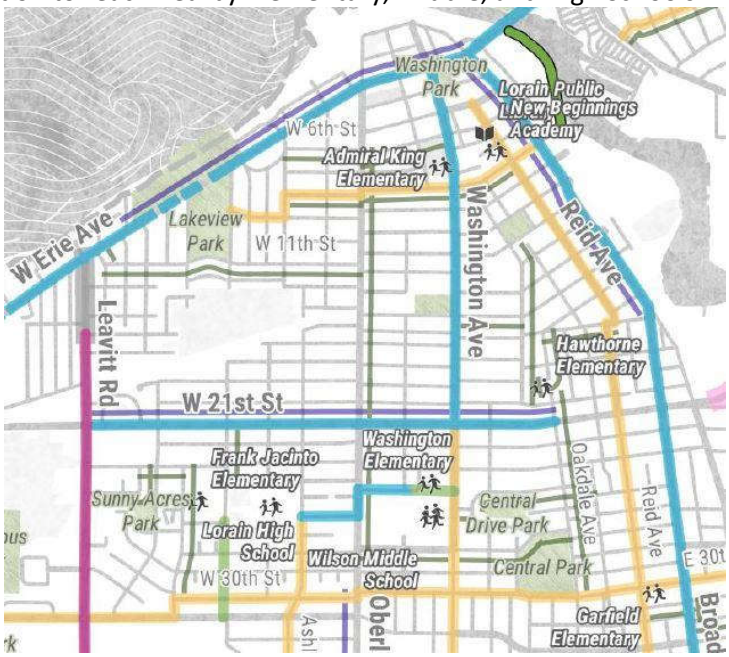

Figure 5 Plan View of Intersection – City of Lorain Active Transportation Plan (2018)

Traffic Volumes

From 2014 to 2020, the average daily traffic (ADT) volumes on the north, east and west approaches show an increase and the south approach shows a slightly decrease as seen below in **Table 1**.

Table 1. Average Daily Traffic (ADT)

Year	Approach ADT (Both Directions)			
	North	South	East	West
2014	3,850	2,250	10,640	10,340
2020	4,000	2,130	12,050	11,460

A turning movement count was taken at the intersection on Thursday, March 5th, 2020. Based on the count data, the morning peak occurs between 7:45 AM and 8:45 AM and the evening peak occurs between 3:30 PM and 4:30 PM. The detailed traffic count report can be found in **Appendix A**.

Pedestrian movements were also counted on Thursday, March 5th, 2020. A total of 81 crossing movements were counted during the 24 hour period – 26% crossing the south approach, 11% crossing the west approach, 16% crossing the north approach, and 47% crossing at the east approach.

Signal Operations

The traffic signal is a 50 foot long rectangular span with strain poles at each corner. All signal heads are three-sections consisting of 8 inch red, amber, and green lenses with incandescent bulbs. All approaches

have two signal heads without back plates controlling the approach. The signal head housings are constructed of aluminum painted yellow and are hung by wire. A view of the signal is provided in **Figure 6**.

Figure 6 – Signal heads, span wire, strain poles

The traffic signal at the State Route 611 / Washington Avenue intersection currently is an electro-mechanical, pre-timed signal with no vehicular detection present. The signal at this intersection operates with a 70 second cycle length. Intersection Capacity Analysis was performed for the signalized intersection utilizing the Highway Capacity Software (HCS7), which is based upon the Highway Capacity Manual, 6th Edition. Additionally, the ODOT preferred balanced approach delay methodology was used in this analysis utilizing the existing traffic signal timings. Traffic volumes from the March 5th, 2020 turning movement count were used for the analyses. **Table 2** displays the intersection operating conditions for the AM and PM peak hours. At current traffic volume levels, the intersection overall operates at an acceptable Level of Service (LOS) C in the AM peak hour and LOS D in the PM peak hour. The HCS reports are in **Appendix B**.

Table 2. Existing Year 2020 'No-Build' Intersection Capacity Analysis Results Summary

Peak Period	NB LOS (Delay)	SB LOS (Delay)	EB LOS (Delay)	WB LOS (Delay)	Overall LOS (Delay)
AM Peak	B (13.7)	B (14.6)	B (14.5)	B (14.1)	B (14.3)
PM Peak	B (16.4)	B (18.1)	B (14.2)	B (18.2)	B (16.7)

Signal clearance times were also evaluated for the intersection. The current and ITE (Institute of Transportation Engineers) formula values for the yellow change intervals and the red clearance intervals are found in Table 3 below and a detailed calculation sheet can be found in **Appendix C**.

Table 3. Yellow Change and Red Clearance Intervals

Interval	West 21st Street (SR611)		Washington Avenue	
	Current	ITE Formula	Current	ITE Formula
Yellow Change Interval (sec)	4.00	3.30	4.00	3.00
Red Clearance Interval (sec)	2.00	1.00	2.00	1.00

Crash Data and Analysis

The most recent five years (2015-2019) of crash data was analyzed. The OH-1 report for each documented crash was reviewed for accuracy and to locate crashes properly within the study limit. The crash diagram is included in **Appendix D**. A total of 45 intersection related crashes were reported from 1/1/2015 to 12/31/2019. The general breakdown of the crash data and observable trends can be found below.

Total Crashes = 45 (1/1/15-12/31/19)

Crashes by Year	
2015	9
2016	4
2017	13
2018	8
2019	11
Grand Total	**45**

Crashes by Severity	
Injury Crash	23
Property Damage Crash	22
Grand Total	**45**

Crashes by Type	
Rear End	17
Angle	15
Left Turn	6
Backing	3
Head On	2
Sideswipe - Passing	2
Grand Total	**45**

Crashes by Road Condition	
Dry	38
Wet	7
Grand Total	**45**

Crashes by Time of Day	
6	1
7	2
8	3
9	6
10	3
11	2
12	4
13	3
14	3
15	2
16	1
17	3
18	5
19	2
20	2
21	2
22	1
Grand Total	**45**

Young Drivers

-18/45 (40%) total crashes involved 25 year old or younger driver at fault.

Older Drivers

-8/45 (18%) total crashes involved 65 year old or older driver at fault.

Speeding Drivers

-3/45 (7%) total crashes involved distracted drivers at fault.

Rear end Crashes

-17/45 (38%) total crashes were classified as rear end crashes.

Probable Causes

The main crash type found at the subject intersection is rear-end related crashes, which account for approximately 38% of the total crashes. There are numerous causes that could be contributing factors to the crashes occurring at this intersection, including distracted driving and lack of driver experience. Distracted driving has become more common in recent years and approximately 40% of the crashes occurred due to a motorist being 25 years old or younger. However, these causes cannot be addressed from an engineering perspective. Other factors that could be causing the crashes at this intersection were also investigation that could be mitigated from an engineering perspective.

Looking at the existing conditions at the intersection, it was noted that the current traffic signal installation is an older, span wire installation that lacks traffic signal backplates which affects the visibility of the existing traffic signal, contributing to the rear-end and angle crashes that were found to occur. The below image shows the existing signal heads for the east approach to the intersection.

The existing traffic signal timings and clearance intervals could be leading to the presence of both rear-end and angle crashes occurring at the intersection. The existing signal timings have not been revised for numerous years, including the clearance intervals. If the clearance intervals are too short for motorists to clear the intersection during the phase change, angle crashes could be occurring as traffic isn't clearing the intersection before the phase changes.

The two contributing factors mentioned above that cause rear-end and angle crashes to occur have contributed to the fact that 71% of the crashes found at the intersection are rear-end and angle related. Additionally, due the number of angle crashes, over 50% of the crashes were injury crashes. Therefore, the identified improvements should focus on the reduction of rear-end and angle crashes and the injuries associated with those crash types.

Rear-end crashes were predominantly found to occur on the eastbound and westbound approaches to the intersection. The capacity analysis results does not show excessive delay at the intersection and from a geometric standpoint, there is not a significant difference between the eastbound and westbound approaches compared to the northbound and southbound approaches. The largest difference (and what appears to be contributing to more crashes on the eastbound and westbound approaches) are the traffic volumes. The eastbound and westbound approaches account for approximately 81% of the traffic entering the intersection in the AM peak hour and 78% in the PM peak hour. This volume disparity appears to be the reason that more rear-end crashes are occurring on those two approaches, which can be attributed to the poor signal visibility, 8" incandescent signal heads, and lack of signal backplates.

Countermeasures

In order to address the safety deficiencies at the intersection, as noted in the previous section, the following improvements are recommended at the intersection:

1. Implement updated signal timings and clearance intervals
2. Reconstruct the traffic signal at the intersection and include backplates on the traffic signal heads. Upgrade the pedestrian accommodations at the intersection to include a pedestrian countdown timer.
3. Investigate signal coordination on SR 611
4. Community and school promotion of driver safety to students and parents

The above improvement list will help to mitigate the existing crash patterns that were identified at the study intersection. It should be noted that the existing span wire signal installation will be unable to accommodate the traffic signal backplates and the existing traffic signal installation will need to be reconstructed. The traffic signals should be reconstructed and upgraded to include full vehicular detection, meet current design standards, and incorporate current technology. All traffic signals should be designed to accommodate traffic signal backplates on all approaches to increase signal visibility and add target value to the signal heads. Additionally, the upgraded signals should provide full pedestrian accommodations with pushbuttons and countdown displays. The new traffic signal should also have updated signal timings and clearance intervals incorporated. The city will also investigate the addition of advance warning signs with street name plaques and lane use signs for the eastbound and westbound approaches during the detailed design phase of this project.

The estimated cost for this project is $391,000, which includes the design, right-of-way, construction, and construction inspection services necessary for the reconstruction project. The cost estimate is included in **Appendix F**. The City of Lorain is requesting 100% of this funding from the ODOT Highway Safety Improvement program. The construction is proposed to occur in ODOT State Fiscal Year 2023, which begins on July 1st, 2022.

Implementation Plan

Intersection Improvements Under Design

Safety improvements are currently underway along SR 611 with the construction of PID 110315 – Lorain TLCI. This project restripes SR 611 from SR58 to Oberlin Avenue. The project is comprised of a road diet, that right sizes the roadway cross section in this residential area to include bike lanes, a center turn lane, and two travel lanes; one in each direction.

Future safety improvements will occur in 2021 along SR 611 with the construction of PID 109068 – SR 611 sidewalk and pedestrian improvements. This project will improve sidewalks, curb ramps, and pedestrian crossings along SR 611 from SR58 to Oakdale Avenue.

Please refer to **Appendix K** for an Intersection Concept Plan.

Requested Intersection Safety Improvements

This safety study is requesting funding for intersection improvements listed in the 'Countermeasures' section of this document. These improvements are proposed to be constructed in ODOT FY 2023.

Long Term Intersection Improvements

The City of Lorain has an active transportation team, Lorain Connected that is working towards building a better Lorain. Lorain Connected applies for SRTS infrastructure and non-infrastructure yearly as well as other grants from public and private sources. This interdisciplinary team meets monthly to discuss safety concerns in the community and addresses issues. The goal is to engage the community in safety issues and improvements. Over the past 3 years, Lorain Connected has leveraged over $1 Million dollars in grant funding to host bike and walk to school days, implement temporary safety improvements for study, and assisted in the building of an inclusive playground in the City of Lorain.

In the future the City of Lorain would like to improve travelling along the SR611 corridor by implementing signal coordination. Signal coordination could reduce the number of stops along the corridor, improving air quality from idling vehicles and provide for a continuous flow of traffic at the target speed, by adjusting cycle lengths.

The City of Lorain would look to the ODOT task order consultant to assist in evaluating citywide signal coordination for other intersecting routes.

Benefit to Cost Analysis

The reduction of crashes within the State of Ohio is the top priority of ODOT's Highway Safety Improvement Program. ECAT analysis was performed at the study intersection in order to perform a Benefit to Cost analysis on the proposed intersection improvements. **Table 4** provides a summary of the Benefit to Cost Ratio for the proposed intersection improvements and **Appendix G** contains the Benefit to Cost Analysis worksheets. Additionally, the formal safety application for this improvement project is contained in **Appendix H**.

Table 4. Benefit to Cost Summary Chart

	Net Present Value of Project	Net Present Value of Safety Benefits	Benefit to Cost Ratio
Benefit to Cost Results	$334,000.00	$1,072,981.64	3.21

The Benefit to Cost Ratio analysis was performed based upon a project cost of $334,000 (which is the total cost of the State Route 611 /Washington Avenue intersection improvement project, not including the construction inspection or inflation). This results in a Benefit to Cost Ratio of 3.21. Based on the Benefit to Cost Ratio being significantly greater than 1.00, this intersection safety improvement project should be considered a fundable project and should receive the consideration of the funding committee.

Traffic Signal Warrant Analysis

In order to determine whether the study intersection meets a traffic signal warrant based on the current traffic conditions, the existing traffic volumes were compared to the volumes thresholds and criteria outlined in Section 402-2 of the ODOT Traffic Engineering Manual (TEM). The results of the Existing Year 2020 traffic signal warrant analysis are shown in **Table 5** below and the traffic signal warrant analysis printouts are contained in **Appendix I**.

Table 5. Existing Year 2019 Traffic Signal Warrant Analysis Summary

Intersection	Signal Warrant		
	Warrant #1 (Eight Hour Vehicular Volume)	**Warrant #2** (Four Hour Vehicular Volume)	**Warrant #3** (Peak Hour Vehicular Volume)
State Route 611 / Washington Avenue	**Satisfied**	**Satisfied**	**Satisfied**

'Build' Intersection Capacity Analysis

Intersection capacity analysis was performed for the 'Build' conditions in order to determine the anticipated operating conditions once the proposed improvements are implemented at the study intersection. This analysis was performed utilizing the computer program HCS7 and following the ODOT preferred balanced approach delay methodology. **Table 6** displays the intersection operating conditions for the AM and PM peak hours. Under the proposed intersection operations, the overall intersection is anticipated to operate at an improved LOS C in the AM peak hour and LOS C in the PM peak hour. The HCS reports are contained in **Appendix B**.

Table 6. Existing Year 2020 'Build' Intersection Capacity Analysis Results Summary

Peak Period	NB LOS (Delay)	SB LOS (Delay)	EB LOS (Delay)	WB LOS (Delay)	Overall LOS (Delay)
AM Peak	B (12.8)	B (13.7)	B (13.7)	B (13.4)	B (13.5)
PM Peak	B (15.2)	B (16.9)	B (13.5)	B (16.9)	B (15.6)

When comparing the capacity analysis results between the 'No-Build' (shown in **Table 1**) and 'Build' (shown in **Table 6**) conditions, there is a slight reduction in overall delay noted between the two conditions. In the AM peak hour, the overall intersection is anticipated to operate at LOS B during the 'No-Build' and 'Build' conditions; however the overall intersection delay is reduced from 14.3 seconds of delay to 13.5 seconds. In the PM peak hour, the overall intersection is anticipated to operate at LOS B during the 'No-Build' and 'Build' conditions; however the overall intersection delay decreases from 16.7 seconds to 15.6 seconds.

APPENDIX A

Traffic Count Data

Washington Ave and West 21st St
Lorain Ohio
03/05/2020 07:00:00

Time	Southbound Washington Ave						Westbound West 21st St						Northbound Washington Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
12:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
12:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
12:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
12:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
1:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
1:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
1:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
1:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
2:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
2:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
2:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
2:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
3:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
3:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
3:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
3:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
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4:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
4:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
4:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
5:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
5:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
5:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
5:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
6:00 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
6:15 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
6:30 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
6:45 AM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
7:00 AM	0	11	4	12	0	*27*	0	0	74	6	0	*80*	0	2	3	2	0	*7*	0	3	65	0	0	*68*	**182**
7:15 AM	0	9	7	11	0	*27*	0	2	67	6	0	*75*	0	0	9	1	0	*10*	0	1	89	1	1	*91*	**203**
7:30 AM	0	26	5	5	0	*36*	0	4	62	14	0	*80*	0	1	5	3	0	*9*	0	8	92	1	0	*101*	**226**
7:45 AM	0	12	20	16	0	*48*	0	9	75	7	0	*91*	0	1	15	11	0	*27*	0	8	96	2	5	*106*	**272**
Hourly Total	0	58	36	44	0	*138*	0	15	278	33	0	*326*	0	4	32	17	0	*53*	0	20	342	4	6	*366*	**883**

Washington Ave and West 21st St
Lorain Ohio
03/05/2020 07:00:00

Time	Southbound Washington Ave						Westbound West 21st St						Northbound Washington Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
8:00 AM	0	13	16	10	0	*39*	0	3	82	13	0	*98*	0	3	17	8	0	*28*	0	7	85	5	0	*97*	**262**
8:15 AM	0	15	9	7	0	*31*	0	6	52	7	1	*65*	0	1	7	6	0	*14*	0	4	83	4	1	*91*	**201**
8:30 AM	0	20	21	19	0	*60*	0	2	80	1	0	*83*	0	2	18	8	0	*28*	0	8	67	3	0	*78*	**249**
8:45 AM	0	13	23	16	0	*52*	0	5	80	9	1	*94*	0	4	21	12	0	*37*	0	6	69	7	0	*82*	**265**
Hourly Total	0	61	69	52	0	*182*	0	16	294	30	2	*340*	0	10	63	34	0	*107*	0	25	304	19	1	*348*	**977**
9:00 AM	0	18	6	10	1	*34*	0	4	63	15	0	*82*	0	2	8	4	0	*14*	0	1	65	3	1	*69*	**199**
9:15 AM	0	8	11	11	0	*30*	0	2	46	8	1	*56*	0	4	2	2	0	*8*	0	6	76	2	1	*84*	**178**
9:30 AM	0	14	6	9	0	*29*	0	4	68	5	1	*77*	0	1	4	1	0	*6*	0	5	51	1	1	*57*	**169**
9:45 AM	0	8	6	12	0	*26*	0	2	67	3	0	*72*	0	1	6	2	0	*9*	0	4	69	5	0	*78*	**185**
Hourly Total	0	48	29	42	1	*119*	0	12	244	31	2	*287*	0	8	20	9	0	*37*	0	16	261	11	3	*288*	**731**
10:00 AM	0	9	13	10	0	*32*	0	1	65	8	0	*74*	0	0	6	4	0	*10*	0	3	60	1	0	*64*	**180**
10:15 AM	0	12	10	9	0	*31*	0	1	10	3	0	*14*	0	1	3	4	0	*8*	0	4	48	3	0	*55*	**108**
10:30 AM	0	11	16	6	0	*33*	0	2	84	7	1	*93*	0	3	4	6	0	*13*	0	5	74	2	0	*81*	**220**
10:45 AM	0	10	6	6	0	*22*	0	6	78	9	0	*93*	0	2	5	4	0	*11*	0	7	70	1	0	*78*	**204**
Hourly Total	0	42	45	31	0	*118*	0	10	237	27	1	*274*	0	6	18	18	0	*42*	0	19	252	7	0	*278*	**712**
11:00 AM	0	9	2	11	0	*22*	0	1	74	8	0	*83*	0	3	8	3	0	*14*	0	11	71	2	0	*84*	**203**
11:15 AM	0	12	14	11	1	*37*	0	4	63	7	0	*74*	0	2	8	6	0	*16*	0	3	74	0	0	*77*	**204**
11:30 AM	0	11	11	9	0	*31*	0	5	73	9	0	*87*	0	1	5	3	0	*9*	0	1	70	0	0	*71*	**198**
11:45 AM	0	12	9	14	0	*35*	0	5	86	8	0	*99*	0	2	10	4	0	*16*	0	3	67	2	0	*72*	**222**
Hourly Total	0	44	36	45	1	*125*	0	15	296	32	0	*343*	0	8	31	16	0	*55*	0	18	282	4	0	*304*	**827**
12:00 PM	0	11	9	18	0	*38*	0	0	85	10	0	*95*	0	0	6	3	0	*9*	0	9	90	4	1	*103*	**245**
12:15 PM	0	10	5	13	0	*28*	0	0	88	9	0	*97*	0	1	12	3	0	*16*	0	2	90	0	0	*92*	**233**
12:30 PM	0	15	10	8	1	*33*	0	4	88	7	0	*99*	0	1	8	2	1	*11*	0	4	88	7	0	*99*	**242**
12:45 PM	0	17	13	11	1	*41*	0	3	76	10	0	*89*	0	3	13	3	0	*19*	0	9	85	2	0	*96*	**245**
Hourly Total	0	53	37	50	2	*140*	0	7	337	36	0	*380*	0	5	39	11	1	*55*	0	24	353	13	1	*390*	**965**
1:00 PM	0	16	18	10	0	*44*	0	5	102	13	0	*120*	0	3	6	2	0	*11*	0	7	69	4	0	*80*	**255**
1:15 PM	0	14	7	16	0	*37*	0	2	81	11	1	*94*	0	0	7	3	0	*10*	0	10	69	5	0	*84*	**225**
1:30 PM	0	9	3	17	0	*29*	0	2	88	11	0	*101*	0	6	7	5	0	*18*	0	7	90	6	0	*103*	**251**
1:45 PM	0	10	12	22	0	*44*	0	1	108	11	0	*120*	0	1	3	10	1	*14*	0	9	86	3	0	*98*	**276**
Hourly Total	0	49	40	65	0	*154*	0	10	379	46	1	*435*	0	10	23	20	1	*53*	0	33	314	18	0	*365*	**1007**
2:00 PM	0	20	14	21	0	*55*	0	2	115	16	1	*133*	0	2	6	2	2	*10*	0	6	80	2	0	*88*	**286**
2:15 PM	0	17	22	12	0	*51*	0	7	120	15	0	*142*	0	6	15	7	0	*28*	0	12	102	12	0	*126*	**347**
2:30 PM	0	17	24	24	5	*65*	0	4	62	9	0	*75*	0	4	20	12	1	*36*	0	7	72	8	6	*87*	**263**
2:45 PM	0	14	14	13	0	*41*	0	7	97	11	0	*115*	0	0	23	3	0	*26*	0	8	88	8	3	*104*	**286**
Hourly Total	0	68	74	70	5	*212*	0	20	394	51	1	*465*	0	12	64	24	3	*100*	0	33	342	30	9	*405*	**1182**
3:00 PM	0	15	13	14	0	*42*	0	7	93	16	0	*116*	0	1	9	3	0	*13*	0	6	102	1	2	*109*	**280**
3:15 PM	0	17	23	16	2	*56*	0	8	101	16	0	*125*	0	6	10	8	1	*24*	0	6	100	3	2	*109*	**314**
3:30 PM	0	10	19	19	0	*48*	0	7	134	24	0	*165*	0	2	26	9	0	*37*	0	7	138	6	2	*151*	**401**
3:45 PM	0	15	15	13	0	*43*	0	5	123	24	1	*152*	0	6	12	8	0	*26*	0	9	120	5	1	*134*	**355**
Hourly Total	0	57	70	62	2	*189*	0	27	451	80	1	*558*	0	15	57	28	1	*100*	0	28	460	15	7	*503*	**1350**

Washington Ave and West 21st St
Lorain Ohio
03/05/2020 07:00:00

Time	Southbound Washington Ave						Westbound West 21st St						Northbound Washington Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
4:00 PM	0	22	10	23	2	*55*	0	4	116	18	0	*138*	0	2	14	4	0	*20*	0	5	102	3	2	*110*	**323**
4:15 PM	0	17	30	21	0	*68*	0	8	116	33	0	*157*	0	3	8	5	0	*16*	0	9	101	5	0	*115*	**356**
4:30 PM	0	20	18	27	3	*65*	0	7	114	16	0	*137*	0	1	12	3	0	*16*	0	14	115	3	0	*132*	**350**
4:45 PM	0	12	14	22	1	*48*	0	6	118	16	1	*140*	0	2	13	2	0	*17*	0	9	102	2	0	*113*	**318**
Hourly Total	0	71	72	93	6	*236*	0	25	464	83	1	*572*	0	8	47	14	0	*69*	0	37	420	13	2	*470*	**1347**
5:00 PM	0	7	15	19	0	*41*	0	7	109	19	0	*135*	0	2	12	4	2	*18*	0	5	123	2	1	*130*	**324**
5:15 PM	0	23	12	11	1	*46*	0	3	120	24	0	*147*	0	4	14	11	1	*29*	0	6	100	1	1	*107*	**329**
5:30 PM	0	20	21	18	0	*59*	0	4	121	22	0	*147*	0	1	17	4	0	*22*	0	10	103	1	0	*114*	**342**
5:45 PM	0	15	9	15	0	*39*	0	6	99	20	0	*125*	0	2	13	6	0	*21*	0	4	102	2	0	*108*	**293**
Hourly Total	0	65	57	63	1	*185*	0	20	449	85	0	*554*	0	9	56	25	3	*90*	0	25	428	6	2	*459*	**1288**
6:00 PM	0	14	12	12	0	*38*	0	4	79	14	0	*97*	0	2	13	6	3	*21*	0	9	96	4	6	*109*	**265**
6:15 PM	0	15	15	19	1	*49*	0	4	79	13	0	*96*	0	2	11	3	0	*16*	0	8	82	3	0	*93*	**254**
6:30 PM	0	19	9	8	2	*36*	0	6	66	14	0	*86*	0	2	8	4	0	*14*	0	9	83	2	0	*94*	**230**
6:45 PM	0	13	18	11	0	*42*	0	3	97	23	0	*123*	0	3	9	3	1	*15*	0	2	91	2	1	*95*	**275**
Hourly Total	0	61	54	50	3	*165*	0	17	321	64	0	*402*	0	9	41	16	4	*66*	0	28	352	11	7	*391*	**1024**
7:00 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
7:15 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
7:30 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
7:45 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
8:00 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
8:15 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
8:30 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
8:45 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
9:00 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
9:15 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
9:30 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
9:45 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
10:00 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
10:15 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
10:30 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
10:45 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
11:00 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
11:15 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
11:30 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
11:45 PM	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
Hourly Total	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*	**0**
DAILY TOTAL	**0**	**677**	**619**	**667**	**21**	***1963***	**0**	**194**	**4144**	**598**	**9**	***4936***	**0**	**104**	**491**	**232**	**13**	***827***	**0**	**306**	**4110**	**151**	**38**	***4567***	**12293**
Cars	0	677	619	667	21	*1963*	0	184	4008	591	9	*4783*	0	102	473	226	13	*801*	0	297	3999	144	38	*4440*	**11987**
Heavy Vehicles	0	0	0	0	0	*0*	0	10	136	7	0	*153*	0	2	18	6	0	*26*	0	9	111	7	0	*127*	**306**
Heavy Vehicle %	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	5.15%	3.28%	1.17%	0.00%	*3.10%*	0.00%	1.92%	3.67%	2.59%	0.00%	*3.14%*	0.00%	2.94%	2.70%	4.64%	0.00%	*2.78%*	**2.49%**

Washington Ave and West 21st St
Lorain Ohio
03/05/2020 07:00:00

AM Peak Hour

Time	Southbound						Westbound						Northbound						Eastbound						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehide Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
7:45 AM	0	12	20	16	0	*48*	0	9	75	7	0	*91*	0	1	15	11	0	*27*	0	8	96	2	5	*106*	**272**
8:00 AM	0	13	16	10	0	*39*	0	3	82	13	0	*98*	0	3	17	8	0	*28*	0	7	85	5	0	*97*	**262**
8:15 AM	0	15	9	7	0	*31*	0	6	52	7	1	*65*	0	1	7	6	0	*14*	0	4	83	4	1	*91*	**201**
8:30 AM	0	20	21	19	0	*60*	0	2	80	1	0	*83*	0	2	18	8	0	*28*	0	8	67	3	0	*78*	**249**
Peak Hour Total	0	60	66	52	0	*178*	0	20	289	28	1	*337*	0	7	57	33	0	*97*	0	27	331	14	6	*372*	**984**
PHF	0.000	0.750	0.786	0.684	0.000	*0.742*	0.000	0.556	0.881	0.538	0.250	*0.860*	0.000	0.583	0.792	0.750	0.000	*0.866*	0.000	0.844	0.862	0.700	0.300	*0.877*	**0.904**

PM Peak Hour

Time	Southbound						Westbound						Northbound						Eastbound						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
3:30 PM	0	10	19	19	0	*48*	0	7	134	24	0	*165*	0	2	26	9	0	*37*	0	7	138	6	2	*151*	**401**
3:45 PM	0	15	15	13	0	*43*	0	5	123	24	1	*152*	0	6	12	8	0	*26*	0	9	120	5	1	*134*	**355**
4:00 PM	0	22	10	23	2	*55*	0	4	116	18	0	*138*	0	2	14	4	0	*20*	0	5	102	3	2	*110*	**323**
4:15 PM	0	17	30	21	0	*68*	0	8	116	33	0	*157*	0	3	8	5	0	*16*	0	9	101	5	0	*115*	**356**
Peak Hour Total	0	64	74	76	2	*214*	0	24	489	99	1	*612*	0	13	60	26	0	*99*	0	30	461	19	5	*510*	**1435**
PHF	0.000	0.727	0.617	0.826	0.250	*0.787*	0.000	0.750	0.912	0.750	0.250	*0.927*	0.000	0.542	0.577	0.722	0.000	*0.669*	0.000	0.833	0.835	0.792	0.625	*0.844*	**0.895**

Total Vehicles On Leg			3358		
Vehicles Entering Intersection	1963		Vehicles Exiting Intersection	1395	
Southbound					
Cars	667	619	677	0	21
Heavy	0	0	0	0	0
Total	**667**	**619**	**677**	**0**	**21**

Total Vehicles on Leg 9482	Vehicles Entering Intersection 4567	**Eastbound**	Cars	Heavy	**Total**
			38	0	**38**
			0	0	**0**
	Vehicles Exiting Intersection 4915		297	9	**306**
			3999	111	**4110**
			144	7	**151**

Daily Volumes

Cars	Heavy	**Total**	**Westbound**	Vehicles Entering Intersection 4936	Total Vehicles on Leg 9955
591	7	**598**			
4008	136	**4144**			
184	10	**194**		Vehicles Exiting Intersection 5019	
0	0	**0**			
9	0	**9**			

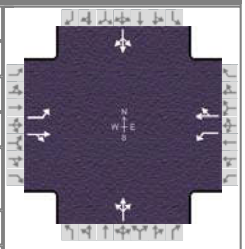
Cars	13	0	102	473	226
Heavy	0	0	2	18	6
Total	**13**	**0**	**104**	**491**	**232**
Northbound					
Vehicles Entering Intersection	827		Vehicles Exiting Intersection	964	
Total Vehicles On Leg			1791		

APPENDIX B

Capacity Analysis – 'No Build' and 'Build' Conditions

HCS7 Signalized Intersection Results Summary

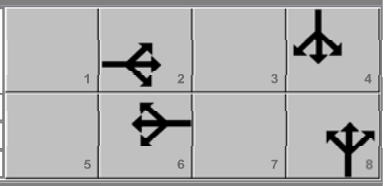
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	AM Peak Hour	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'No-Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Washi…	File Name	611 and Washington - AM Peak - 2020 NB.xus		
Project Description	State Route 611 / Washington Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	370	20	20	330	30	10	60	40	70	70	60

Signal Information			
Cycle, s	70.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	31.0	27.8	0.0	0.0	0.0	0.0	
Yellow	3.5	3.5	0.0	0.0	0.0	0.0	
Red	2.1	2.1	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		8.0		8.0
Phase Duration, s		36.6		36.6		33.4		33.4
Change Period, (*Y+R c*), s		5.6		5.6		5.6		5.6
Max Allow Headway (*MAH*), s		1.1		1.1		1.2		1.2
Queue Clearance Time (*g s*), s		14.0		14.5		5.0		8.2
Green Extension Time (*g e*), s		0.1		0.1		0.0		0.0
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	424		22	391			120			217	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1008	1883		979	1872			1749			1597	
Queue Service Time (*g s*), s	1.6	11.3		1.1	10.3			0.0			2.4	
Cycle Queue Clearance Time (*g c*), s	12.0	11.3		12.5	10.3			3.0			6.2	
Green Ratio (*g/C*)	0.44	0.44		0.44	0.44			0.40			0.40	
Capacity (*c*), veh/h	401	834		378	829			751			704	
Volume-to-Capacity Ratio (*X*)	0.081	0.508		0.058	0.472			0.159			0.309	
Back of Queue (*Q*), ft/ln (50 th percentile)	9	106.6		6.1	96.3			27.8			53.7	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.4	4.3		0.2	3.9			1.1			2.1	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00			0.00			0.00	
Uniform Delay (*d 1*), s/veh	17.9	14.0		18.5	13.7			13.6			14.5	
Incremental Delay (*d 2*), s/veh	0.0	0.2		0.0	0.2			0.0			0.1	
Initial Queue Delay (*d 3*), s/veh	0.0	0.0		0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh	18.0	14.2		18.5	13.9			13.7			14.6	
Level of Service (LOS)	B	B		B	B			B			B	
Approach Delay, s/veh / LOS	14.5	B		14.1	B		13.7	B		14.6	B	
Intersection Delay, s/veh / LOS	14.3						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.67	B	1.67	B	1.90	B	1.90	B
Bicycle LOS Score / LOS	1.24	A	1.17	A	0.68	A	0.85	A

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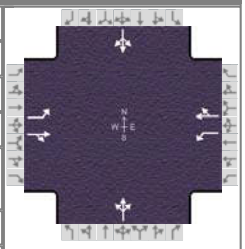
HCS7 Signalized Intersection Results Summary

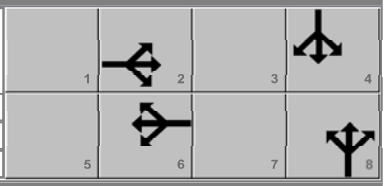
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	AM Peak Hour	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'No-Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Washi…	File Name	611 and Washington - PM Peak - 2020 NB.xus		
Project Description	State Route 611 / Washington Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	520	20	30	550	110	10	70	30	70	80	90

Signal Information			
Cycle, s	70.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	35.0	23.8	0.0	0.0	0.0	0.0	
Yellow	3.5	3.5	0.0	0.0	0.0	0.0	
Red	2.1	2.1	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		8.0		8.0
Phase Duration, s		40.6		40.6		29.4		29.4
Change Period, (*Y+R c*), s		5.6		5.6		5.6		5.6
Max Allow Headway (*MAH*), s		1.1		1.1		1.2		1.2
Queue Clearance Time (*g s*), s		26.9		24.3		5.3		10.4
Green Extension Time (*g e*), s		0.1		0.1		0.0		0.0
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.00		0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	587		33	717			120			261	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	746	1887		842	1845			1775			1622	
Queue Service Time (*g s*), s	2.6	15.8		2.0	22.3			0.0			3.6	
Cycle Queue Clearance Time (*g c*), s	24.9	15.8		17.8	22.3			3.3			8.4	
Green Ratio (*g/C*)	0.50	0.50		0.50	0.50			0.34			0.34	
Capacity (*c*), veh/h	238	944		334	922			660			618	
Volume-to-Capacity Ratio (*X*)	0.137	0.622		0.098	0.778			0.181			0.422	
Back of Queue (*Q*), ft/ln (50 th percentile)	11.1	146.9		9.4	218.7			31.3			75.2	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.4	5.9		0.4	8.7			1.3			3.0	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00			0.00			0.00	
Uniform Delay (*d 1*), s/veh	24.5	12.7		19.2	14.3			16.3			17.9	
Incremental Delay (*d 2*), s/veh	0.1	0.9		0.0	3.9			0.0			0.2	
Initial Queue Delay (*d 3*), s/veh	0.0	0.0		0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh	24.6	13.6		19.2	18.2			16.4			18.1	
Level of Service (LOS)	C	B		B	B			B			B	
Approach Delay, s/veh / LOS	14.2	B		18.2	B		16.4	B		18.1	B	
Intersection Delay, s/veh / LOS	16.7						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.66	B	1.66	B	1.91	B	1.91	B
Bicycle LOS Score / LOS	1.51	B	1.73	B	0.68	A	0.92	A

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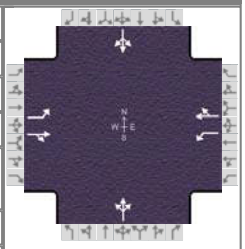
HCS7 Signalized Intersection Results Summary

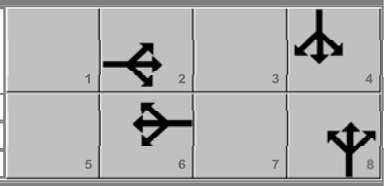
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	AM Peak Hour	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Washi…	File Name	611 and Washington - AM Peak - 2020 B.xus		
Project Description	State Route 611 / Washington Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	370	20	20	330	30	10	60	40	70	70	60

Signal Information			
Cycle, s	70.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	32.4	29.3	0.0	0.0	0.0	0.0	
Yellow	3.3	3.0	0.0	0.0	0.0	0.0	
Red	1.0	1.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		8.0		8.0
Phase Duration, s		36.7		36.7		33.3		33.3
Change Period, (*Y+R c*), s		4.3		4.3		4.0		4.0
Max Allow Headway (*MAH*), s		4.1		4.1		4.2		4.2
Queue Clearance Time (*g s*), s		13.5		14.0		4.9		7.9
Green Extension Time (*g e*), s		3.3		3.2		1.2		1.2
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.03		0.04		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	424		22	391			120			217	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1008	1883		979	1872			1748			1596	
Queue Service Time (*g s*), s	1.6	10.9		1.1	9.9			0.0			2.2	
Cycle Queue Clearance Time (*g c*), s	11.5	10.9		12.0	9.9			2.9			5.9	
Green Ratio (*g/C*)	0.46	0.46		0.46	0.46			0.42			0.42	
Capacity (*c*), veh/h	426	871		403	866			788			737	
Volume-to-Capacity Ratio (*X*)	0.076	0.486		0.054	0.452			0.152			0.295	
Back of Queue (*Q*), ft/ln (50 th percentile)	8.7	103.2		5.9	93.3			26.7			51.7	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.3	4.1		0.2	3.7			1.1			2.1	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00			0.00			0.00	
Uniform Delay (*d 1*), s/veh	16.7	13.0		17.2	12.8			12.7			13.5	
Incremental Delay (*d 2*), s/veh	0.1	0.4		0.1	0.4			0.1			0.2	
Initial Queue Delay (*d 3*), s/veh	0.0	0.0		0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh	16.8	13.5		17.3	13.1			12.8			13.7	
Level of Service (LOS)	B	B		B	B			B			B	
Approach Delay, s/veh / LOS	13.7	B		13.4	B		12.8	B		13.7	B	
Intersection Delay, s/veh / LOS	13.5						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.66	B	1.66	B	1.90	B	1.90	B
Bicycle LOS Score / LOS	1.24	A	1.17	A	0.68	A	0.85	A

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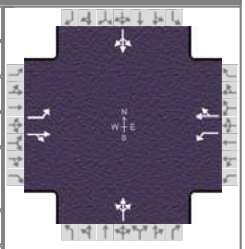
HCS7 Signalized Intersection Results Summary

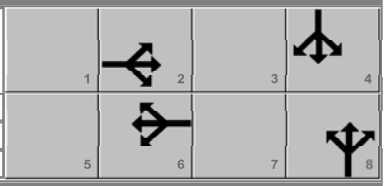
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	AM Peak Hour	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Washi…	File Name	611 and Washington - PM Peak - 2020 B.xus		
Project Description	State Route 611 / Washington Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	30	520	20	30	550	110	10	70	30	70	80	90

Signal Information			
Cycle, s	70.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	36.1	25.6	0.0	0.0	0.0	0.0	
Yellow	3.3	3.0	0.0	0.0	0.0	0.0	
Red	1.0	1.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		8.0		8.0
Phase Duration, s		40.4		40.4		29.6		29.6
Change Period, (*Y+R c*), s		4.3		4.3		4.0		4.0
Max Allow Headway (*MAH*), s		4.1		4.1		4.2		4.2
Queue Clearance Time (*g s*), s		26.1		23.6		5.1		10.0
Green Extension Time (*g e*), s		4.4		5.0		1.4		1.2
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.51		0.38		0.00		0.01

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	33	587		33	717			120			261	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	746	1887		842	1845			1773			1620	
Queue Service Time (*g s*), s	2.5	15.3		2.0	21.6			0.0			3.2	
Cycle Queue Clearance Time (*g c*), s	24.1	15.3		17.3	21.6			3.1			8.0	
Green Ratio (*g/C*)	0.52	0.52		0.52	0.52			0.37			0.37	
Capacity (*c*), veh/h	258	973		353	951			705			659	
Volume-to-Capacity Ratio (*X*)	0.127	0.603		0.092	0.754			0.170			0.396	
Back of Queue (*Q*), ft/ln (50 th percentile)	10.9	141.2		9.2	207.7			30			72.4	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.4	5.6		0.4	8.3			1.2			2.9	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00			0.00			0.00	
Uniform Delay (*d 1*), s/veh	23.0	11.9		18.0	13.4			15.1			16.5	
Incremental Delay (*d 2*), s/veh	0.2	1.1		0.1	3.5			0.1			0.4	
Initial Queue Delay (*d 3*), s/veh	0.0	0.0		0.0	0.0			0.0			0.0	
Control Delay (*d*), s/veh	23.2	13.0		18.1	16.9			15.2			16.9	
Level of Service (LOS)	C	B		B	B			B			B	
Approach Delay, s/veh / LOS	13.5	B		16.9	B		15.2	B		16.9	B	
Intersection Delay, s/veh / LOS	15.6						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.66	B	1.66	B	1.90	B	1.90	B
Bicycle LOS Score / LOS	1.51	B	1.73	B	0.68	A	0.92	A

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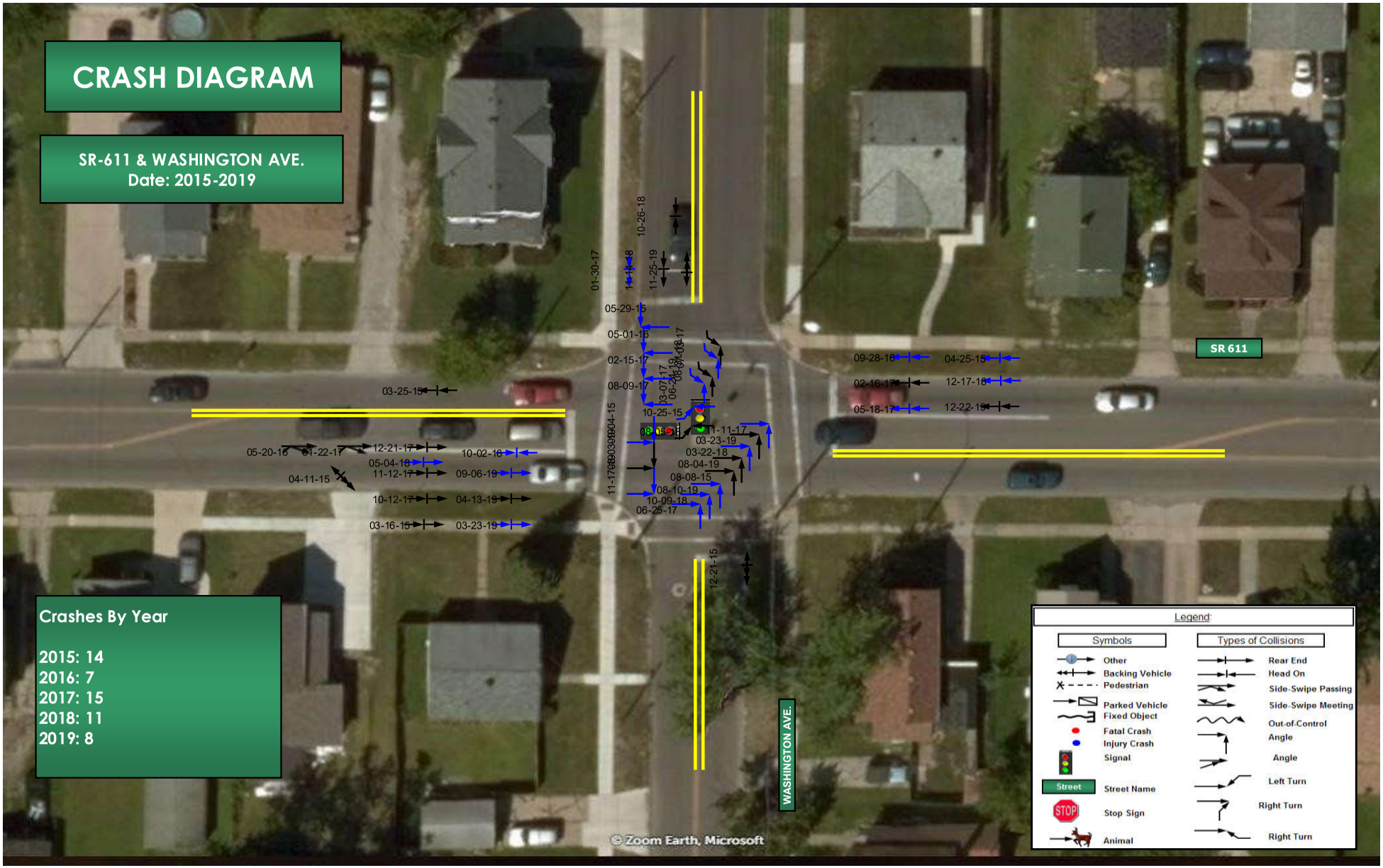
APPENDIX C

Yellow Change and Red Clearance Intervals Calculations

ASSOCIATED PHASE	DIRECTION	MOVEMENT	TRAFFIC SIGNAL														PEDESTRIAN													
			FACTORS *(TEM 403-2)								CALCULATED (TEM 403-2)			FINAL CLEARANCE							OMUTCD 4E.06-12	OMUTCD 4E.06-07		3 fps CHECKS (OMUTCD 4E.06, 01-14)				FINAL PED TIMING	
			POSTED SPEED LIMIT	PERCEPTION/REACTION TIME (1s TYP)	YELLOW CHANGE APPROACH SPEED*	RED APPROACH SPEED*	DECELERATION RATE (10 fps TYP)	WIDTH OF INTERSECTION*	LENGTH OF VEHICLE (20 ft TYP)	APPROACH GRADE	YELLOW	RED	Y + R	YELLOW	RED	Y + R	PED MOVEMENT	ASSOCIATED PHASE	CROSSWALK LENGTH	PUSHBUTTON PROVIDED	DISTANCE TO PUSHBUTTON FROM CURB	WALK INTERVAL (4-7s TYP)	CALCULATED PED CLEARANCE	PED CHANGE INTERVAL (FDW)	(L+P)/(3 fps) (NOTE: P=6 IF NO PUSHBUTTON)	WALK + PED CHANGE INTERVALS	IS Y>=X?	ADDITIONAL WALK INTERVAL REQUIRED	FINAL WALK INTERVAL	FINAL PED CHANGE INTERVAL (FDW)
				t	V_Y	V_R	a	W	L	g	Y	R	TOTAL	Y (3-6s TYP)	R (1-6s TYP)	TOTAL			L		P		= 3.5 fps WALK TIME	= 3.5 fps WALK TIME - 3 sec BUFFER	X	Y				
			MPH	SEC	MPH	MPH	FPS	FT	FT	%	SEC	SEC	SEC	SEC	SEC	SEC			FT		FT	SEC	SEC	SEC	SEC	SEC		SEC	SEC	SEC
1	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EB	THROUGH/RT	35	1	42	42	10	51	20	0.5	4.0	0.1	4.1	3.3	1	4.3	EB	2	32	NO	-	7	9.1	6.1	12.7	13.1	YES	N/A	7	7
3	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	SB	THROUGH/RT	25	1	32	32	10	59	20	0.75	3.3	0.7	4.0	3	1	4.0	SB	4	48	NO	-	7	13.7	10.7	18.0	17.7	NO	0.3	8	11
5	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	WB	THROUGH/RT	35	1	42	42	10	53	20	-0.25	4.1	0.2	4.3	3.3	1	4.3	WB	6	48	NO	-	7	13.7	10.7	18.0	17.7	NO	0.3	8	11
7	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	NB	THROUGH/RT	25	1	32	32	10	57	20	0	3.4	0.6	4.0	3	1	4.0	NB	8	47	NO	-	7	13.4	10.4	17.7	17.4	NO	0.2	8	11

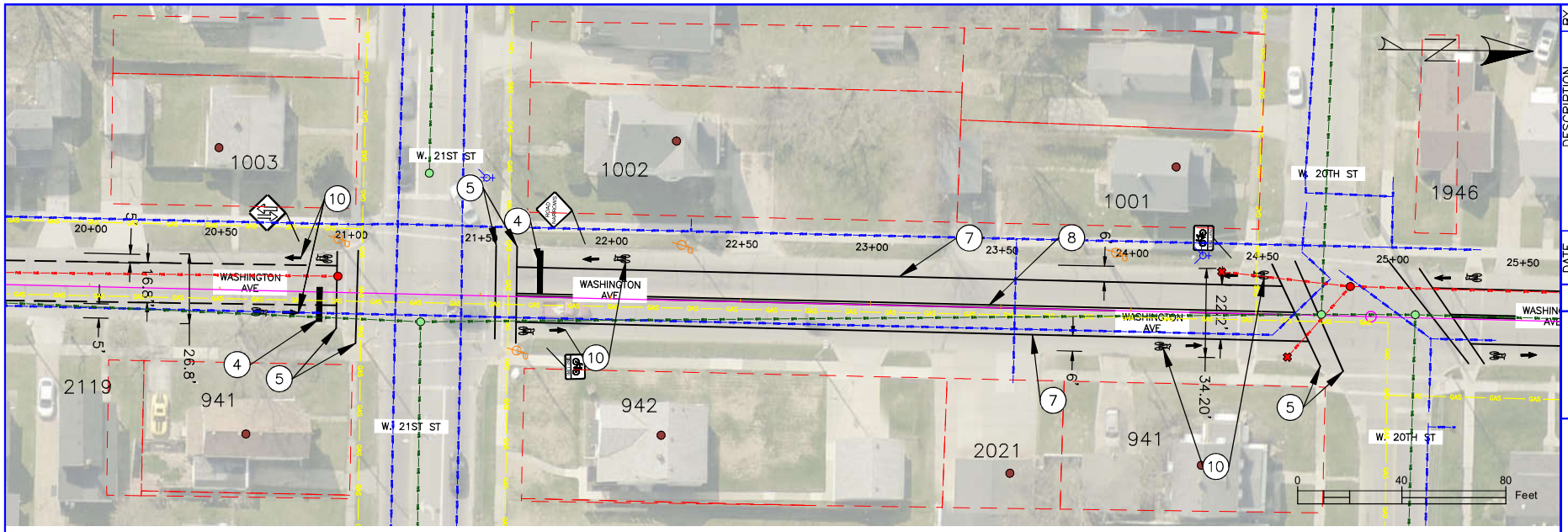
APPENDIX D

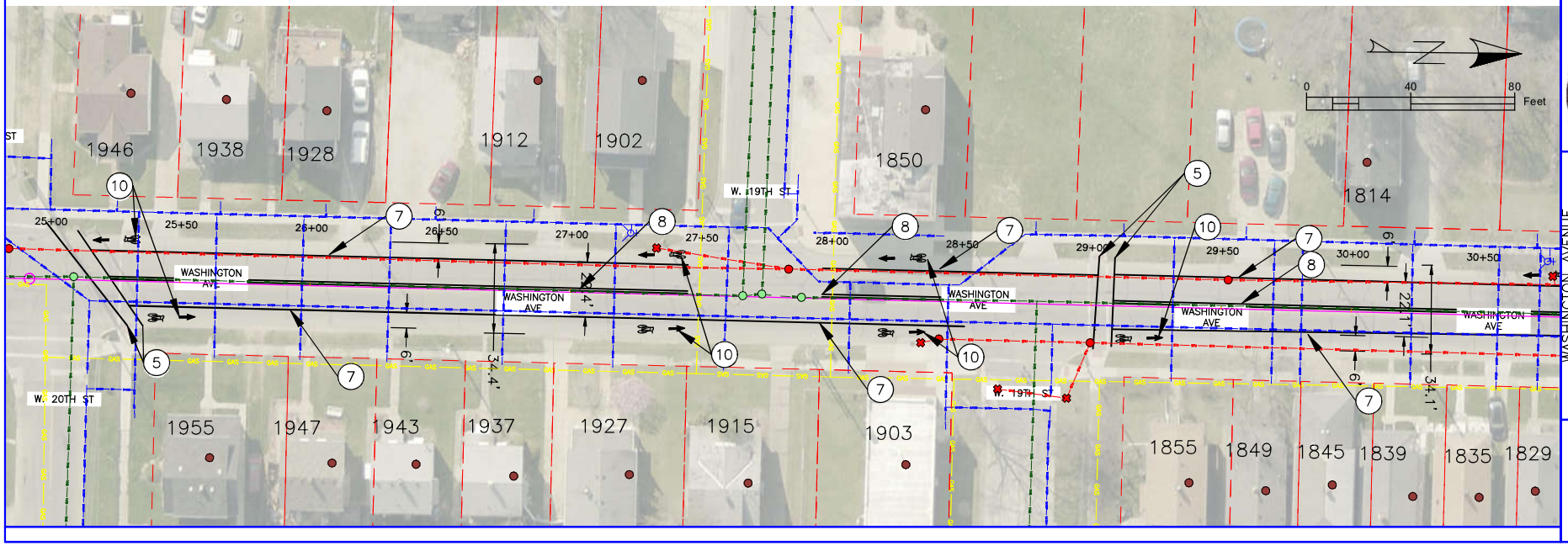
Crash Diagram


CRASH DIAGRAM
SR-611 & WASHINGTON AVE.
Date: 2015-2019
Crashes By Year
2015: 14
2016: 7
2017: 15
2018: 11
2019: 8
SR 611
WASHINGTON AVE.
01-30-17
10-26-18
11-25-19
05-29-15
05-01-16
02-15-17
08-09-17
10-25-15
03-25-15
05-20-16
01-22-17
12-21-17
10-02-16
05-04-18
04-11-15
11-12-17
09-06-19
10-12-17
04-13-19
03-16-15
03-23-19
03-22-18
08-04-19
08-08-15
08-10-19
10-09-18
06-25-17
12-21-15
09-28-16
04-25-15
02-16-17
12-17-18
05-18-17
12-22-19
Legend:
Symbols
Other
Backing Vehicle
Pedestrian
Parked Vehicle
Fixed Object
Fatal Crash
Injury Crash
Signal
Street
Street Name
STOP
Stop Sign
Animal
Types of Collisions
Rear End
Head On
Side-Swipe Passing
Side-Swipe Meeting
Out-of-Control
Angle
Angle
Left Turn
Right Turn
Right Turn
© Zoom Earth, Microsoft

APPENDIX E

CMAQ PID 108526 Washington Ave. Bikeway





DESCRIPTION	DATE	BY
ISSUED DRAWINGS	04/26/17	VAN
REVISION #1	08/15/18	VAN
REVISION #2	12/01/18	VAN
REVISION #3	03/01/19	VAN
REVISION #4	06/01/19	VAN

REVISIONS

DATE: APR 26, 2017
DRAWN BY: VAN
CH'D BY: KTM & GS

CITY OF LORAIN
ENGINEERING DEPARTMENT
200 WEST ERIE AVENUE
4TH FLOOR
LORAIN, OH 44052
PHONE: (440) 204-2003
FAX: (440) 204-2522

WASHINGTON AVENUE
20+00–30+00

BICYCLE IMPROVEMENTS

WASHINGTON AVENUE BIKEWAY
CITY OF LORAIN
COUNTY OF LORAIN, STATE OF OHIO

12
19

APPENDIX F

Cost Estimate

Preliminary Opinion of Probable Cost

ITEM	DESCRIPTION	TOTAL QUANTITY	UNIT	ESTIMATED PRICE	TOTAL COST
	TRAFFIC CONTROL				
	SIGNING	1	LS	$5,000	$5,000
	TRAFFIC CONTROL SUBTOTAL:				**$5,000**
	SIGNALIZATION				
632	TRAFFIC SIGNAL	1	EACH	$167,500	$160,000
	SIGNALIZATION SUBTOTAL:				**$160,000**
	MISCELLANEOUS				
623	CONSTRUCTION LAYOUT STAKES	1	LS	$2,000	$2,000
624	MOBILIZATION	1	LS	$10,000	$10,000
SPECIAL	PERFORMANCE BOND	1	LS	$2,000	$2,000
	MISCELLANEOUS SUBTOTAL:				**$14,000**
	RIGHT OF WAY				
	PERMANENT R/W TAKE - MINOR - COMMERCIAL	3	EACH	$10,000	$30,000
	PERMANENT R/W TAKE - MINOR - RESIDENTIAL	1	EACH	$5,000	$5,000
	ACQUISITION SERVICES	4	EACH	$5,000	$20,000
	APPRAISAL REVIEW SERVICES	4	EACH	$500	$2,000
	RIGHT OF WAY SUBTOTAL:				**$57,000**
	TOTAL CONSTRUCTION AND RIGHT OF WAY COST:				**$236,000**
	DESIGN ENGINEERING COST:	(20% OF CONSTR. & R/W COST)			**$49,000**
	DESIGN CONTINGENCY COSTS	(20% OF CONSTR. & R/W COST)			**$49,000**
	PROJECT SUBTOTAL:				**$334,000**
	3% INFLATION CONTINGENCY OVER 2 YEARS (6%):				**$21,000**
	PROJECT TOTAL WITHOUT CONSTRUCTION INSPECTION				**$355,000**
	CONSTRUCTION INSPECTION COST:	(10% OF PROJECT TOTAL)			**$36,000**
				TOTAL:	**$391,000**

APPENDIX G

Benefit to Cost Analysis

Safety Benefit - Cost Analysis

General Information

Project Name	State Route 611 / Washington Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00		
		$0.00			$0.00	$0.00		
		$0.00			$0.00	$0.00		
CMF 1 - Improve Signal Visibility	20	$7,076.27			$7,076.27	$7,076.27	-1.585	$871,299
CMF 2 - Install Pedestrian Countdown Timer	20	$326,923.73			$326,923.73	$326,923.73	-0.446	$201,682
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
		$0.00			$0.00	$0.00	0.000	$0
Totals		**$334,000.00**	**$0.00**	**$0.00**	**$334,000.00**	**$334,000.00**	**-2.032**	**$1,072,982**

Safety Benefit - Cost Analysis

General Information

Project Name	State Route 611 / Washington Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

Benefit - Cost Calculator

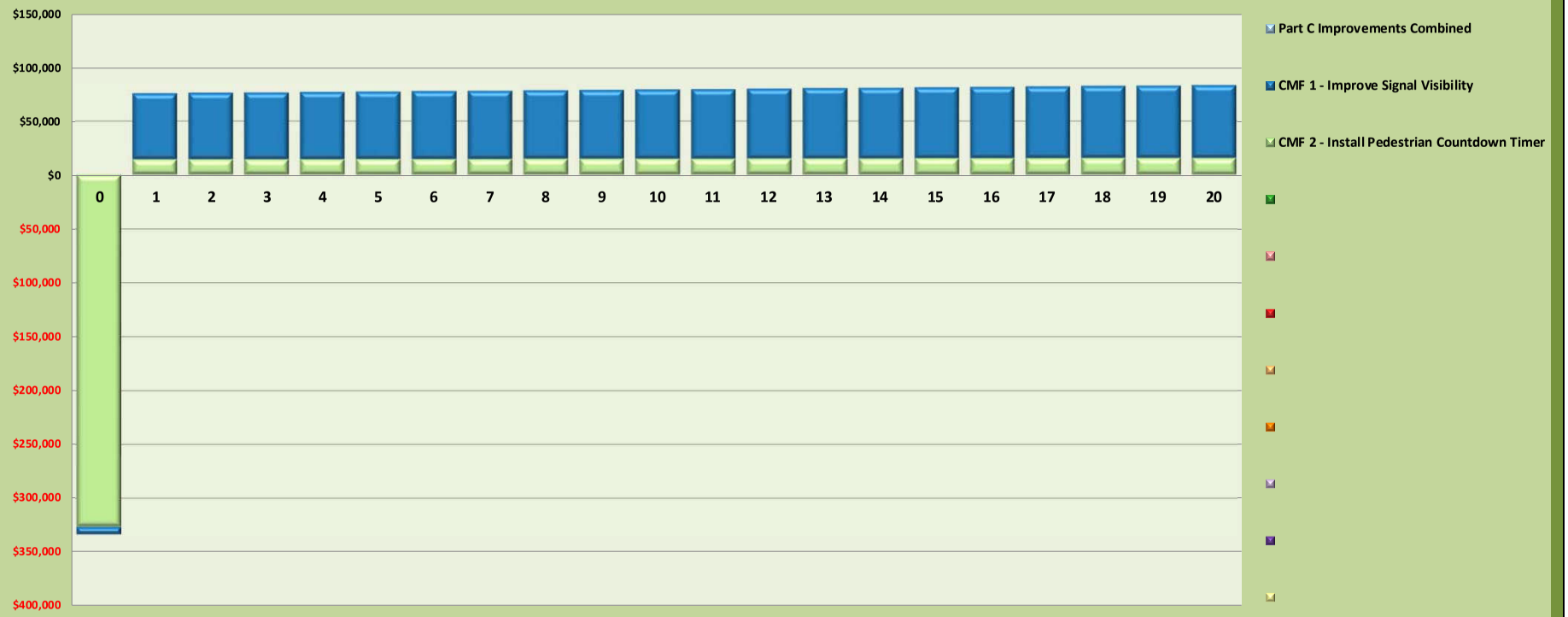
Net Present Value of Project	$334,000.00
Net Present Value of Safety Benefits	$1,072,981.64
Net Benefit	$738,981.64
Benefit / Cost Ratio	3.21

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.065
Number of Injury Crashes	-0.828
Number of Total Crashes	-2.032

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year

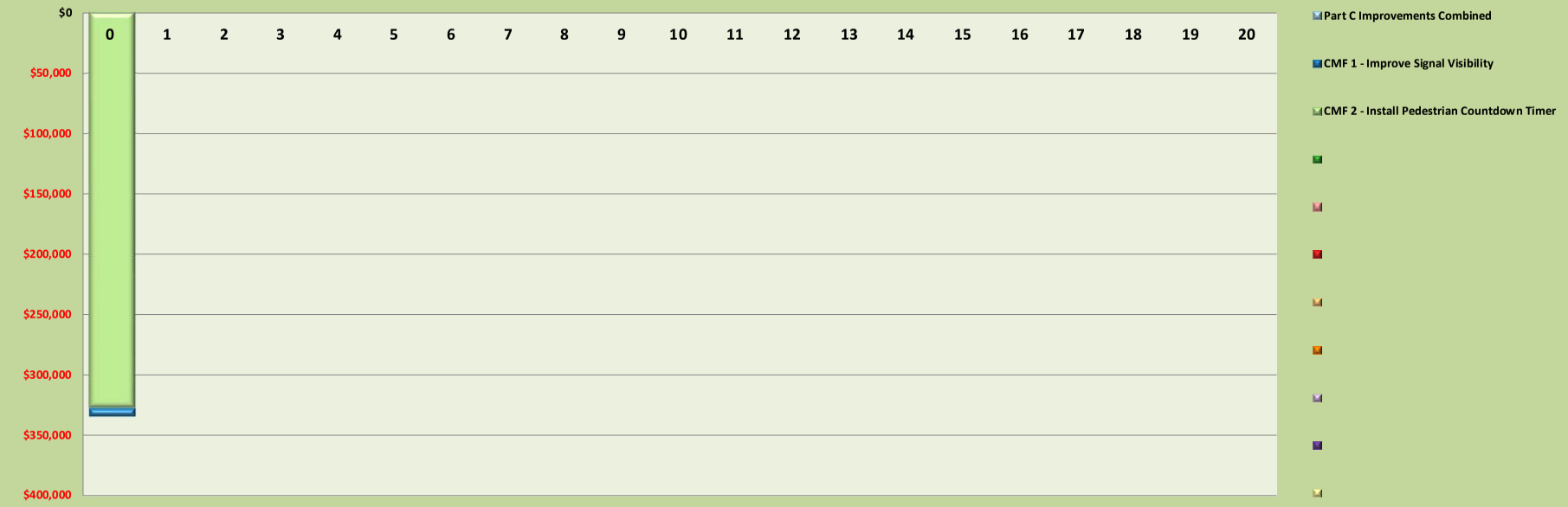


Safety Benefit - Cost Analysis

General Information

Project Name	State Route 611 / Washington Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)

First year to observe a positive return on investiment: 2025 (5 years)

Percentage of Service Life to observe a continuous Positive Return on Investment: 80.00%

APPENDIX H

Formal Safety Application

OHIO DEPARTMENT OF TRANSPORTATION

Safety Funding Application

General Project Information	
Project Sponsoring Agency	City of Lorain
Project Name	State Route 611 / Washington Avenue Intersection Safety Improvement
PID	Not Assigned
Project Manager	Veronica A. Newsome. P.E.
Contact Phone	(440) 204-2003
Contact Email	veronica_newsome@cityoflorain.org

Location Information			
ODOT District	3	**County**	LOR
Route Number	SR-611R	**Road Name**	West 21st Street
Begin Logpoint	2.340	**End Logpoint**	2.340
Begin Latitude	41.451	**Begin Longitude**	-82.179
End Latitude	41.451	**End Longitude**	-82.179

Project Description

Summary of Crash Patterns

Looking at the existing conditions at the intersection, it was noted that the current traffic signal installation is an older, span wire installation that lacks traffic signal backplates which affects the visibility of the existing traffic signal, contributing to the rear-end and angle crashes that were found to occur.

The existing traffic signal timings and clearance intervals could be leading to the presence of both rear-end and angle crashes. The existing signal timings have not been revised for numerous years, including the clearance intervals. If the clearance intervals are too short for motorists to clear the intersection during the phase change, angle crashes could be occurring as traffic isn't clearing the intersection before the phase changes.

The two contributing factors mentioned above that cause rear-end and angle crashes to occur have contributed to the fact that 71% of the crashes found at the intersection are rear-end and angle related. Additionally, due the number of angle crashes, over 50% of the crashes were injury crashes. Therefore, the identified improvements should focus on the reduction of rear-end and angle crashes and the injuries associated with those crash types.

Rear-end crashes were predominantly found to occur on the eastbound and westbound approaches to the intersection. The capacity analysis results does not show excessive delay at the intersection and from a geometric standpoint, there is not a significant difference between the eastbound and westbound approaches compared to the northbound and southbound approaches. The largest difference (and what appears to be contributing to more crashes on the eastbound and westbound approaches) are the traffic volumes. The eastbound and westbound approaches account for approximately 81% of the traffic entering the intersection in the AM peak hour and 78% in the PM peak hour. This volume disparity appears to be the reason that more rear-end crashes are occurring on those two approaches, which can be attributed to the poor signal visibility, 8" incandescent signal heads, and lack of signal backplates.

Summary of Recommended Countermeasures

1.Implement updated signal timings and clearance intervals
2.Reconstruct the traffic signal at the intersection and include backplates on the traffic signal heads. Upgrade the pedestrian accommodations at the intersection to include a pedestrian countdown timer.
3.Investigate signal coordination on SR 611
4.Community and school promotion of driver safety to students and parents

Project Priority Information

The State Route 611 / Washington Avenue intersection is the #233 ranked urban intersection on a statewide basis and the 7th highest ranked intersection within the City of Lorain. These rankings are provided from the 2018 ODOT HSIP safety priority list.

Safety Funding Application

Crash Data

Crash Totals

	Fatal & Serious Injury (KA)	Visible Injury (B)	Non-Visible (C)	Property Damage Only (O)	Total
Existing Conditions: Predicted Crash Frequency	0.1197	0.5436	0.7569	3.8810	5.30
Existing Conditions: Expected Crash Frequency	0.1837	0.8727	1.2920	4.3064	6.65
Potential for Safety Improvement	0.0640	0.3291	0.5351	0.4254	1.35
Proposed Conditions: Expected Crash Frequency	0.1189	0.5651	0.8366	3.1027	4.62
Observed Crashes	0.0000	2.6000	2.0000	4.4000	9.00

Observed People Injury Totals

	Fatal Injury (K)	Serious Injury (A)	Visible Injury (B)	Non-Visible (C)	Total
Observed People Injury Totals	0.0000	0.0000	4.4000	4.6000	9.00

Application Scoring

Category	Scoring Value	Points Awarded	Points Possible
Expected Crash Frequency	6.65	4	10
Ratio of Observed Fatal and Serious Injuries to Observed Total Crashes	0.00	0	5
% of the Potential for Safety Improvement to Total Expected Crashes	20.30%	20	20
Relative Severity Index	$25,609	4	10
Equivalent Property Damage Only Index	3.45	3	5
Volume to Capacity Ratio	0.78	6	10
Benefit Cost Ratio	3.21	30	30
Safety Funding Request Percentage	100.00%	10	10
Total		77	100

Strategic Highway Safety Plan

Functional Class	Other Principal Arterial Roadway
Major Route AADT	12,050
Ohio Emphasis Area	Serious Crash Types
Ohio Emphasis Area Subcategory	Intersection
FHWA Emphasis Area	Improving the design and operation of highway intersections
FHWA Improvement Category	Intersection traffic control
FHWA Improvement Subcategory	Modify traffic signal - add additional signal heads

Work Locations

NLFID	Begin Logpoint	End Logpoint	Begin Latitude	Begin Longitude	Location Termini (i.e. from Street 1 to Street 2)
SLORSR00611**C	2.340	2.340	41.451	-82.1791	State Route 611 / Washington Avenue Intersection

OHIO DEPARTMENT OF TRANSPORTATION

Safety Funding Application

Project Funding

Project Phase	Safety Study	Interchange Mod. Study	PE - Environmental	PE - Detailed Design	Right of Way /Utilities	Construction	Total
Fiscal Year	2021		2021	2021	2022	2023	
Project Phase Completed	☑	☐	☐	☐	☐	N/A	
Previous Safety	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
New Safety	$0.00	$0.00	$33,000.00	$16,000.00	$57,000.00	$285,000.00	$391,000.00
Sponsor Funding	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00	$0.00	$33,000.00	$16,000.00	$57,000.00	$285,000.00	$391,000.00

Additional Funding Detail

The City of Lorain is requesting 100% funding for this project with an anticipated construction in ODOT State Fiscal Year 2023, which will begin on July 1st, 2022. This will give the City of Lorain two years to design and acquire any necessary R/W for this project to move forward.

At this time, the R/W funding is being requested as it is assumed that corner roundings will be necessary on all 4 corners of the intersection.

Project Development

Project Phase	Completed by	Completion Date
Safety Study	City of Lorain	Jul-20

Applicant Information

Name	Title	Phone Number
Dale Vandersommen, P.E.	City Engineer	(440) 204-2003
Signature		**Date**

Version: 20150917

The following information should be included in submission of the safety project application:

1. An electronic copy of the Safety Engineering Study
2. All Excel Analysis Files
   May include Crash Analysis Module (CAM) Tool, Economic Crash Analysis Tool (ECAT), HSIP Application and Scoring Tool.
3. Benefit-Cost Results (Economic Analysis)
4. DSRT approval signatures

APPENDIX I

Signal Warrants

Study Name: Washington and W 21
Study Date : 6/22/2020

Signal Warrants - Summary

Major Street Approaches

Eastbound: West 21st Street
Number of Lanes : 1

Total Approach Volume: 4,567

Westbound: West 21st Street
Number of Lanes :1

Total Approach Volume: 4,936

Minor Street Approaches

Northbound: Washington Avenue
Number of Lanes :1

Total Approach Volume: 827

Southbound: Washington Avenue
Number of Lanes :1

Total Approach Volume: 1,963

Warrant Summary (Urban Values Apply)

Warrant 1 - Eight Hour Vehicular Volumes ..... **Satisfied**

Warrant 1A - Minimum Vehicular Volume ..... **Satisfied**
Required volumes reached for 8 hours, 8 are needed

Warrant 1B - Interruption of Continuous Traffic ..... **Not Satisfied**
Required volumes reached for 7 hours, 8 are needed

Warrant 1C - Combination of Warrants ..... **Satisfied**
Required 1A volumes reached for 11 hours, 8 are needed
Required 1B volumes reached for 10 hours, 8 are needed

Warrant 2 - Four Hour Volumes ..... **Satisfied**
Number of hours (7) volumes exceed minimum >= minimum required (4).

Warrant 3 - Peak Hour ..... **Satisfied**

Warrant 3A - Peak Hour Delay ..... **Not Satisfied**
Total approach volumes and delays on minor street do not exceed minimums for any one hour period.

Warrant 3B - Peak Hour Volumes ..... **Satisfied**
Volumes exceed minimums for at least one hour period.

Warrant 4 - Pedestrian Volumes ..... **Not Evaluated**

Warrant 5 - School Crossing ..... **Not Evaluated**

Warrant 6 - Coordinated Signal System ..... **Not Evaluated**

Warrant 7 - Crash Experience ..... **Not Evaluated**

Warrant 8 - Roadway Network ..... **Not Evaluated**

Warrant 9 - Intersection Near a Grade Crossing ..... **Not Evaluated**

Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 1A - Minimum Volumes

Description

Intended for sites where the volume of intersecting traffic is the principal reason for consideration of a signal installation.

Summary

8 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **False**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Veh/Hr Major = **500**

Veh/Hr Minor = **150**

	Major Road West 21st Street					Minor Road Washington Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
15:30 - 16:30	510	+	612	=	1122	99	214	Yes
16:30 - 17:30	482	+	559	=	1041	80	200	Yes
13:30 - 14:30	415	+	496	=	911	70	179	Yes
17:30 - 18:30	424	+	465	=	889	80	185	Yes
14:30 - 15:30	409	+	431	=	840	99	204	Yes
12:30 - 13:30	359	+	402	=	761	51	155	Yes
07:15 - 08:15	395	+	344	=	739	74	150	Yes
08:15 - 09:15	320	+	324	=	644	93	177	Yes
12:15 - 13:15	367	+	405	=	772	57	146	No
12:00 - 13:00	390	+	380	=	770	55	140	No
11:45 - 12:45	366	+	390	=	756	52	134	No
11:30 - 12:30	338	+	378	=	716	50	132	No
07:00 - 08:00	366	+	326	=	692	53	138	No
11:15 - 12:15	323	+	355	=	678	50	141	No
10:30 - 11:30	320	+	343	=	663	54	114	No
10:45 - 11:45	310	+	337	=	647	50	112	No
11:00 - 12:00	304	+	343	=	647	55	125	No
10:15 - 11:15	298	+	283	=	581	46	108	No
09:15 - 10:15	283	+	279	=	562	33	117	No
10:00 - 11:00	278	+	274	=	552	42	118	No
09:45 - 10:45	278	+	253	=	531	40	122	No
06:45 - 07:45	260	+	235	=	495	26	90	No
09:30 - 10:30	254	+	237	=	491	33	118	No
18:30 - 19:30	189	+	209	=	398	29	78	No
06:30 - 07:30	159		155		314	17	54	No

Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 1B - Interruption of Continuous Traffic

Description

Intended for sites where the volume of the major street is so heavy that traffic on the minor street suffers excessive delay or hazard.

Summary

Only 7 one hour periods meet minimums.
Warrant is NOT met.

Site Data Required

Rural Settings Apply = **False**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Veh/Hr Major = **750**

Veh/Hr Minor = **75**

	Major Road West 21st Street					Minor Road Washington Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
15:45 - 16:45	491	+	584	=	1075	78	231	Yes
16:45 - 17:45	464	+	569	=	1033	86	194	Yes
14:45 - 15:45	473	+	521	=	994	100	187	Yes
13:45 - 14:45	399	+	470	=	869	88	215	Yes
17:45 - 18:45	404	+	404	=	808	72	162	Yes
12:45 - 13:45	363	+	404	=	767	58	151	Yes
11:45 - 12:45	366	+	390	=	756	52	134	Yes
07:15 - 08:15	395	+	344	=	739	74	150	No
07:30 - 08:30	395	+	334	=	729	78	154	No
11:30 - 12:30	338	+	378	=	716	50	132	No
07:45 - 08:45	372	+	337	=	709	97	178	No
07:00 - 08:00	366	+	326	=	692	53	138	No
08:00 - 09:00	348	+	340	=	688	107	182	No
11:15 - 12:15	323	+	355	=	678	50	141	No
10:30 - 11:30	320	+	343	=	663	54	114	No
10:45 - 11:45	310	+	337	=	647	50	112	No
11:00 - 12:00	304	+	343	=	647	55	125	No
08:15 - 09:15	320	+	324	=	644	93	177	No
08:30 - 09:30	313	+	315	=	628	87	176	No
08:45 - 09:45	292	+	309	=	601	65	145	No
10:15 - 11:15	298	+	283	=	581	46	108	No
09:00 - 10:00	288	+	287	=	575	37	119	No
09:15 - 10:15	283	+	279	=	562	33	117	No
10:00 - 11:00	278	+	274	=	552	42	118	No
09:45 - 10:45	278		253		531	40	122	No

Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 1C Combination of Warrants

Description

Intended for sites where the traffic volumes don't meet individual warrants but where Warrants 1A and 1B are both met to 80% of their stated values.

Summary

11 hours meet 1A minimums.
10 hours meet 1B minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply =	**False**
Number of Major Lanes =	**1**
Number of Minor Lanes =	**1**

Volume Requirements

Warrant	1A	1B
Veh/Hr Major =	**400**	**600**
Veh/Hr Minor =	**120**	**60**

Major Road: West 21st Street

Minor Road: Washington Avenue

Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1A?
15:00 - 16:00	503	+	558	=	1061	100	189	Yes
16:00 - 17:00	470	+	572	=	1042	69	236	Yes
17:00 - 18:00	459	+	554	=	1013	90	185	Yes
14:00 - 15:00	405	+	465	=	870	100	212	Yes
13:00 - 14:00	365	+	435	=	800	53	154	Yes
18:00 - 19:00	391	+	402	=	793	66	165	Yes
12:00 - 13:00	390	+	380	=	770	55	140	Yes
07:00 - 08:00	366	+	326	=	692	53	138	Yes
08:00 - 09:00	348	+	340	=	688	107	182	Yes
11:00 - 12:00	304	+	343	=	647	55	125	Yes
09:45 - 10:45	278	+	253	=	531	40	122	Yes
10:45 - 11:45	310		337		647	50	112	No

Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1B?
15:30 - 16:30	510	+	612	=	1122	99	214	Yes
16:30 - 17:30	482	+	559	=	1041	80	200	Yes
13:30 - 14:30	415	+	496	=	911	70	179	Yes
17:30 - 18:30	424	+	465	=	889	80	185	Yes
14:30 - 15:30	409	+	431	=	840	99	204	Yes
12:30 - 13:30	359	+	402	=	761	51	155	Yes
11:30 - 12:30	338	+	378	=	716	50	132	Yes
07:00 - 08:00	366	+	326	=	692	53	138	Yes
08:00 - 09:00	348	+	340	=	688	107	182	Yes
10:30 - 11:30	320	+	343	=	663	54	114	Yes
10:15 - 11:15	298	+	283	=	581	46	108	No
09:00 - 10:00	288		287		575	37	119	No

Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 2 - Four Hour Volumes

Description

Intended for sites where the volume of intersecting traffic during any four hours of the day is the principal reason for consideration of a signal installation.

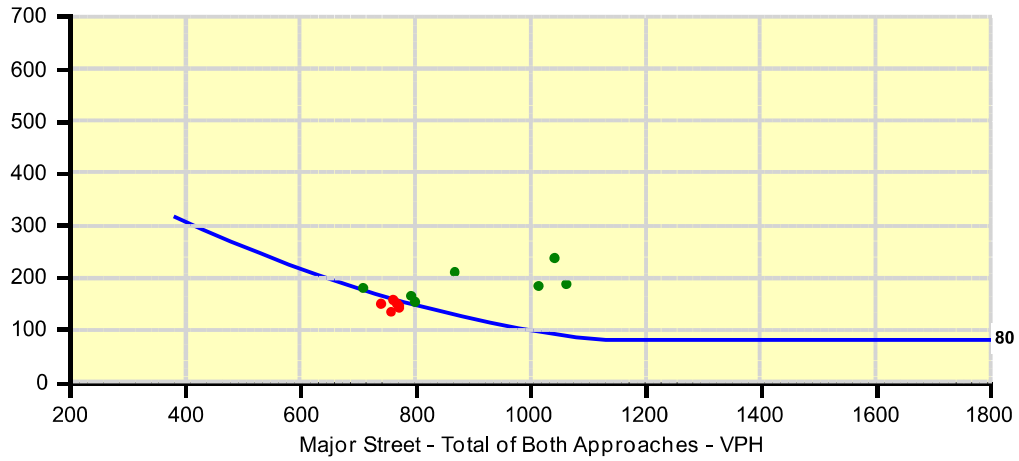
Summary

7 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply =	**False**
Number of Major Lanes =	**1**
Number of Minor Lanes =	**1**

	Major Road West 21st Street					Minor Road Washington Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
15:00 - 16:00	503	+	558	=	1061	100	189	Yes
16:00 - 17:00	470	+	572	=	1042	69	236	Yes
17:00 - 18:00	459	+	554	=	1013	90	185	Yes
14:00 - 15:00	405	+	465	=	870	100	212	Yes
13:00 - 14:00	365	+	435	=	800	53	154	Yes
18:00 - 19:00	391	+	402	=	793	66	165	Yes
07:45 - 08:45	372	+	337	=	709	97	178	Yes
12:15 - 13:15	367	+	405	=	772	57	146	No
12:00 - 13:00	390	+	380	=	770	55	140	No
12:45 - 13:45	363	+	404	=	767	58	151	No
12:30 - 13:30	359	+	402	=	761	51	155	No
							134	No



Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 3A - Peak Hour Delay

Description

Intended for sites where for one hour of the day minor street traffic suffers undue traffic delay entering or crossing the major street.

Summary

39 one hour periods meet minimums.
Warrant is NOT met.

Site Data Required

Number of Minor Lanes = **1**

Volume and Delay Requirements

Veh/Hr All Approaches = **800**
Veh/Hr Minor = **100**
Total Delay (Veh-Hrs) = **4**

	Major Road					Minor Road			
	West 21st Street					Washington Avenue			
Time	Total of All Approaches	Met?	Minor NB	Delay NB	Met?	Minor SB	Delay SB	Met?	Warrant Met?
15:30 - 16:30	1435	Yes	99	0.0	---	214	0.0	---	No
15:15 - 16:15	1393	Yes	107	0.0	---	202	0.0	---	No
15:45 - 16:45	1384	Yes	78	0.0	---	231	0.0	---	No
15:00 - 16:00	1350	Yes	100	0.0	---	189	0.0	---	No
16:15 - 17:15	1348	Yes	67	0.0	---	222	0.0	---	No
16:00 - 17:00	1347	Yes	69	0.0	---	236	0.0	---	No
16:30 - 17:30	1321	Yes	80	0.0	---	200	0.0	---	No
16:45 - 17:45	1313	Yes	86	0.0	---	194	0.0	---	No
17:00 - 18:00	1288	Yes	90	0.0	---	185	0.0	---	No
14:45 - 15:45	1281	Yes	100	0.0	---	187	0.0	---	No
17:15 - 18:15	1229	Yes	93	0.0	---	182	0.0	---	No
14:00 - 15:00	1182	Yes	100	0.0	---	212	0.0	---	No
14:15 - 15:15	1176	Yes	103	0.0	---	199	0.0	---	No
13:45 - 14:45	1172	Yes	88	0.0	---	215	0.0	---	No
13:30 - 14:30	1160	Yes	70	0.0	---	179	0.0	---	No
17:30 - 18:30	1154	Yes	80	0.0	---	185	0.0	---	No
14:30 - 15:30	1143	Yes	99	0.0	---	204	0.0	---	No
17:45 - 18:45	1042	Yes	72	0.0	---	162	0.0	---	No
13:15 - 14:15	1038	Yes	52	0.0	---	165	0.0	---	No
18:00 - 19:00	1024	Yes	66	0.0	---	165	0.0	---	No
13:00 - 14:00	1007	Yes	53	0.0	---	154	0.0	---	No
07:45 - 08:45	984	Yes	97	0.0	---	178	0.0	---	No
08:00 - 09:00	977	Yes	107	0.0	---	182	0.0	---	No
12:45 - 13:45	976	Yes	58	0.0	---	151	0.0	---	No
12:15 - 13:15	975	Yes	57	0.0	---	146	0.0	---	No

Study Name: Washington and W 21

Study Date : 6/22/2020

Warrant 3B - Peak Hour Volumes

Description

Intended for sites where the volume of intersecting traffic during one hour of the day is the principal reason for consideration of a signal installation.

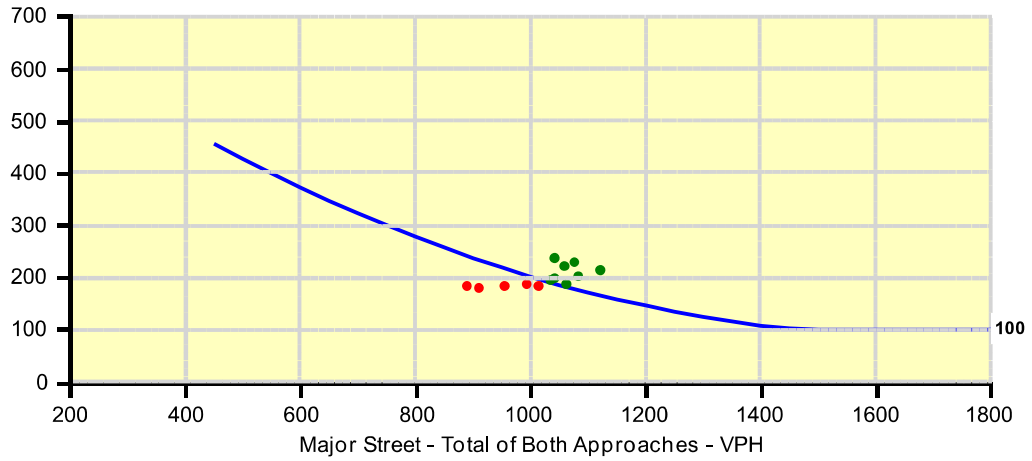
Summary

8 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply =	**False**
Number of Major Lanes =	**1**
Number of Minor Lanes =	**1**

	Major Road West 21st Street					Minor Road Washington Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
15:30 - 16:30	510	+	612	=	1122	99	214	Yes
15:15 - 16:15	504	+	580	=	1084	107	202	Yes
15:45 - 16:45	491	+	584	=	1075	78	231	Yes
15:00 - 16:00	503	+	558	=	1061	100	189	Yes
16:15 - 17:15	490	+	569	=	1059	67	222	Yes
16:00 - 17:00	470	+	572	=	1042	69	236	Yes
16:30 - 17:30	482	+	559	=	1041	80	200	Yes
16:45 - 17:45	464	+	569	=	1033	86	194	Yes
17:00 - 18:00	459	+	554	=	1013	90	185	No
14:45 - 15:45	473	+	521	=	994	100	187	No
17:15 - 18:15	438	+	516	=	954	93	182	No
							179	No



APPENDIX J

City of Lorain Priority List

City Priority	Roadway1	Roadway2	Total Crashes (2014-2018)	FSI Crashes
1	SR611 (W. 21st St)	Kansas Ave	71	2
2	SR58 (Leavitt Rd)	Tower Blvd	64	5
3	SR611 (W. 21st St)	Broadway Ave	60	2
4	SR58 (Leavitt Rd)	SR611 (W. 21st St)	57	1
5	SR611 (W. 21st St)	Oberlin Ave	56	0
6	SR57 (Grove Ave)	Fairless Dr	53	3
7	SR611 (W. 21st St)	Washington Ave	46	0
8	SR57 (Grove Ave)	East 31st St	42	3
9	Oberlin Ave	Meister Rd	42	1
10	SR57 (Grove Ave)	Broadway Ave	40	1
11	SR58 (Leavitt Rd)	Jaeger Rd	40	0
12	SR611 (W. 21st St)	Reid Ave	39	1
13	SR58 (Leavitt Rd)	Meister Rd	38	1
14	SR611 (W. 21st St)	Root Rd	38	1
15	SR611 (W. 21st St)	Oakdale Ave	36	4
16	Tower Blvd	Oberlin Ave	36	0
17	SR611 (W. 21st St)	Elyria Ave	35	3
18	SR57 (Grove Ave)	Elyria Ave	35	2
19	Broadway Ave	W. 33rd St	34	0
20	US6 (W. Erie Ave)	Oberlin Ave	33	0
21	SR58 (Leavitt Rd)	W. 40th St	31	1
22	Broadway Ave	E. 30th St	31	0
23	US6 (W. Erie Ave)	Broadway Ave	31	0
24	Missouri Ave	SR611 (W. 21st St)	30	0
25	SR254 (Cooper Foster Park Rd.)	Broadway Ave	30	0
26	SR57 (Grove Ave)	E. 28th St	29	0
27	Broadway Ave	W. 39th St	28	0
28	SR57 (Grove Ave)	Pearl Ave	27	1
29	US6 (W. Erie Ave)	Leavitt Rd	27	0
30	SR254 (Cooper Foster Park Rd.)	Pearl Ave	27	0
31	W. 37th St	Oberlin Ave	26	1
32	US6 (W. Erie Ave)	Oakpoint Rd.	26	1
33	Reeves Ave	SR611 (W. 21st St)	26	0
34	Tower Blvd	Ashland Ave	24	1
35	SR254 (Cooper Foster Park Rd.)	Oberlin Ave	24	0
36	Fulton Rd	E. 28th St	23	0
37	W. 33rd St	Falbo Ave	22	0
38	SR2	Broadway Ave	22	0
39	SR57 (Grove Ave)	E. 42nd St	21	0
40	W. 28th St	Reid Ave	20	0
41	Pearl Ave	E. 36th St	19	1
42	North Ridge Rd	Cooper Foster Parkway	19	0
43	SR611 (W. 21st St)	Access Dr	18	2
44	US6 (E. Erie Ave)	Colorado Ave	18	0
45	Beech Ave	W. 22nd St	16	1
46	Cooper Foster Park	Oakpoint Rd.	16	0
47	Elyria Ave	E. 36th St	16	0
48	US6	Frankie Dr	15	1

APPENDIX J

Intersection Concept Plan

Placeholder for diagram showing signal replacement plans and proposed/exisiting striping

July 31, 2020