



FY 2018

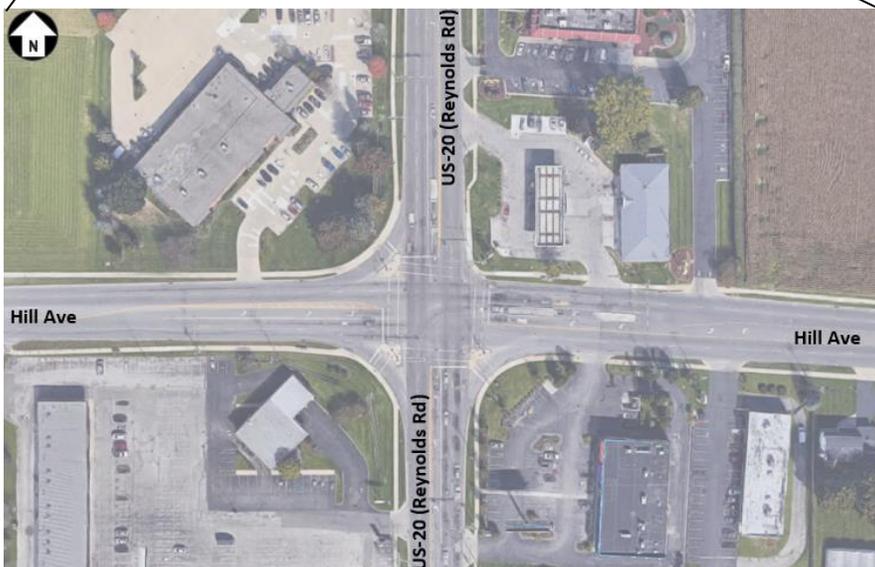
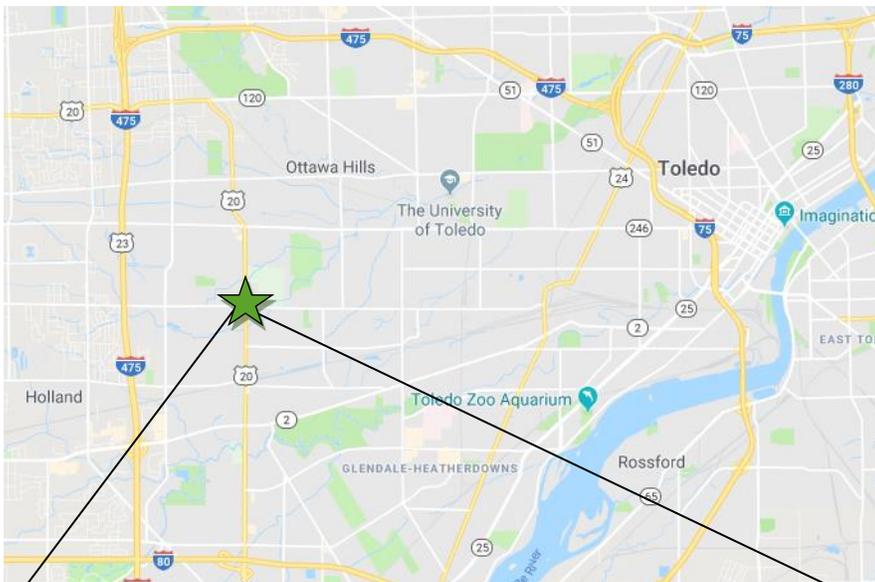
District 2 Planning & Engineering

LUC-20-13.41 Safety Study

Reynolds Road (U.S. Route 20) at Hill Avenue

City of Toledo, Lucas County

2016 HSIP Urban Intersection Rank #7



Planning & Engineering

Department

ODOT District 2

4/1/2018

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A. PURPOSE AND NEED

The purpose of this study is to evaluate the existing safety conditions and to identify potential countermeasures at the intersection of Reynolds Road (U.S. Route 20) and Hill Avenue in the City of Toledo. This location has been selected for study by the FY 2018 Highway Safety Improvement Program and is listed as #7 on the Urban Intersection Priority List.

A review of crash data yielded 115 relevant crashes within the study area during the 3 year period of 2014-2016. During this time 46 (40%) of the crashes resulted in injury. There were zero fatal crashes within this intersection during the study period.

A comparison of crash type and condition percentages within this study site to the 2010-2014 statewide average for state-system non-freeways reveals that this intersection exceeds the statewide average in the following categories (statewide average in parentheses):

- Injury: 46 crashes – 40% (26.1%)
- Rear End: 65 crashes – 56% (31.1%)
- Left Turn: 14 crashes – 12% (5.3%)

B. EXISTING CONDITIONS AND BACKGROUND

The study site is a 4 leg signalized intersection located in the City of Toledo in Lucas County. Approaching this intersection, Reynolds Road (U.S. Route 20) runs North and South. Hill Avenue travels perpendicular to Reynolds Road running East and West. The North, South, and West legs of the intersection have 1 through/right, 1 through, and 1 left turn only lane as they approach the intersection. On these legs, a right turn slip ramp splits from the outer lane at the intersection. Traffic islands are used to separate the through and right turn movement. These traffic islands serve as a pedestrian refuge area, as well as a location for pole-mounted supplemental signal heads. The East Leg has 1 through/right, 1 through, and 2 left turn only lanes with no channelizing island to separate the through and right turn movements. All legs of the intersection have 2 receiving lanes. The speed limit is 45 mph through the study area.

C. TRAFFIC VOLUMES

In 2017, the AADT for the intersection was as shown below:

Leg	AADT	B&C Comm. Vehicles (%)
Reynolds Rd. (North Leg)	24,302	6
Reynolds Rd. (South Leg)	28,196	6
Hill Ave. (West Leg)	9,815	10
Hill Ave. (East Leg)	13,070	N/A

Intersection turning movement data was collected on Tuesday, December 19, 2017 from 6:00am – 6:00pm. See Appendix A for a summary of the traffic volumes.

Traffic signal timing information for the intersection was obtained from the City of Toledo. All left turn phases are actuated making the signal semi-actuated. All phases have a 4 second yellow and a 1 second all red clearance interval. Northbound and Eastbound traffic have a permissive/protected left turn movement. Southbound and Westbound traffic have a protected left turn movement. According to Section 403-2 of the Traffic Engineering Manual, the clearance intervals shown below should be used given the characteristics of the intersection. Additional signal timing information can be found in Appendix B.

Leg	Movement	Intersection Width	Yellow Clearance Interval (Sec)	Red Clearance Interval (Sec)
Reynolds Rd. (North Leg)	Through	115 ft	4.8	0.8
Reynolds Rd. (North Leg)	Left	135 ft	3.9	3.2
Reynolds Rd. (South Leg)	Through	115 ft	4.8	0.8
Reynolds Rd. (South Leg)	Left	135 ft	3.9	3.2
Hill Ave. (West Leg)	Through	115 ft	4.8	0.8
Hill Ave. (West Leg)	Left	125 ft	3.9	2.9
Hill Ave. (East Leg)	Through	115 ft	4.8	0.8
Hill Ave. (East Leg)	Left	125 ft	3.9	2.9

A Highway Capacity Software (HCS) analysis was completed for the intersection to determine the delay and level of service (LOS) of each approach and the intersection as a whole. Only the most congested hour was analyzed, which according to the count data was 4:30pm-5:30pm. Additional HCS analyses were completed taking into consideration 2 of the proposed countermeasures. A table is provided below which compares the delay and LOS of the existing condition to the proposed conditions. The existing and proposed conditions are based on a 120 second cycle length. Reports of the HCS analyses can be found in Appendix C.

	Delay/LOS				
	Intersection Delay	EB Approach	WB Approach	NB Approach	SB Approach
Existing condition	32.8 C	42.8 D	54.8 D	26.1 C	19.7 B
All protected-only left turns	33.1 C	45.1 D	54.8 D	26.1 C	19.7 B
Dual EB Left, protected-only	32.0 C	43.3 D	54.8 D	21.7 C	21.8 C

D. CRASH DATA

YEAR	CRASHES
2014	25
2015	35
2016	55

PAVEMENT CONDITION	
80%	Dry
17%	Wet
2%	Snow
1%	Unknown

TIME OF DAY	
81%	Day
14%	Night
3%	Dusk
2%	Dawn

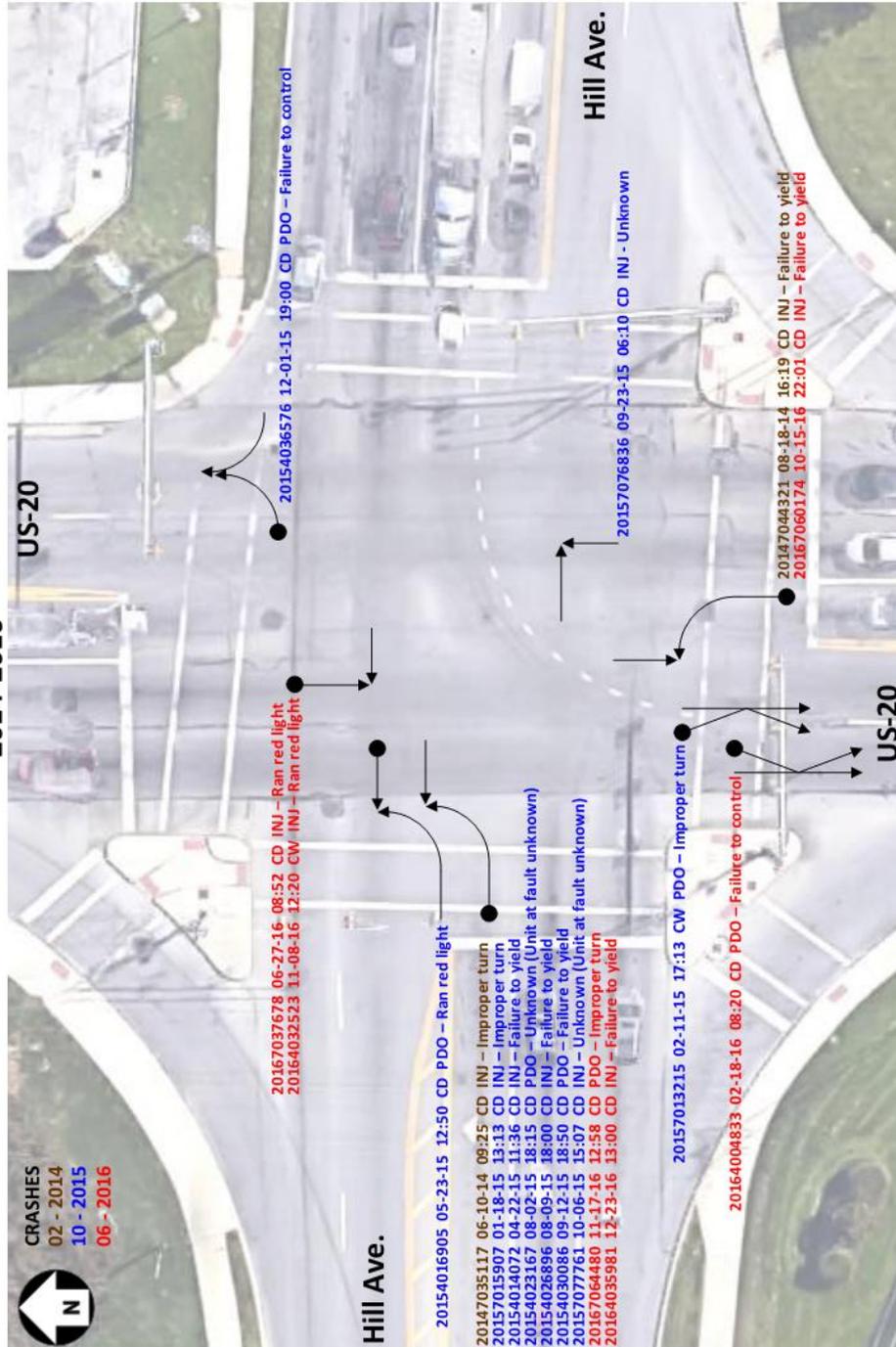
CRASH SEVERITY	
60%	Property Damage Only
40%	Injury
0%	Fatal

TYPE OF CRASH	
56%	Rear End
16%	Angle
12%	Left Turn
9%	Sideswipe Passing
2%	Fixed Object
2%	Backing
2%	Pedestrian
1%	Head-On

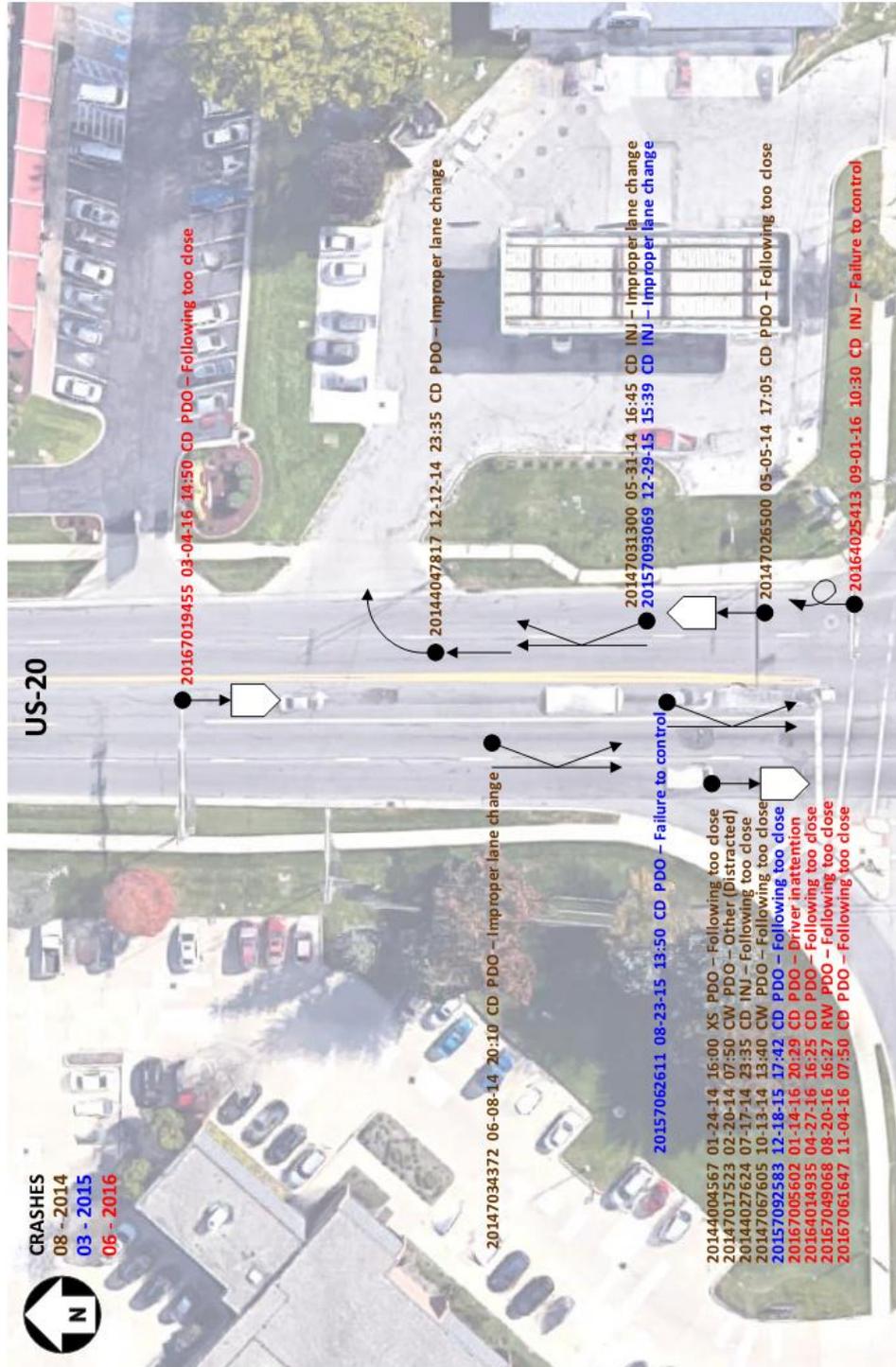
CONTRIBUTING FACTOR	
51%	Following too Close
17%	Failure to Yield
8%	Improper Lane Change
7%	Failure to Control
6%	Improper Turn
3%	Ran Red Light
3%	Unknown
1%	Left of Center
1%	Improper Backing
1%	Improper Crossing
1%	Driver Inattention
1%	Other

E. COLLISION DIAGRAMS

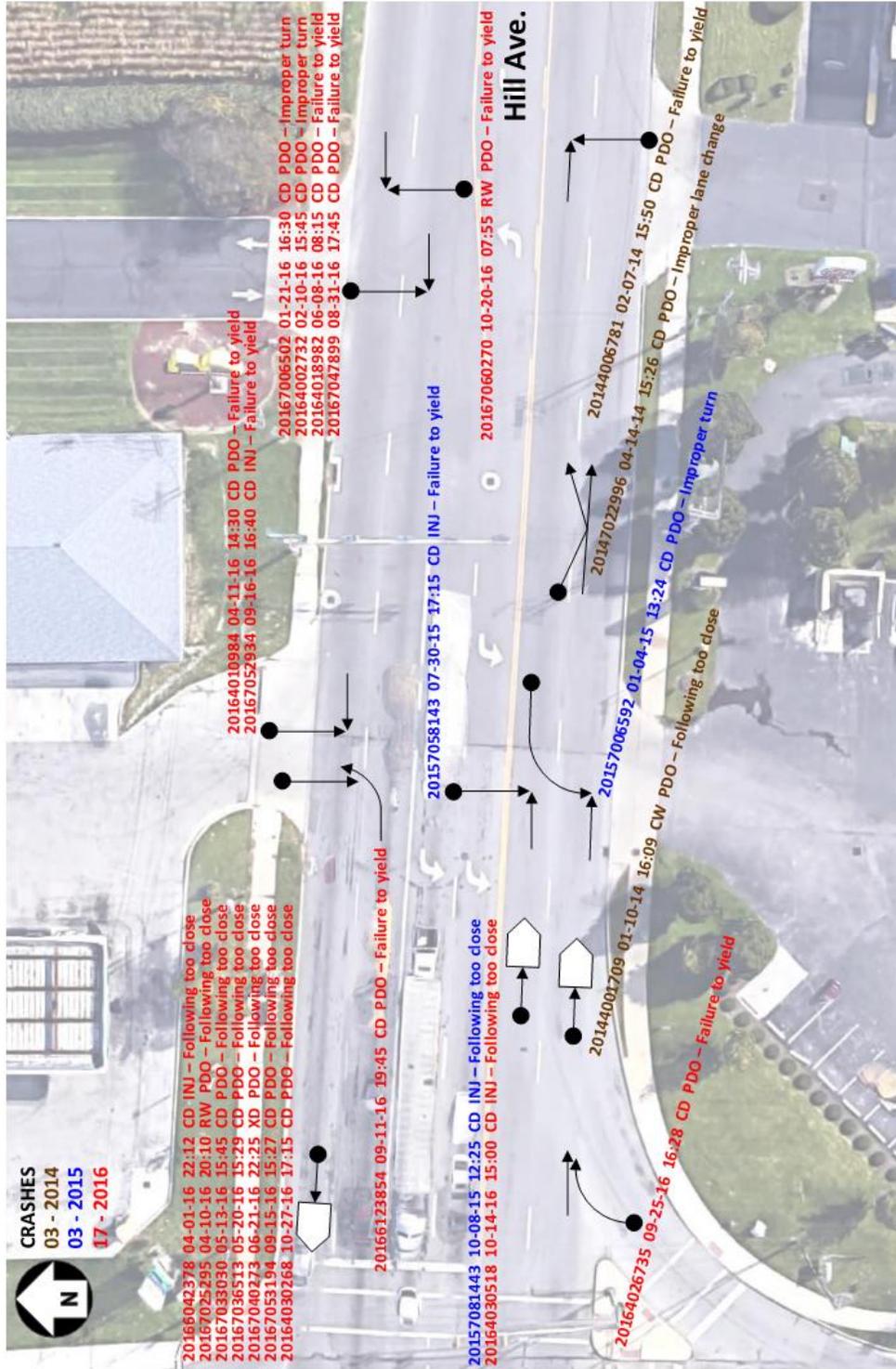
LUC-20-13.41
Intersection
2014-2016



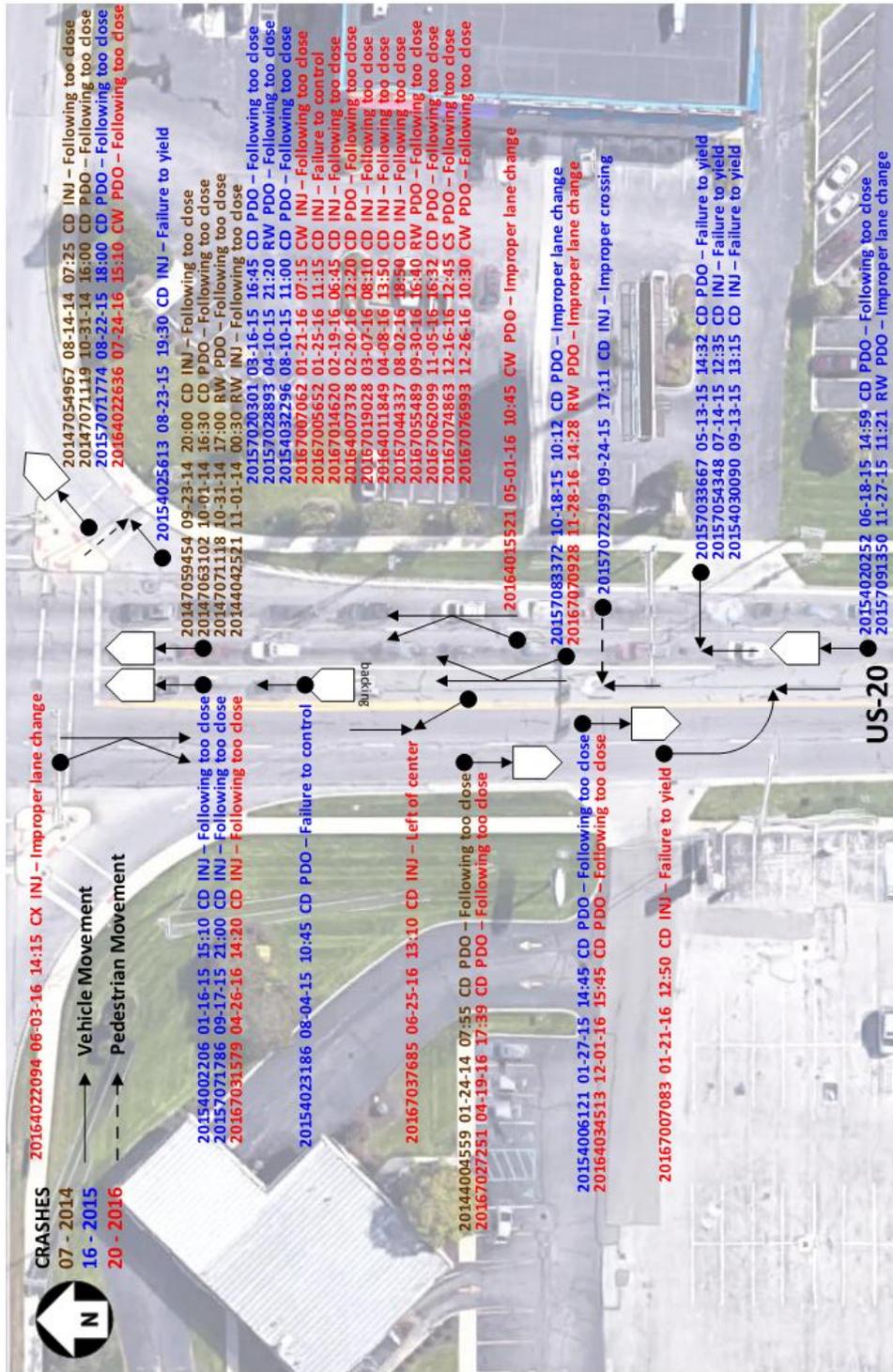
LUC-20-13.41 US-20 (North Leg) 2014-2016



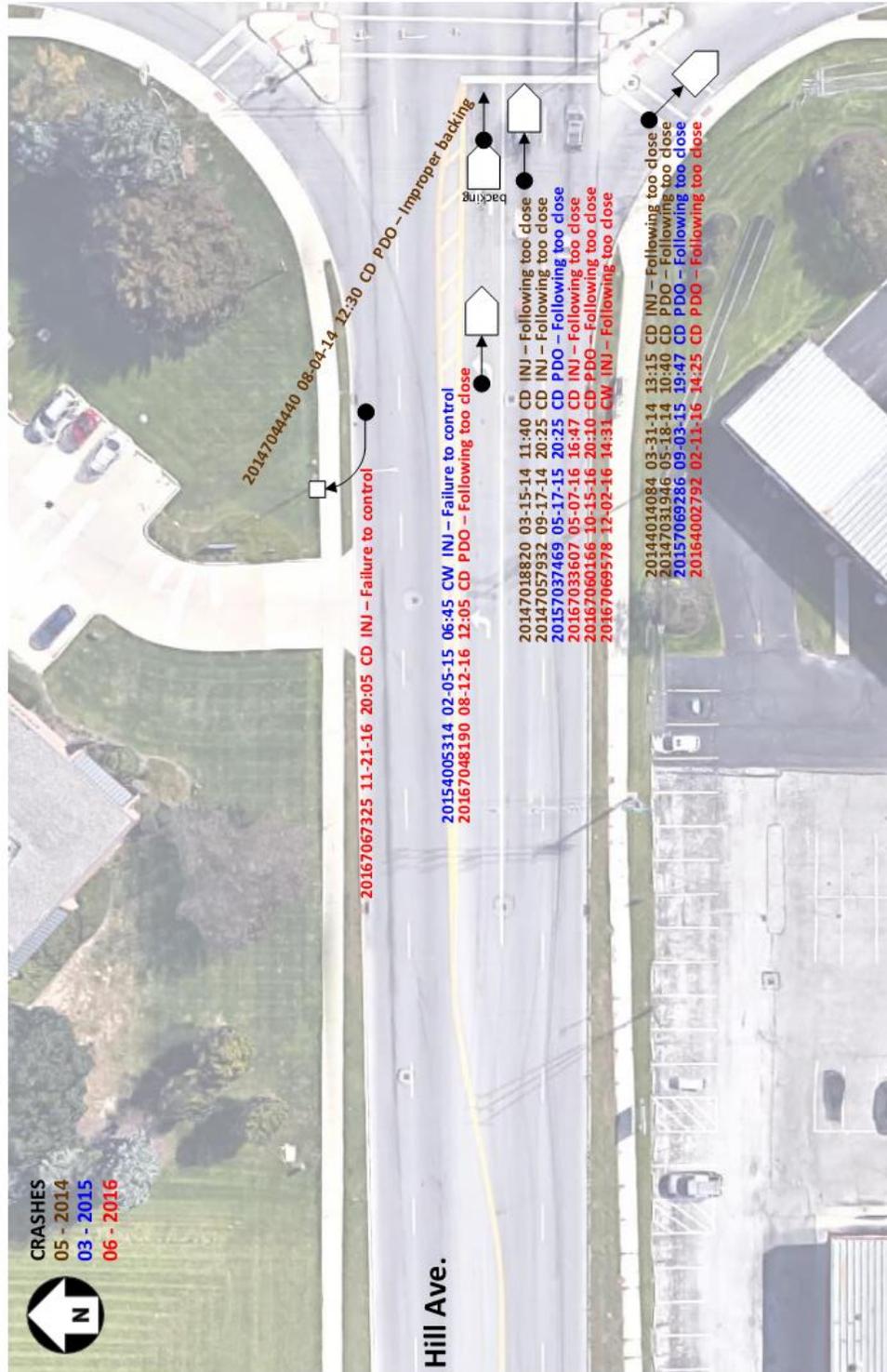
LUC-20-13.41 Hill Ave. (East Leg) 2014-2016



LUC-20-13.41 US-20 (South Leg) 2014-2016



LUC-20-13.41 Hill Ave. (West Leg) 2014-2016



F. PROBABLE CAUSES

The probable causes or deficiencies within the intersection were identified through a detailed analysis of the crash patterns, roadway conditions, existing traffic control, traffic volumes and traffic speeds.

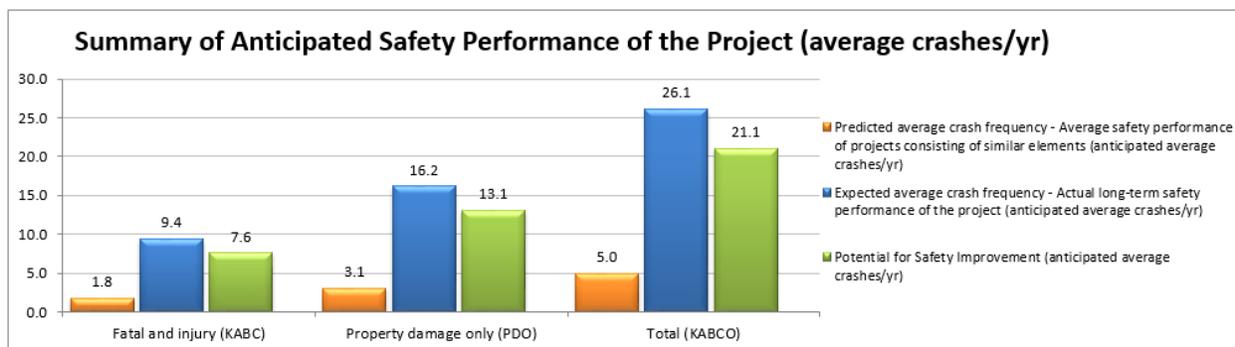
We have identified possible safety items within the intersection as follows:

1. Motorists are following too closely on all approaches. This could be caused by poor signal timing, inadequate clearance intervals, or impatient drivers traveling at high speeds and being unable to stop quickly at the onset of a red light.
2. Motorists are causing angle crashes when they fail to yield the right of way and perform improper turns while entering and exiting business drives near the intersection.
3. Motorists slowing down or stopping the queue of traffic to turn into business drives are contributing to rear end and sideswipe passing crashes.
4. Motorists are failing to yield and completing improper left turns on the northbound and westbound approaches. This may be caused by the permissive/protected left turn phase.

G. HIGHWAY SAFETY MANUAL RESULTS

HSM calculations were completed using the methodology for Urban and Suburban Arterial Intersections. The results are summarized below.

	Reynolds Rd. at Hill Ave.
Predicted Average Crash Frequency (crashes/yr)	5.0
Expected Average Crash Frequency (crashes/yr)	26.1
Expected Excess Crashes (crashes/yr)	21.1
Potential for Safety Improvement?	YES



H. RECOMMENDED COUNTERMEASURES

Rear End Crashes - Approaching Intersection (53)

1. Increase yellow and red clearance intervals to meet ITE standards, as shown on Page 4.

Crashes related to Business Drives (30)

1. Consider access management for businesses on the Northeast and Southeast corners of the intersection.

Left Turn Crashes (12)

1. Change northbound and eastbound left turn phasing from permissive/protected to protected only.
2. Install dual left turn lanes for the eastbound Hill Avenue approach.

I. PROJECT INFORMATION

Previous Projects:

PID: 78395

Project Name: LUC US 20 12.40 Phase 2

Description: Mill 3 inches of asphalt and fill 3 inches of new asphalt with some pavement repairs between SLM 12.40 & SLM 14.36. Replace and/or repair existing curb, curb ramps and sidewalk. Perform necessary related work. This is an urban paving project where the district contributes 80% of the cost of the top 3 inches of asphalt. The City application for Safety funding (\$720K) to upgrade signals has been approved between SLM 11.25 & SLM 16.61. Signal upgrade plans will be added to the resurfacing project plans.

Construction: May 2007 – November 2007

PID: 84082

Project Name: LUC US 20 13.41 Greenhouse Row

Description: Construct pilot enhancement project that includes bioswales and which utilizes local plants; other enhancement features to be included as appropriate. A \$495K earmark "Greenhouse Row (US-20)" is for the segment between Heatherdowns and Turnpike, and a \$735K earmark "US-20 Southwyck Corridor Improvements, OH" is for the segment between Glendale and Hill. Perform necessary related work. See PID 89716.

Sale Date: 04-29-2009

Construction: May 2009 – August 2009

Future Projects:

N/A

APPENDIX A

TRAFFIC VOLUMES

OHIO DEPARTMENT OF TRANSPORTATION																					
DISTRICT 2 • 317 EAST POE RD. • BOWLING GREEN, OHIO 43402 • (419) 353-8131																					
JOHN R. KASICH, GOVERNOR • JERRY WRAY, DIRECTOR • PATRICK MCCOLLEY, P.E., S.I., DISTRICT DEPUTY DIRECTOR																					
File Name : LUC-20-13.41 Factor 1.007 12-19-17																					
Site Code :																					
Start Date : 12/19/2017																					
Page No : 1																					
Groups Printed- Pass, A Comm. - B,C Comm.																					
Start Time	US-20 (Reynolds Rd.) Southbound					Hill Ave. Westbound					US-20 (Reynolds Rd.) Northbound					Hill Ave. Eastbound					Int. Total
	Right	Thru	Left	Peds	Acc Total	Right	Thru	Left	Peds	Acc Total	Right	Thru	Left	Peds	Acc Total	Right	Thru	Left	Peds	Acc Total	
06:00 AM	10	33	10	0	53	9	39	14	0	62	11	34	8	0	53	0	33	5	0	38	206
06:15 AM	13	37	10	0	60	15	50	14	0	79	11	29	11	0	51	0	54	7	0	61	251
06:30 AM	10	68	17	0	95	12	60	22	0	94	22	59	18	0	99	0	61	9	0	70	358
06:45 AM	6	80	12	0	98	7	36	28	0	71	24	57	15	0	96	0	96	7	0	103	368
Total	39	218	49	0	306	43	185	78	0	306	68	179	52	0	299	0	244	28	0	272	1183
07:00 AM	6	75	11	0	92	11	40	30	0	81	19	67	12	0	98	0	93	7	0	100	371
07:15 AM	7	109	24	0	140	17	59	47	0	123	35	96	15	0	146	0	91	5	0	96	505
07:30 AM	16	153	25	0	194	20	82	55	0	157	39	115	46	0	200	0	152	15	0	167	718
07:45 AM	14	174	42	0	230	26	110	64	0	200	38	170	43	0	251	0	128	14	0	142	823
Total	43	511	102	0	656	74	291	196	0	561	131	448	116	0	695	0	464	41	0	505	2417
08:00 AM	6	125	30	0	161	37	53	39	0	129	33	120	21	0	174	0	111	10	0	121	585
08:15 AM	8	151	30	0	189	34	63	41	0	138	45	143	13	0	201	0	81	18	0	99	627
08:30 AM	14	116	23	0	153	39	42	37	0	118	31	146	17	0	194	0	78	16	0	94	559
08:45 AM	23	148	34	0	205	56	50	41	0	147	23	145	29	0	197	0	71	10	0	81	630
Total	51	540	117	0	708	166	208	158	0	532	132	554	80	0	766	0	341	54	0	395	2401
09:00 AM	24	135	20	0	179	33	57	36	0	126	31	131	31	0	193	0	70	17	0	87	585
09:15 AM	16	114	20	0	150	28	64	27	0	119	30	123	26	0	179	0	54	25	0	79	527
09:30 AM	16	124	22	0	162	28	59	43	0	130	29	117	11	0	157	0	51	13	0	64	513
09:45 AM	9	119	29	0	157	26	53	34	0	113	27	107	29	0	163	0	56	17	0	73	506
Total	65	492	91	0	648	115	233	140	0	488	117	478	97	0	692	0	231	72	0	303	2131
10:00 AM	18	104	12	0	134	23	45	25	0	93	29	124	21	0	174	0	44	15	0	59	460
10:15 AM	14	122	22	0	158	25	50	31	0	106	21	118	18	0	157	0	49	12	0	61	482
10:30 AM	7	140	27	0	174	42	56	38	0	136	34	112	25	0	171	0	67	14	0	81	562
10:45 AM	12	141	34	0	187	30	66	34	0	130	31	120	17	0	168	0	60	26	0	86	571
Total	51	507	95	0	653	120	217	128	0	465	115	474	81	0	670	0	220	67	0	287	2075
11:00 AM	25	136	29	0	190	20	70	31	0	121	45	143	36	0	224	0	53	15	0	68	603
11:15 AM	15	148	32	0	195	34	71	31	0	136	42	144	29	0	215	0	89	25	0	114	660
11:30 AM	11	147	31	0	189	35	55	34	0	124	32	141	23	0	196	0	76	22	0	98	607
11:45 AM	16	162	26	0	204	34	68	41	0	143	38	174	20	0	232	0	59	16	0	75	654
Total	67	593	118	0	778	123	264	137	0	524	157	602	108	0	867	0	277	78	0	355	2524
12:00 PM	24	155	29	0	208	32	61	46	0	139	39	143	21	0	203	0	46	18	0	64	614
12:15 PM	12	154	30	0	196	29	59	41	0	129	35	154	19	0	208	0	54	16	0	70	603
12:30 PM	23	140	32	0	195	38	66	30	0	134	35	158	19	0	212	0	46	27	0	73	614
12:45 PM	24	168	30	0	222	29	56	22	0	107	44	175	24	0	243	0	64	15	0	79	651
Total	83	617	121	0	821	128	242	139	0	509	153	630	83	0	866	0	210	76	0	286	2482

OHIO DEPARTMENT OF TRANSPORTATION

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File Name : LUC-20-13.41 Factor 1.007 12-19-17

Site Code :

Start Date : 12/19/2017

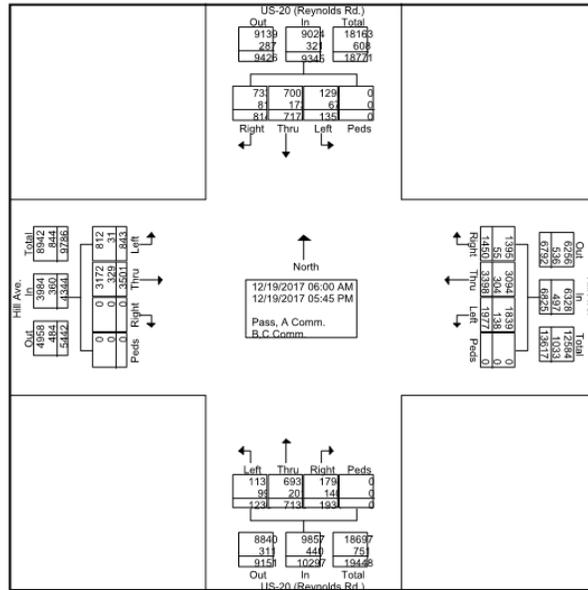
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Groups Printed- Pass, A Comm. - B.C Comm.

Start Time	US-20 (Reynolds Rd.) Southbound					Hill Ave. Westbound					US-20 (Reynolds Rd.) Northbound					Hill Ave. Eastbound					Int. Total
	Right	Thru	Left	Peds	Acc. Total	Right	Thru	Left	Peds	Acc. Total	Right	Thru	Left	Peds	Acc. Total	Right	Thru	Left	Peds	Acc. Total	
01:00 PM	23	149	27	0	199	39	70	48	0	157	35	125	15	0	175	0	64	15	0	79	610
01:15 PM	14	158	25	0	197	27	68	27	0	122	35	169	24	0	228	0	53	17	0	70	617
01:30 PM	21	166	28	0	215	36	65	51	0	152	46	168	28	0	242	0	63	17	0	80	689
01:45 PM	17	162	31	0	210	28	66	51	0	145	38	180	28	0	246	0	66	22	0	88	689
Total	75	635	111	0	821	130	269	177	0	576	154	642	95	0	891	0	246	71	0	317	2605
02:00 PM	20	173	32	0	225	28	76	42	0	146	36	185	29	0	250	0	63	14	0	77	698
02:15 PM	17	178	25	0	220	36	62	46	0	144	46	162	21	0	229	0	77	20	0	97	690
02:30 PM	23	179	40	0	242	32	83	44	0	159	40	194	25	0	259	0	67	10	0	77	737
02:45 PM	19	185	31	0	235	31	84	43	0	158	52	171	29	0	252	0	72	21	0	93	738
Total	79	715	128	0	922	127	305	175	0	607	174	712	104	0	990	0	279	65	0	344	2863
03:00 PM	18	180	33	0	231	32	94	45	0	171	57	181	32	0	270	0	79	19	0	98	770
03:15 PM	22	207	38	0	267	45	76	51	0	172	60	209	38	0	307	0	85	30	0	115	861
03:30 PM	20	192	33	0	245	26	97	76	0	199	68	201	35	0	304	0	71	25	0	96	844
03:45 PM	23	205	44	0	272	36	92	54	0	182	46	211	46	0	303	0	89	17	0	106	863
Total	83	784	148	0	1015	139	359	226	0	724	231	802	151	0	1184	0	324	91	0	415	3338
04:00 PM	29	151	39	0	219	40	113	58	0	211	63	193	41	0	297	0	90	23	0	113	840
04:15 PM	30	186	22	0	238	42	109	48	0	199	60	187	29	0	276	0	75	33	0	108	821
04:30 PM	24	200	32	0	256	39	116	65	0	220	58	216	29	0	303	0	94	20	0	114	893
04:45 PM	19	221	31	0	271	37	101	44	0	182	68	193	26	0	287	0	85	36	0	121	861
Total	102	758	124	0	984	158	439	215	0	812	249	789	125	0	1163	0	344	112	0	456	3415
05:00 PM	18	195	41	0	254	38	119	60	0	217	74	227	38	0	339	0	99	30	0	129	939
05:15 PM	19	244	42	0	305	39	97	55	0	191	59	203	35	0	297	0	88	17	0	105	898
05:30 PM	20	184	30	0	234	31	114	52	0	197	73	210	34	0	317	0	79	19	0	98	846
05:45 PM	19	181	40	0	240	19	56	41	0	116	47	183	31	0	261	0	55	22	0	77	694
Total	76	804	153	0	1033	127	386	208	0	721	253	823	138	0	1214	0	321	88	0	409	3377
Grand Total	814	7174	1357	0	9345	1450	3398	1977	0	6825	1934	7133	1230	0	10297	0	3501	843	0	4344	30811
Apprch %	8.7	76.8	14.5	0		21.2	49.8	29	0		18.8	69.3	11.9	0		0	80.6	19.4	0		
Total %	2.6	23.3	4.4	0	30.3	4.7	11	6.4	0	22.2	6.3	23.2	4	0	33.4	0	11.4	2.7	0	14.1	
Pass, A Comm.	733	7001	1290	0	9024	1395	3094	1839	0	6328	1794	6932	1131	0	9857	0	3172	812	0	3984	29193
% Pass, A Comm.	90	97.6	95.1	0	96.6	96.2	91.1	93	0	92.7	92.8	97.2	92	0	95.7	0	90.6	96.3	0	91.7	94.7
B,C Comm.	81	173	67	0	321	55	304	138	0	497	140	201	99	0	440	0	329	31	0	360	1618
% B,C Comm.	10	2.4	4.9	0	3.4	3.8	8.9	7	0	7.3	7.2	2.8	8	0	4.3	0	9.4	3.7	0	8.3	5.3

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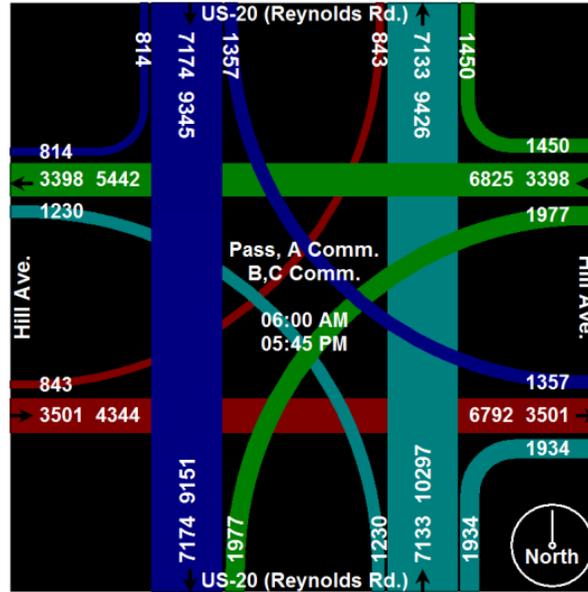
File Name : LUC-20-13.41 Factor 1.007 12-19-17
 Site Code :
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Page No : 4



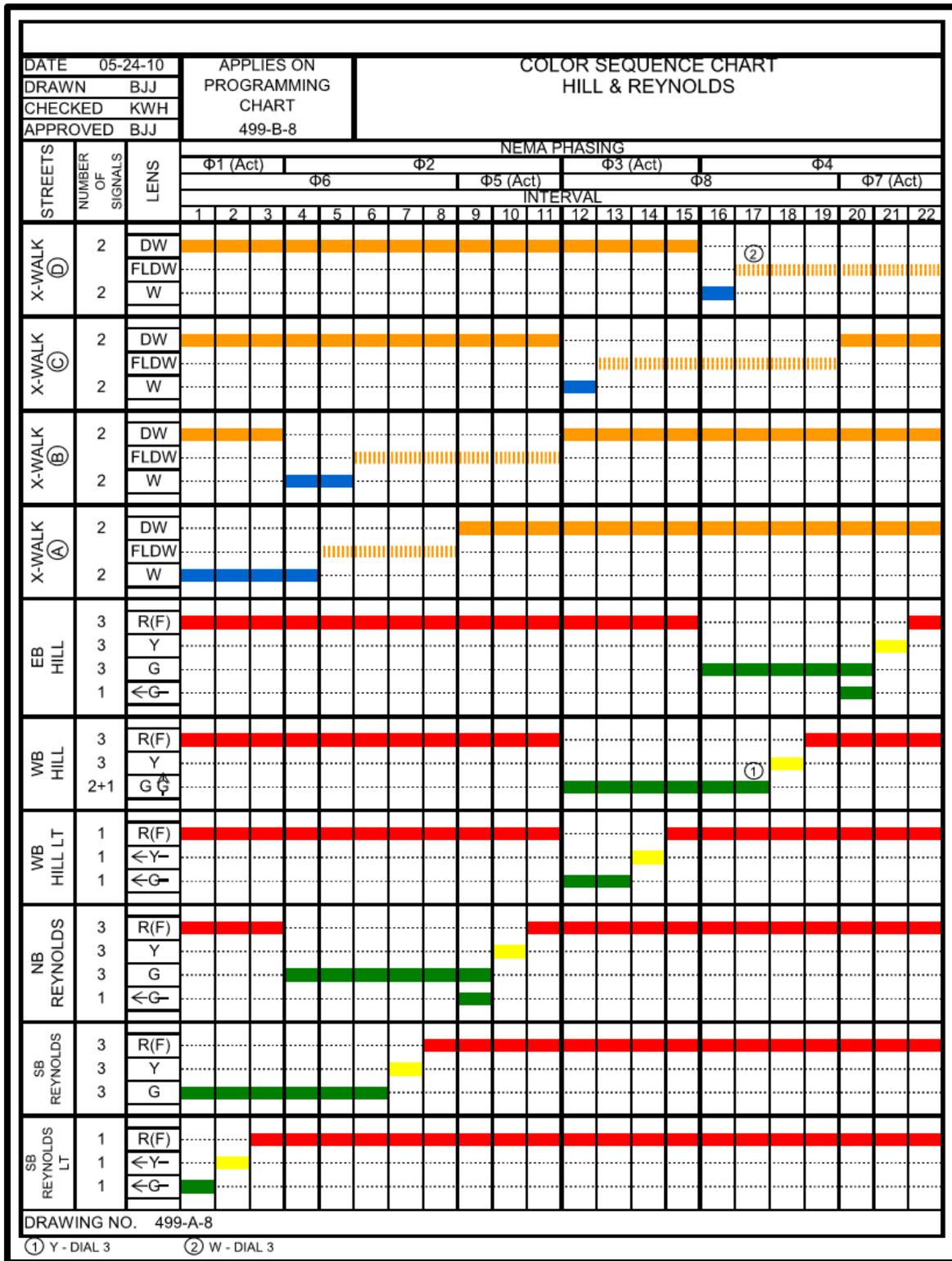
APPENDIX B

SIGNAL TIMING & PHASING

EAGLE CONTROLLER TIMING - #499							
INTERSECTION:		HILL & REYNOLDS		SYSTEM: FAR WEST			
DATE:		10/10/07		BY:		BJJ	
PHASE	DIRECTION	DIAL 1 = 100	DIAL 1 = 100	DIAL 2 = 90	DIAL 3 = 120	MIN	MAX
FLASH 1 (ACT)	SB	G+Y+R= 17	G+Y+R= 15	G+Y+R= 14	G+Y+R= 19	5	20
	Reynolds	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
	LT	G= 12	G= 10	G= 9	G= 14		
FLASH 2	NB	G+Y+R= 40	G+Y+R= 41	G+Y+R= 34	G+Y+R= 54	25	55
	Reynolds	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
		G= 35	G= 36	G= 29	G= 49		
FLASH 3 (ACT)	WB	G+Y+R= 15	G+Y+R= 14	G+Y+R= 12	G+Y+R= 16	5	17
	Hill	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
	LT	G= 10	G= 9	G= 7	G= 11		
FLASH 4	EB	G+Y+R= 28	G+Y+R= 30	G+Y+R= 30	G+Y+R= 31	19	32
	Hill	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
		G= 23	G= 25	G= 25	G= 26		
5 (ACT) Y-BLANK	NB	G+Y+R= 14	G+Y+R= 16	G+Y+R= 13	G+Y+R= 15	5	17
	Reynolds	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
	LT	G= 9	G= 11	G= 8	G= 10		
FLASH 6	SB	G+Y+R= 43	G+Y+R= 40	G+Y+R= 35	G+Y+R= 58	23	59
	Reynolds	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
		G= 38	G= 35	G= 30	G= 53		
7 (ACT) Y-BLANK	EB	G+Y+R= 14	G+Y+R= 14	G+Y+R= 14	G+Y+R= 16	4	17
	Hill	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
	LT	G= 9	G= 9	G= 9	G= 11		
FLASH 8	WB	G+Y+R= 29	G+Y+R= 30	G+Y+R= 28	G+Y+R= 31	19	32
	Hill	Y= 4	Y= 4	Y= 4	Y= 4		
		R= 1	R= 1	R= 1	R= 1		
		G= 24	G= 25	G= 23	G= 26		
2	EAST	W= 18	W= 19	W= 12	W= 32	7	22
	X-WALK	FLDW= 22	FLDW= 22	FLDW= 22	FLDW= 22		
4	SOUTH	W= 8	W= 10	W= 10	W= 11	7	20
	X-WALK	FLDW= 20	FLDW= 20	FLDW= 20	FLDW= 20		
6	WEST	W= 23	W= 20	W= 15	W= 38	7	20
	X-WALK	FLDW= 20	FLDW= 20	FLDW= 20	FLDW= 20		
8	NORTH	W= 8	W= 9	W= 7	W= 10	6	21
	X-WALK	FLDW= 21	FLDW= 21	FLDW= 21	FLDW= 21		
OFFSET	Begin Green	5	0	5	113		

	X-Walk Length	Time
2	X-WALK	86 22
4	X-WALK	78 20
6	X-WALK	78 20
8	X-WALK	84 21

SPECIAL EVENT FUNCTION
NO TIMECLOCK FLASH

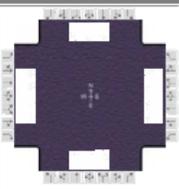


APPENDIX C

HIGHWAY CAPACITY SOFTWARE ANALYSIS

HCS7 Signalized Intersection Results Summary																		
General Information							Intersection Information											
Agency							Duration, h	0.25										
Analyst							Analysis Date	3/6/2018										
Jurisdiction							Area Type	Other										
Urban Street	US-20 (Reynolds Rd.)						PHF	0.96										
Intersection	Hill Ave.						Analysis Year	2018										
Project Description	Existing PM						Analysis Period	1> 7:00										
																		
Demand Information							EB		WB			NB			SB			
Approach Movement							L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h							103	366	0	224	433	153	128	839	259	146	860	80
Signal Information																		
Cycle, s	120.0	Reference Phase	2															
Offset, s	0	Reference Point	End															
Uncoordinated	Yes	Simult. Gap E/W	On	Green	14.0	34.0	10.0	11.0	10.0	11.0								
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	4.0	4.0	4.0	4.0								
				Red	1.0	1.0	1.0	1.0	1.0	1.0								
Timer Results							EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Assigned Phase							3	8	7	4	1	6	5	2				
Case Number							1.3	4.0	2.0	4.0	2.0	4.0	2.0	4.0				
Phase Duration, s							16.0	31.0	16.0	31.0	15.0	54.0	19.0	58.0				
Change Period, (Y+Rc), s							5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0				
Max Allow Headway (MAH), s							2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0				
Queue Clearance Time (g _z), s							2.3	12.5	9.8	21.1	10.8	34.5	11.7	25.7				
Green Extension Time (g _e), s							0.7	0.9	0.1	0.6	0.0	2.4	0.1	1.8				
Phase Call Probability							1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
Max Out Probability							0.01	0.00	1.00	0.36	1.00	0.04	1.00	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							3	8	18	7	4	14	1	6	16	5	2	12
Adjusted Flow Rate (v), veh/h							107	381	0	233	318	293	133	595	548	152	497	482
Adjusted Saturation Flow Rate (s), veh/h/ln							1810	1900		1757	1900	1730	1810	1900		1810	1900	
Queue Service Time (g _s), s							0.3	10.5		7.8	18.9	19.1	8.8	32.4		9.7	23.7	
Cycle Queue Clearance Time (g _c), s							0.3	10.5		7.8	18.9	19.1	8.8	32.4		9.7	23.7	
Green Ratio (g/C)							0.16	0.22		0.09	0.22	0.22	0.08	0.41		0.12	0.44	
Capacity (c), veh/h							259	823		322	412	375	151	776		211	839	
Volume-to-Capacity Ratio (X)							0.414	0.463		0.724	0.771	0.781	0.884	0.767		0.720	0.592	
Back of Queue (Q), ft/ln (50 th percentile)							72.4	119.8		91	237.5	223	139.3	372.9		121.8	257.8	
Back of Queue (Q), veh/ln (50 th percentile)							2.9	4.8		3.6	9.5	8.9	5.6	14.9		4.9	10.3	
Queue Storage Ratio (RQ) (50 th percentile)							0.29	0.00		0.52	0.00	0.00	0.70	0.00		0.81	0.00	
Uniform Delay (d ₁), s/veh							48.8	40.9		53.0	44.2	44.3	54.4	30.6		51.1	25.3	
Incremental Delay (d ₂), s/veh							0.4	0.2		6.9	7.9	9.3	40.4	4.2		9.9	0.8	
Initial Queue Delay (d ₃), s/veh							0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh							49.1	41.1	0.0	59.9	52.1	53.7	94.8	34.8	0.0	61.0	26.1	0.0
Level of Service (LOS)							D	D		E	D	D	F	C	A	E	C	A
Approach Delay, s/veh / LOS							42.8		D	54.8		D	26.1		C	19.7		B
Intersection Delay, s/veh / LOS							32.8						C					
Multimodal Results							EB		WB			NB			SB			
Pedestrian LOS Score / LOS							2.30	B	2.31	B	2.43	B	2.31	B				
Bicycle LOS Score / LOS							0.89	A	1.18	A	1.54	B	1.42	A				
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HCS7 Signalized Intersection Results Summary																
General Information						Intersection Information										
Agency						Duration, h	0.25									
Analyst						Analysis Date	3/6/2018									
Jurisdiction						Area Type	Other									
Urban Street	US-20 (Reynolds Rd.)		Time Period			PHF	0.96									
Intersection	Hill Ave.		Analysis Year	2018		Analysis Period	1> 7:00									
Project Description	Proposed PM (protected only lefts)					File Name										
Demand Information				EB			WB			NB			SB			
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R	
Demand (v), veh/h				103	366	0	224	433	153	128	839	259	146	860	80	
Signal Information																
Cycle, s	120.0	Reference Phase	2													
Offset, s	0	Reference Point	End													
Uncoordinated	Yes	Simult. Gap E/W	On	Green	14.0	34.0	10.0	11.0	10.0	11.0						
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	4.0	4.0	4.0	4.0						
				Red	1.0	1.0	1.0	1.0	1.0	1.0						
Timer Results				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT					
Assigned Phase				3	8	7	4	1	6	5	2					
Case Number				2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0					
Phase Duration, s				16.0	31.0	16.0	31.0	15.0	54.0	19.0	58.0					
Change Period, (Y+R _c), s				5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0					
Max Allow Headway (MAH), s				2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0					
Queue Clearance Time (g _s), s				8.9	12.5	9.8	21.1	10.8	34.5	11.7	25.7					
Green Extension Time (g _e), s				0.2	0.9	0.1	0.6	0.0	2.4	0.1	1.8					
Phase Call Probability				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					
Max Out Probability				1.00	0.00	1.00	0.36	1.00	0.04	1.00	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				3	8	18	7	4	14	1	6	16	5	2	12	
Adjusted Flow Rate (v), veh/h				107	381	0	233	318	293	133	595	548	152	497	482	
Adjusted Saturation Flow Rate (s), veh/h/ln				1810	1900		1757	1900	1730	1810	1900		1810	1900		
Queue Service Time (g _s), s				6.9	10.5		7.8	18.9	19.1	8.8	32.4		9.7	23.7		
Cycle Queue Clearance Time (g _c), s				6.9	10.5		7.8	18.9	19.1	8.8	32.4		9.7	23.7		
Green Ratio (g/C)				0.09	0.22		0.09	0.22	0.22	0.08	0.41		0.12	0.44		
Capacity (c), veh/h				166	823		322	412	375	151	776		211	839		
Volume-to-Capacity Ratio (X)				0.647	0.463		0.724	0.771	0.781	0.884	0.767		0.720	0.592		
Back of Queue (Q), ft/ln (50 th percentile)				83.9	119.8		91	237.5	223	139.3	372.9		121.8	257.6		
Back of Queue (Q), veh/ln (50 th percentile)				3.4	4.8		3.6	9.5	8.9	5.6	14.9		4.9	10.3		
Queue Storage Ratio (RQ) (50 th percentile)				0.34	0.00		0.52	0.00	0.00	0.70	0.00		0.61	0.00		
Uniform Delay (d ₁), s/veh				52.6	40.9		53.0	44.2	44.3	54.4	30.6		51.1	25.3		
Incremental Delay (d ₂), s/veh				6.7	0.2		6.9	7.9	9.3	40.4	4.2		9.9	0.8		
Initial Queue Delay (d ₃), s/veh				0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0		
Control Delay (d), s/veh				59.3	41.1	0.0	59.9	52.1	53.7	94.8	34.8	0.0	61.0	26.1	0.0	
Level of Service (LOS)				E	D		E	D	D	F	C	A	E	C	A	
Approach Delay, s/veh / LOS				45.1		D	54.8		D	26.1		C	19.7		B	
Intersection Delay, s/veh / LOS				33.1					C							
Multimodal Results				EB			WB			NB			SB			
Pedestrian LOS Score / LOS				2.30		B	2.31		B	2.43		B	2.31		B	
Bicycle LOS Score / LOS				0.89		A	1.18		A	1.54		B	1.42		A	

HCS7 Signalized Intersection Results Summary															
General Information						Intersection Information									
Agency						Duration, h	0.25								
Analyst						Analysis Date	3/6/2018								
Jurisdiction						Time Period									
Urban Street	US-20 (Reynolds Rd.)					Analysis Year	2018								
Intersection	Hill Ave.					File Name									
Project Description	Proposed PM (Dual EB Lefts)														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				103	366	0	224	433	153	128	839	259	146	860	80
Signal Information															
Cycle, s	120.0	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	Yes	Simult. Gap E/W	On	Green	14.0	29.0	15.0	11.0	10.0	11.0					
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	4.0	4.0	4.0	4.0					
				Red	1.0	1.0	1.0	1.0	1.0	1.0					
Timer Results				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Assigned Phase				3	8	7	4	1	6	5	2				
Case Number				2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0				
Phase Duration, s				16.0	31.0	16.0	31.0	20.0	54.0	19.0	53.0				
Change Period, (Y+R _c), s				5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0				
Max Allow Headway (MAH), s				2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0				
Queue Clearance Time (g _s), s				5.4	12.5	9.8	21.1	10.4	34.5	11.7	27.5				
Green Extension Time (g _e), s				0.6	0.9	0.1	0.6	0.0	2.4	0.1	1.8				
Phase Call Probability				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
Max Out Probability				0.14	0.00	1.00	0.36	1.00	0.04	1.00	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				3	8	18	7	4	14	1	6	16	5	2	12
Adjusted Flow Rate (v), veh/h				107	381	0	233	318	293	133	595	548	152	497	482
Adjusted Saturation Flow Rate (s), veh/h/ln				1757	1900		1757	1900	1730	1810	1900		1810	1900	
Queue Service Time (g _s), s				3.4	10.5		7.8	18.9	19.1	8.4	32.4		9.7	25.5	
Cycle Queue Clearance Time (g _c), s				3.4	10.5		7.8	18.9	19.1	8.4	32.4		9.7	25.5	
Green Ratio (g/C)				0.09	0.22		0.09	0.22	0.22	0.12	0.41		0.12	0.40	
Capacity (c), veh/h				322	823		322	412	375	226	776		211	760	
Volume-to-Capacity Ratio (X)				0.333	0.463		0.724	0.771	0.781	0.589	0.767		0.720	0.654	
Back of Queue (Q), ft/ln (50 th percentile)				37.2	119.8		91	237.5	223	96.5	372.9		121.8	284.7	
Back of Queue (Q), veh/ln (50 th percentile)				1.5	4.8		3.6	9.5	8.9	3.9	14.9		4.9	11.4	
Queue Storage Ratio (RQ) (50 th percentile)				0.15	0.00		0.52	0.00	0.00	0.48	0.00		0.61	0.00	
Uniform Delay (d ₁), s/veh				51.1	40.9		53.0	44.2	44.3	49.6	30.6		51.1	29.3	
Incremental Delay (d ₂), s/veh				0.2	0.2		6.9	7.9	9.3	2.8	4.2		9.9	1.6	
Initial Queue Delay (d ₃), s/veh				0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh				51.3	41.1	0.0	59.9	52.1	53.7	52.3	34.8	0.0	61.0	30.9	0.0
Level of Service (LOS)				D	D		E	D	D	D	C	A	E	C	A
Approach Delay, s/veh / LOS				43.3		D	54.8		D	21.7		C	21.8		C
Intersection Delay, s/veh / LOS				32.0						C					
Multimodal Results				EB			WB			NB			SB		
Pedestrian LOS Score / LOS				2.30		B	2.31		B	2.43		B	2.46		B
Bicycle LOS Score / LOS				0.89		A	1.18		A	1.54		B	1.42		A