



Lake Otis Parkway & 20th Avenue Traffic Signal Evaluation

Prepared for:

Municipality of Anchorage Traffic Department

Prepared by:

**Hattenburg Dilley & Linnell
3335 Arctic Boulevard
Suite 100
Anchorage, AK 99503**

Table of Contents

Existing Conditions.....	1
Problem Identification	1
Crash Experience	1
Operations	4
Alternative Evaluation	5
Utilities.....	8
Right-of-Way	9
Cost	9
Recommendation	9

Appendices

- Appendix A – Traffic Data
- Appendix B – Engineers Estimate

Existing Conditions

The intersection of Lake Otis Parkway and 20th Avenue is located along the southern edge of the Airport Heights Subdivision in Anchorage, Alaska as shown in the Location and Area Maps (**Figures 1** and **2**). Lake Otis Parkway provides north-south access and is classified in the Official Streets and Highways Plan (OSHP) as a Class III Major Arterial. The 2003-2007, five year Average Annual Daily Traffic (AADT) along Lake Otis Parkway between Debarr Road to the north and Northern Lights Boulevard to the south is 20,300 vehicles per day. The posted maximum speed along Lake Otis Parkway is 35 miles per hour.

20th Avenue is unclassified in the OSHP and as such is a local street though it functions as a collector street. It provides east west access into the Airport Heights Subdivision east of Lake Otis Parkway and the Eastridge Subdivision to the west. The posted speed limit on 20th Avenue to the east and west is 25 miles per hour.

The intersection of Lake Otis Parkway and 20th Avenue is a four-way, signal controlled intersection. 20th Avenue, both east and west of Lake Otis Parkway is a two-lane roadway with parking on both sides. East of Lake Otis, 20th Avenue is level; to the west it drops down a steep grade just west of the intersection approach. Lake Otis Parkway is a four-lane roadway with two lanes for both northbound and southbound traffic south of 20th Avenue; north of 20th Avenue one of the northbound lanes is dropped in lieu of on-street parking to provide parking for the residences adjacent to Lake Otis Parkway.

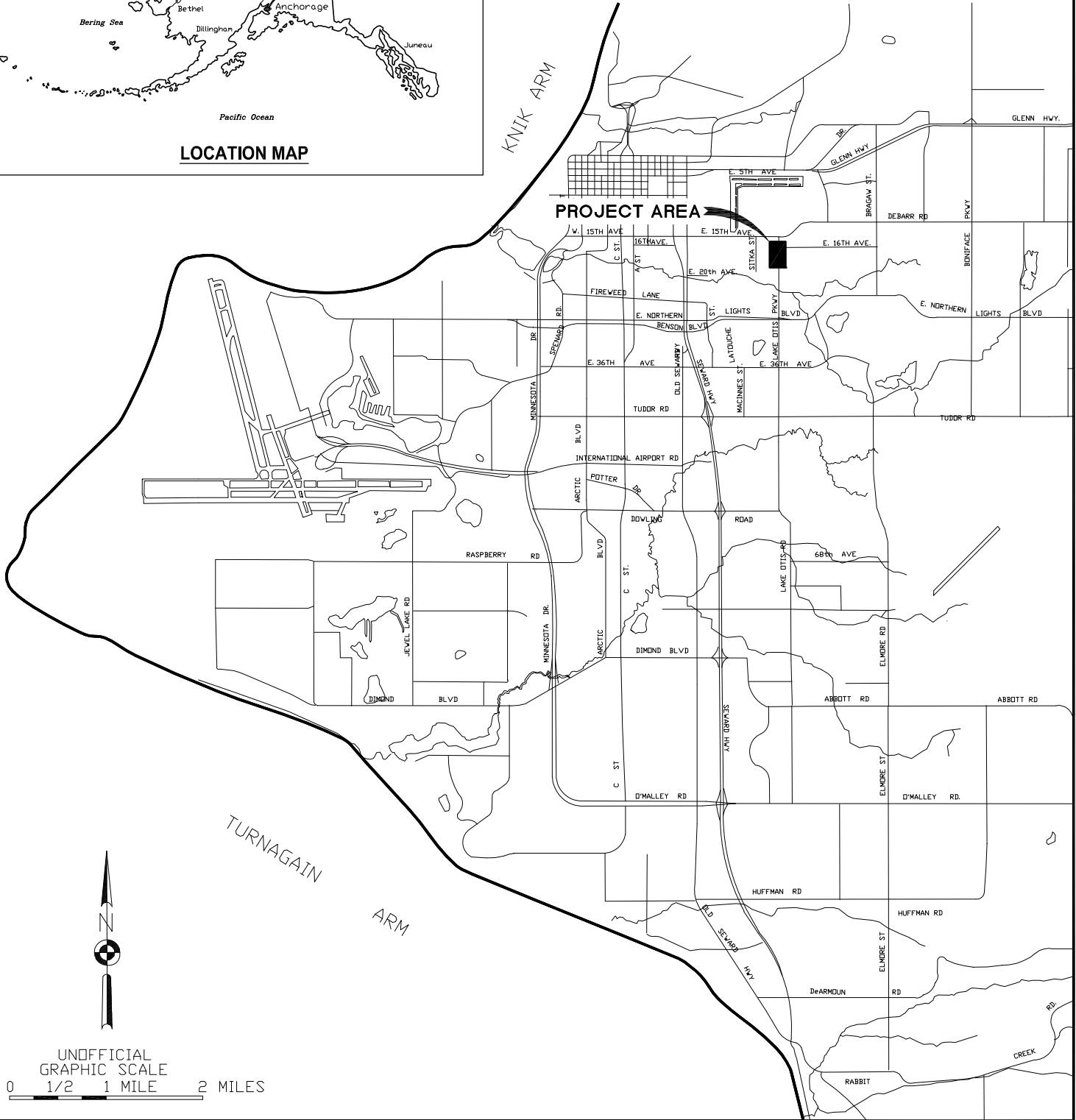
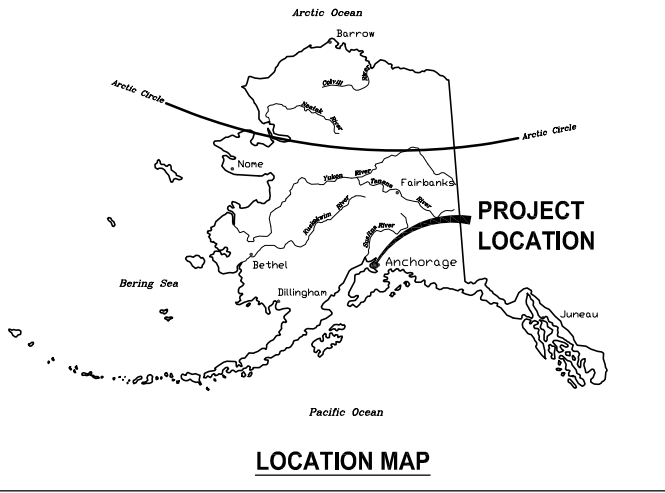
Problem Identification

Crash Experience

During the five year period from 2003 to 2007, there were a total of 24 crashes reported at the intersection of Lake Otis Parkway and 20th Avenue which are recorded in **Table 1** below.

Crash Type	Fatality	Major Injury	Minor Injury	Property Damage Only	Total
Fixed Object				1	1
Left Turn		1	4	4	9
Rear End			2	8	10
Right Angle	1		2	1	4
Total	1	1	8	14	24

Table 1 – Lake Otis Parkway & 20th Ave Crashes



HDL HATTENBURG DILLEY & LINNELL
Engineering Consultants

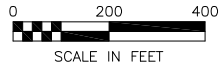
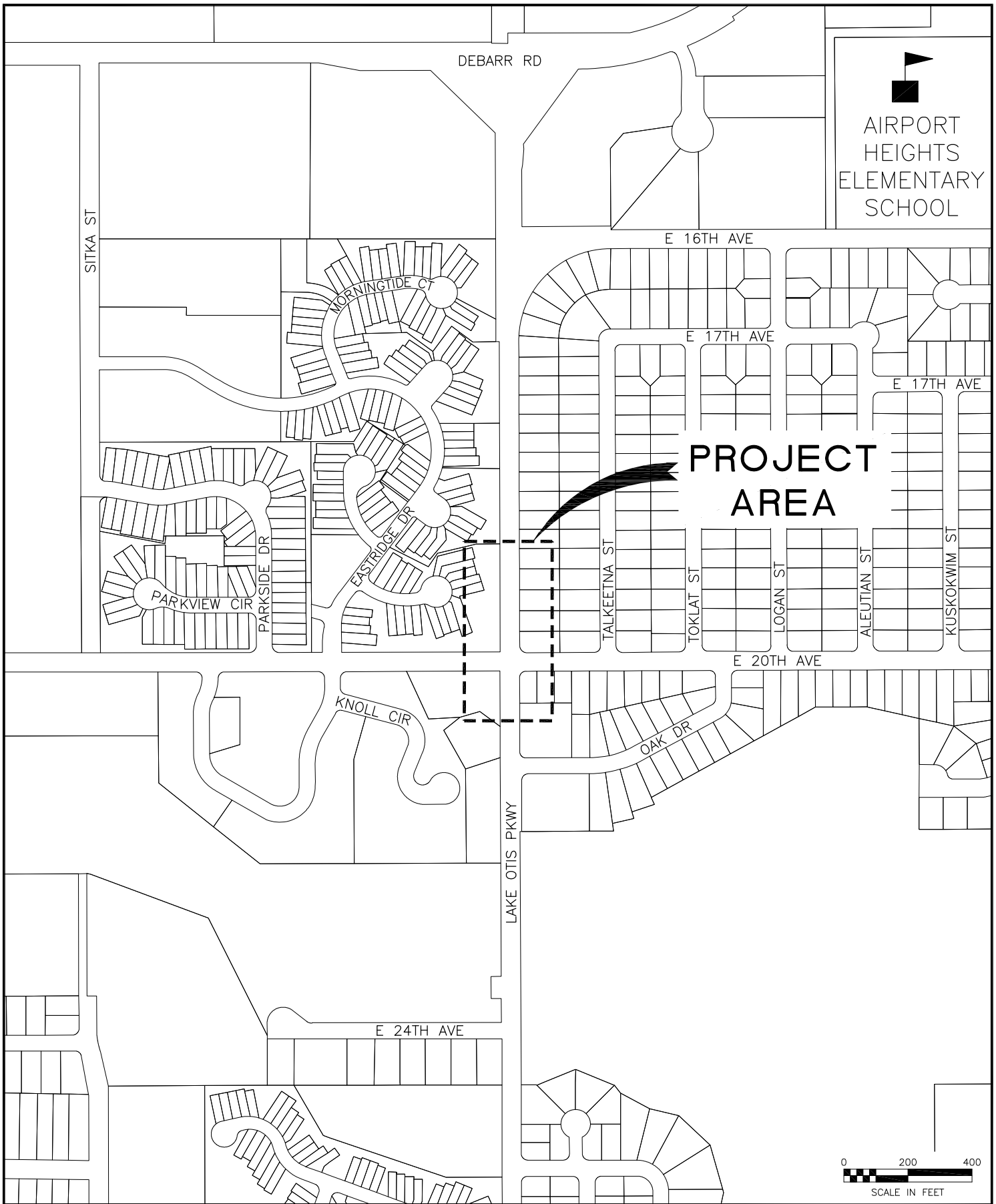
- ENGINEERING
 - SURVEYING
 - PROJECT MANAGEMENT
 - EARTH SCIENCE
 - PLANNING
 - ENVIRONMENTAL
- (907) 564-2120 - ANCHORAGE
(907) 746-5230 - PALMER
WWW.HDLALASKA.COM

**LAKE OTIS AND EAST 20TH AVE SIGNAL EVALUATION
LOCATION AND VICINITY MAP
MUNICIPALITY OF ANCHORAGE
ANCHORAGE, AK**

DATE:	AUGUST 2009	DRAWN BY:	BCY	SHEET:	FIGURE 1
SCALE:	AS SHOWN	CHECKED BY:	AP	JOB NO.:	06-005-56

H:\jobs\06-005 MOA Traffic Design Term\Task 56 Lake Otis & 20th Ave Signal Evaluation\CAD\Drawings\06005_56_fig1_1=1_08/06/09 at 14:58 by bcy
LAYOUT: Figure 1

H:\jobs\06-005 MOA Traffic Design Term\Task 56 Lake Otis & 20th Ave Signal Evaluation\CAD\Drawings\06005_56_fig1_1=1_08/06/09 at 14:58 by bcy LAYOUT: Figure 2



HDL HATTENBURG DILLEY & LINNELL
Engineering Consultants

- ENGINEERING
- SURVEYING
- PROJECT MANAGEMENT
- EARTH SCIENCE
- PLANNING
- ENVIRONMENTAL

(907) 564-2120 - ANCHORAGE
(907) 746-5230 - PALMER
WWW.HDLALASKA.COM

**LAKE OTIS PKWY AND 20TH AVE SIGNAL EVALUATION
AREA MAP
MUNICIPALITY OF ANCHORAGE
ANCHORAGE, AK**

DATE:	AUGUST 2009	DRAWN BY:	BCY
SCALE:	1" = 400'	CHECKED BY:	AP
SHEET:		FIGURE 2	
JOB NO.:		06-005-58	

The intersection has a crash rate of 0.59 crashes per million entering vehicles (MEV) which is lower than the statewide crash rate for four-way signalized intersections of 1.34 crashes per MEV. Of the 24 crashes, nine (37.5%) were left turn crashes and ten (41.7%) were rear end crashes. Of the nine left turn crashes, seven involved southbound vehicles being struck by northbound left turning vehicles and of the ten rear end crashes, seven were in the northbound direction. The left turn and rear end crash type crash percentages are slightly higher than may be expected but of particular note is the directional distribution of the crashes. The higher percentage of left turn crashes is likely a result of left turning vehicles attempting to turn through inadequate gaps as a result of feeling hurried as they block the through movement.

There was one fatal crash at the intersection but it is not directly attributable to deficiencies in the intersection as it involved a DUI and high speed police pursuit.

The intersection geometry of Lake Otis Parkway and 20th Avenue is unlike the geometry at any other intersection along Lake Otis Parkway between Huffman Road and Debarr Road and is not what a driver would typically expect at a four-way, signalized intersection. There is a bulb out at the northeast corner along Lake Otis Parkway that forces northbound vehicles in the outside lane to turn right instead of having an option to drive through the intersection, this forces all through traffic to merge to the inside lane. The existing intersection layout can be seen on **Figure 3**.

Operations

Hattenburg Dilley & Linnell (HDL) conducted traffic counts at the intersection of Lake Otis Parkway and 20th Avenue; the results can be viewed in **Appendix A**. From the counts it was found that the AM Peak Hour is from 7:15 to 8:15 and the PM Peak Hour is from 4:45 to 5:45. HDL also obtained the signal timing information from the MOA Traffic Department. Based on the intersection counts and the signal timing, the existing intersection operation was evaluated using Highway Capacity Software from McTrans. This evaluation provides the Level of Service (LOS) of an intersection. The LOS is a measure of the effectiveness of the traffic signal system rated on a scale of A to F. A LOS of A reflects a condition at which vehicles have free mobility between lanes and can travel at or above the posted speed limit, a traffic signal with a LOS of A will have an intersection delay of ten seconds or less per vehicle. A LOS of F represents a state in which the traffic flow has experienced a forced break down, where vehicles move in lockstep with the vehicles in front of them with frequent slowing or stopping. A traffic signal with LOS F will have an intersection delay of eighty seconds or more per vehicle.

The evaluation at Lake Otis Parkway and 20th Avenue showed that the intersection currently operates at LOS C during the AM Peak Hour with an intersection delay of 21.1 seconds per vehicle. During the PM Peak Hour the

intersection operates at LOS B with an intersection delay of 18.8 seconds per vehicle. The results of the intersection analysis are in **Appendix A**.

Alternative Evaluation

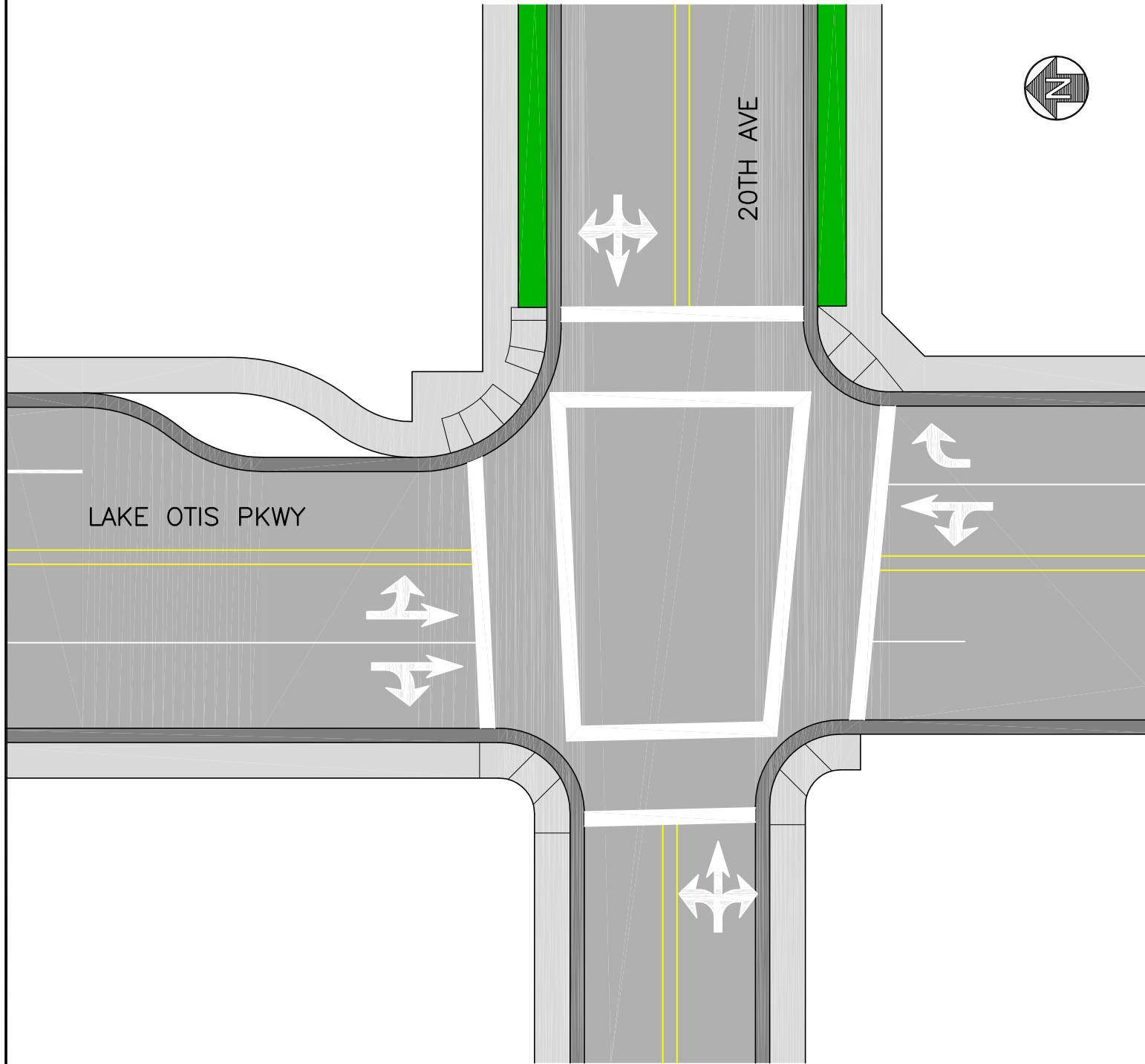
Hattenburg Dilley & Linnell (HDL) has been asked to provide a concise feasibility study to evaluate the operational impacts and provide an estimated construction cost for geometric and signal modifications reduce crashes involving northbound vehicles and improve the signal operations. The proposed intersection geometry is shown on **Figure 3** and the overall proposed geometric modifications are shown on **Figure 4**. The modifications include removing the bulb out at the northeast quadrant of the intersection to allow for continuous through movement along the northbound, outside lane; the inside lane will be restriped as a left only turn lane. The southbound approach will be restriped to include a left turn lane opposite the northbound left turn lane and two through lanes, one of which will be shared with southbound right turning vehicles. This intersection configuration is typical with respect to driver expectations; typical with all other signalized intersections along Lake Otis Parkway; and will eliminate the existing northbound merge to the through left lane.

In order to make an equal comparison of the existing and proposed intersection configurations, traffic signal timing and phasing is being kept the same for both alternatives. The only difference being that with the proposed geometric changes, dual left turns are feasible. Traffic signal analysis shows that the proposed modifications will result in an AM Peak Hour LOS of C with an intersection delay of 27.3 seconds per vehicle. Overall, the intersection LOS will be maintained as a result of the proposed modifications though the overall intersection delay will increase by 6.2 seconds per vehicle. During the PM Peak Hour the intersection will continue to operate at LOS B with an overall intersection delay of 19.7 seconds per vehicle, an increase in delay of 0.9 seconds.

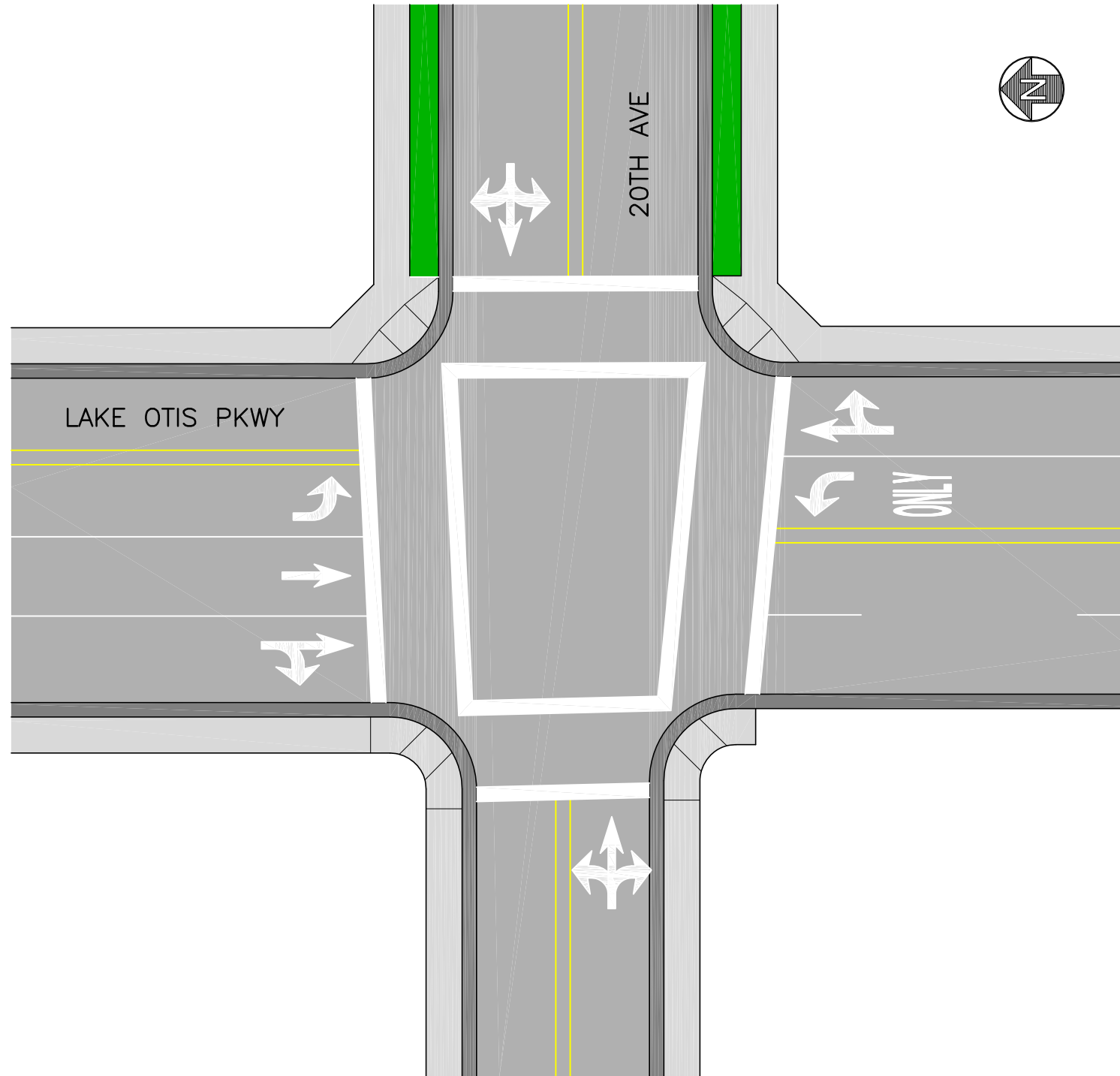
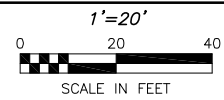
The reason for the increased intersection delay has solely to do with the changes to the northbound approach as through vehicles will share the lane with the right turning vehicles and that there are more right turning vehicles than left. However, the through vehicles will no longer be forced to wait for left turning vehicles to find an adequate gap in traffic to safely turn and the right turning vehicles, while having to slow down; will be able to make a continuous movement without stopping. All other intersection approaches will continue to operate at their existing LOS if not slightly improve.

The major benefit of the channelization modifications at the intersection of Lake Otis Parkway and 20th Avenue will be in crash reduction. As can be seen from the crash experience at this intersection, there is a disproportionate amount of crashes that involve northbound vehicles; 77.8% of all left turn crashes at the intersection involved northbound left turning vehicles being struck by southbound

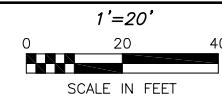
H:\jobs\06-005 MDA Traffic Design Term\Task 56 Lake Otis & 20th Ave Signal Evaluation\CAD\Drawings\06005_56_fig_1=1_08/06/09 at 15:17 by bcy LAYOUT: Layout1 (2)



EXISTING INTERSECTION CONFIGURATION



PROPOSED INTERSECTION CONFIGURATION



FIELD BOOKS	BM NO.	LOCATION	ELEV.	DATA	DRAWN BY	CHECKED BY	DATA	DRAWN BY	CHECKED BY	REV	DATE	DESCRIPTION	BY	REV	DATE	DESCRIPTION	BY	
DESIGN:	NAME		ELEV	BASE			TELEPHONE											
STAKING:				TOPOGRAPHY			ELECTRIC											
ASBUILT:				PROFILE			CABLE TV											
				SANITARY SEWER			DESIGN											
				STORM SEWER			QUANTITIES											
CONTRACTOR:	BASIS OF DATUM:			WATER			MUN. FINAL CHECK											
INSPECTOR:				GAS														
CONSTRUCTION RECORD	VERTICAL DATUM			PLAN CHECK						REVISIONS						SEAL	SEAL	

HDL
HATTENBURG DILLEY & LINNELL
 Engineering Consultants

- ENGINEERING
- SURVEYING
- PROJECT MANAGEMENT
- EARTH SCIENCE
- PLANNING
- ENVIRONMENTAL

3335 Arctic Blvd., Suite 100
 Anchorage, Ak 99503
 (907) 564-2120 www.HDLalaska.com

SEAL



PROJECT MANAGEMENT AND ENGINEERING DEPARTMENT

LAKE OTIS AND 20TH AVE SIGNAL STUDY

FIGURE 3
INTERSECTION CONFIGURATION

SCALE: HOR. 1"=20'
 VER. 1"=NTS

DATE: 5/22/2009
 ACCT. NO.

GRIDS: 1433,1434,1533,1534

SHEET **3** of **4**

FILE NO.-

vehicles and 70% of all rear end crashes were also on the northbound approach. Both of these crash types can be severe with respect to injury, particularly the left turn crashes, five of the nine left turn crashes involved injuries, one of them a major injury. There did not appear to be environmental factors involved in these crashes as there is an even distribution of crashes with respect to environmental conditions (eg. dry or icy roads, light conditions, time of day, time of year). Because environmental factors do not appear to play a role in the high percentage of crashes involving the northbound approach, it can be determined that the primary cause of the crashes is intersection geometrics. As noted previously, this intersection has atypical geometrics that drivers would not expect along a high speed major arterial roadway; especially when considering all other intersections along Lake Otis Parkway. It forces drivers to merge from the outside lane to the inside lane prior to the intersection, merges are typically done on the downstream side of traffic signals, and the merge forces the through traffic into the same stream as left turning vehicles where they may have to suddenly stop or slow drastically. Because of the speed that through vehicles are traveling at, drivers attempting to make left turns will feel rushed and attempt to turn through gaps in southbound traffic that they are not normally comfortable with. The crux of the crash problem is the merge, if it can be eliminated the intersection is expected to see a reduction in crashes. The operations analysis shows that the merge can be eliminated with very little impact to operations.

The one detriment of this project will be the loss of on-street parking along Lake Otis between 20th Avenue and 16th Avenue to the north, it is anticipated that seven parking spots will be lost as a result of the channelization modifications. This will have an immediate impact on the stakeholders that own or lease the first four homes north of 20th Avenue that front Lake Otis Parkway as not all of the lots currently have sufficient off street parking. Two of the homes have driveways that provide access to the back lot of the homes but two only have shallow parking spaces available in the driveway on the front of the house, this will provide parking for two cars on one lot and one on the other. Other household members or guests would have to park further to the north and walk to the homes. It should be noted that on street parking along major arterials outside of a cities central business district is highly unusual and not recommended as an arterials function is to provide mobility and not direct access to properties. While the loss of the parking will be difficult it will also serve as a benefit to the transportation hierarchy within the MOA.

Utilities

There are a significant amount of utilities within the intersection including overhead electric, cable, and telephone. There is a north-south overhead run that parallels Lake Otis Parkway on the east side. Additionally, there are overhead lines that parallel 20th Avenue on both the north and south sides through the intersection. Ideally, the lines would be undergrounded as part of the project but that work is outside the scope of this project and would better suited to future, planned improvements along Lake Otis Parkway between

Northern Lights Boulevard and Debarr Road. It is anticipated that minor relocations will be necessary but the extent cannot be determined until a design survey has been completed.

Right-of-Way

Though the ROW corridor along both Lake Otis Parkway and 20th Avenue is narrow, it isn't anticipated that it will be necessary to acquire additional ROW to complete construction of the project though this can't be fully determined until a design survey has been completed. It will be necessary to acquire Temporary Construction Easements for pole installation and driveway reconstruction from five, possibly six, properties in order to complete the project.

Cost

The estimated cost to modify the intersection is detailed in the **Table 2** below.

Work Description	Cost
Design Cost	\$50,000
Utility Cost	\$30,000
ROW Cost	\$15,000
Construction	\$352,000
Contingency (15%)	\$67,000
Total	\$514,000

Table 2 –Cost Summary

Recommendation

The Municipality of Anchorage has recognized a traffic safety concern at the existing intersection of Lake Otis & 20th Avenue which has a large percentage of angle and rear-end crashes. The existing intersection has the following north and southbound lane configuration:

Northbound: Left-Through Lane
 Right-Only Lane
 Southbound: Left-Through Lane
 Right-Through Lane

On January 21, 2010, HDL and MOA Traffic Department met with the Airport Heights Community Council (AHCC) to discuss the concerns with the existing intersection. HDL presented the findings of the signal evaluation study completed in December, 2009 which proposed one alternative (“Study Alternative”) to improve safety at the intersection. A second meeting was held on February 11, 2010 to gather community input about the proposed improvement from homeowners in the vicinity of Lake Otis and 20th Avenue. Community members present for the second meeting requested that two alternatives be considered in addition to the “Study Alternative”. The two additional alternatives included a “3-Lane Alternative” and a “Dedicated Northbound Right Turn Lane

Alternative". They also requested that split phase timing be evaluated for the new signal. HDL presented an analysis of the three alternatives and the split phasing option at the next AHCC meeting held on February 18, 2010. Community members at the meeting decided that the split timing option was not preferable because it reduced the Level Of Service (LOS) for the intersection and created unwanted delays. Community members also agreed the "Dedicated Northbound Right Turn Lane Alternative" was not preferable because it increases the road width which would require right-of-way acquisition and adversely affected existing houses at the intersection. The residents appeared to be evenly split between the "3-Lane Alternative" and the "Study Alternative". At the end of the meeting the community council voted in favor of a resolution that stated they acknowledge that a safety concern exists with the current configuration of the Lake Otis and 20th intersection and favored the implementation of either the "3-Lane Alternative" or the "Study Alternative" to improve safety at the intersection. The final decision between which of the two alternatives will be implemented was left up to the MOA Traffic Department and their design team. The two alternatives preferred by the Airport Heights community are presented below:

The first alternative was proposed in the signal evaluation study prepared by HDL and dated December 2009. It calls for the removal of the bulb-out in the northeast corner of the intersection and a reconfiguration of the northbound lanes. The "Study Alternative" has the following north and southbound lane configuration:

Northbound: Left-Only Lane
 Through-Right Lane
Southbound: Left-Only Lane
 Through Lane
 Through-Right Lane

This alternative requires modification of the curb line north of the intersection, which would eliminate on-street parking for four existing houses on Lake Otis Parkway. No additional right-of-way would be required.

The "3-Lane Alternative" uses striping to change the existing lane configuration at the intersection and the existing curb line is not modified. The "3-Lane Alternative" has the following north and southbound lane configuration:

Northbound: Left-Only Lane
 Through Lane
 Right-Only Lane
Southbound: Left-Only Lane
 Through-Right Lane

This alternative necks the southbound traffic to one lane south of the intersection which will create more merging traffic. Also, the potential exists that drivers may become confused on snow covered roads in the winter when the new traffic

pattern is not distinguishable by striping. No additional right-of-way would be required for this alternative.

The level of service (LOS) at the intersection is shown below for the two alternatives as well as the existing intersection. Both alternatives have a comparable LOS to the existing intersection. The largest difference is an additional 11 sec delay during the AM Peak for the “3-Lane Alternative” compared to the existing intersection.

	AM Peak		PM Peak	
	LOS	Delay (secs)	LOS	Delay (secs)
Existing	C	21.1	B	18.8
Study	C	27.3	B	19.7
Three Lane	C	32.2	B	17.3

The 2003-2007 crash data for the intersection shows a disproportionate amount of northbound rear-end and northbound left-turn angle crashes. Currently all northbound through traffic must wait if a driver is attempting to make an unprotected left turn. This causes pressure on the driver to make an unprotected left turn through gaps they would otherwise not feel safe to pass through. Both alternatives would lower the number of rear-end and left-turn angle crashes because they alleviate this problem.

The estimated cost to design and construct the “Study Alternative” and the “3-Lane Alternative” are \$514,000 and \$440,000, respectively. The “3-Lane Alternative” will not require any change to the existing curb line which reduces the cost. Both alternatives include intersection signal improvements.

HDL recommends construction of the “Study Alternative”. This alternative will reduce the amount of crashes at the intersection while minimizing the impacts to the existing traffic pattern. The “3-Lane Alternative” is not preferred because of the increased intersection delays and safety risks associated with the additional merging movement in the southbound direction.

Appendix A

Traffic Data



**Municipality of Anchorage
Incident Report**

[Map](#)

Intersection Related: Yes

Date Range: 01/01/2003 - 12/31/2007

Location - Street: LAKE OTIS PARKWAY, ANCHORAGE Cross Street: EAST 20TH AVENUE, ANCHORAGE

Analysis Information

Date	Time	DOW	Peak	Dist	Dir	Street	Cross Reference	1st Seq Events Location	1st Seq Events Type	Lighting	Weather	Roadway Surface	Unit No.	Dir. of Travel	Traffic Control	2nd Sequence of Events	Vehicle Action	Roadway Circumstances	Sex	Age	Human Circum 1	Human Circum 2	Poss. Alc / Drug	Ins	Occupant Type	Restraint / Airbag	Injury Status	Int Related		
01/17/2003	PM 05:14	FRIDAY	PM	0		EAST 20TH AVENUE, ANCHORAGE	LAKE OTIS PARKWAY, ANCHORAGE	Roadway	Sideswipe	Dark, lighted roadway	Rain	Ice	1	West	Traffic control signal	Unk	Turning left	Unk	Unk	Failure to yield	Red light violation	Unk	Unk	Driver	Unknown	None	Related			
													2	East	Unk	Unk	Straight ahead	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
													3	North	Unk	Unk	Stopped	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
12/08/2003	PM 06:47	MONDAY	Off	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Dark, lighted roadway	Cloudy	Ice	1	North	Traffic control signal	Unk	Straight ahead	Unk	Unk	Driver inattention	Unk	Unk	Driver	Unknown	None	Related				
													2	North	Unk	Unk	Slowing	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	Possible	Related				
02/25/2004	AM 11:29	WEDNESDAY	Midday	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Daylight	Clear	Dry	1	North	Traffic control signal	Unk	Straight ahead	Road surface condition	Unk	Following too closely	Unk	Unk	Driver	Unknown	None	Related				
													2	North	Unk	Unk	Skidding	Unk	Unk	Following too closely	Unk	Unk	Driver	Unknown	None	Related				
													3	North	Unk	Vehicle - rear end	Stopped	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
													4	North	Traffic control signal	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Driver	Unknown	None	Related				
07/06/2004	AM 11:38	TUESDAY	Midday	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Daylight	Cloudy	Dry	1	North	Traffic control signal	Unk	Straight ahead	Unk	Unk	Other	Unk	Unk	Driver	Unknown	None	Related				
													2	North	Unk	Unk	Stopped	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
09/02/2004	PM 03:41	THURSDAY	PM	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Sideswipe	Daylight	Cloudy	Dry	1	North	Traffic control signal	Unk	Turning left	Unk	Unk	Failure to yield	Red light violation	Unk	Unk	Driver	Unknown	None	Related			
													2	South	Unk	Unk	Straight ahead	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	Non-incapacitating	Related				
02/19/2005	PM 02:25	SATURDAY		0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Daylight	Clear	Ice	1	North	Traffic control signal	Unk	Skidding	Unk	Unk	Following too closely	Unk	Unk	Driver	Unknown	None	Related				
													2	North	Unk	Unk	Stopped	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
03/28/2005	PM 02:03	MONDAY	Off	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Daylight	Cloudy	Ice	1	South	Traffic control signal	Unk	Skidding	Unk	Unk	Unsafe speed	Unk	Unk	Driver	Unknown	None	Related				
													2	South	Unk	Unk	Stopped	Unk	Unk	No improper driving	Unk	Unk	Driver	Unknown	None	Related				
09/11/2005	PM 04:52	SUNDAY		0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Sideswipe	Daylight	Cloudy	Dry	1	North	Traffic control signal	Unk	Turning left	Unk	Unk	Other	Unk	Unk	Driver	Unknown	None	Related				
													2	South	Unk	Unk	Straight ahead	Unk	Unk	Other	Unk	Unk	Driver	Unknown	None	Related				
	PM					LAKE OTIS	EAST 20TH																							



**Municipality of Anchorage
Incident Report**

[Map](#)

Intersection Related: Yes

Date Range: 01/01/2003 - 12/31/2007

Location - Street: LAKE OTIS PARKWAY, ANCHORAGE Cross Street: EAST 20TH AVENUE, ANCHORAGE

Date	Time	DOW	Peak	Dist	Dir	Street	Cross Reference	1st Seq Events Location	1st Seq Events Type	Lighting	Weather	Roadway Surface	Unit No.	Dir. of Travel	Traffic Control	2nd Sequence of Events	Vehicle Action	Roadway Circumstances	Sex	Age	Human Circum 1	Human Circum 2	Poss. Alc / Drug	Ins	Occupant Type	Restraint / Airbag	Injury Status	Int Related	
09/27/2005	04:12	TUESDAY	PM	0		PARKWAY, ANCHORAGE	AVENUE, ANCHORAGE	Roadway	Sideswipe	Daylight	Cloudy	Dry	2	South	Unk		Straight ahead	Unk	Unk		No improper driving		Unk	Unk	Driver	Unknown	Non-incapacitating	Related	
													3	East	Unk	Unk	Stopped	Unk	Unk		No improper driving		Unk	Unk	Driver	Unknown	None	Related	
10/30/2005	AM 01:18	SUNDAY		0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Sideswipe	Dark, lighted roadway	Cloudy	Dry	1	North	Traffic control signal	Unk	Turning left	Unk	Unk		Red light violation	Alcohol	Unk	Unk	Driver	Unknown	Non-incapacitating	Related	
													2	South	Unk	Unk	Straight ahead	Unk	Unk		No improper driving	Unk	Unk	Driver	Unknown	Non-incapacitating	Related		
11/28/2005	PM 03:51	MONDAY	PM	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Sideswipe	Daylight	Cloudy	Ice	1	North	Traffic control signal	Unk	Turning left	Unk	Unk		Failure to yield	Red light violation	Unk	Unk	Driver	Unknown	None	Related	
													2	South	Unk	Unk	Straight ahead	Unk	Unk		No improper driving	Unk	Unk	Driver	Unknown	Non-incapacitating	Related		
12/10/2005	PM 07:02	SATURDAY		0		EAST 20TH AVENUE, ANCHORAGE	LAKE OTIS PARKWAY, ANCHORAGE	Roadway	Vehicle - angle	Dark, lighted roadway	Cloudy	Ice	1	East	Traffic control signal	Unk	Turning left	Unk	Unk		Improper turn		Unk	Unk	Driver	Unknown	None	Related	
													2	North	Unk	Unk	Straight ahead	Unk	Unk		No improper driving	Unk	Unk	Driver	Unknown	None	Related		
01/11/2006	AM 09:33	WEDNESDAY	Off	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Daylight	Clear	Ice	1	North	Traffic control signal	Unk	Skidding	Road surface condition	Unk		Unsafe speed		Unk	Unk	Driver	Unknown	None	Related	
													2	North	Unk	Unk	Stopped	Road surface condition	Unk		No improper driving	Unk	Unk	Driver	Unknown	None	Related		
01/31/2006	AM 08:11	TUESDAY	AM	0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - angle	Dark, lighted roadway	Cloudy	Ice	1	North	Traffic control signal	Unk	Straight ahead	Unk	Unk		DUI		Both	Unk	Unk	Driver	Unknown	Non-incapacitating	Related
													2	West	Unk		Turning left	Unk	Unk		No improper driving		Unk	Unk	Driver	Unknown	Fatal	Related	
													3	South	Unk	Unk	Slowing	Unk	Unk		No improper driving		Unk	Unk	Driver	Unknown	Possible	Related	
													4	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													5	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													6	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													7	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													8	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													9	Unk	Traffic control signal		Unk	Unk	Unk		Unk		Unk	Unk	Driver	Unknown	None	Related	
													1	South	Traffic control signal	Unk	Skidding	Unk	Unk		Unsafe speed		Unk	Unk	Driver	Unknown	None	Related	



**Municipality of Anchorage
Incident Report**

[Map](#)

Intersection Related: Yes

Date Range: 01/01/2003 - 12/31/2007

Location - Street: LAKE OTIS PARKWAY, ANCHORAGE Cross Street: EAST 20TH AVENUE, ANCHORAGE

Date	Time	DOW	Peak	Dist	Dir	Street	Cross Reference	1st Seq Events Location	1st Seq Events Type	Lighting	Weather	Roadway Surface	Unit No.	Dir. of Travel	Traffic Control	2nd Sequence of Events	Vehicle Action	Roadway Circumstances	Sex	Age	Human Circum 1	Human Circum 2	Poss. Alc / Drug	Ins	Occupant Type	Restraint / Airbag	Injury Status	Int Related
11/04/2007	PM 07:41	SUNDAY		0		LAKE OTIS PARKWAY, ANCHORAGE	EAST 20TH AVENUE, ANCHORAGE	Roadway	Vehicle - rear end	Dark, lighted roadway	Cloudy	Dry	2	South	Traffic control signal	Unk	Turning left	None	F	20	No improper driving		None	N	Driver	A/bag not Dplyd	None	Related
																								Passenger	Lap/Shldr A/bag not Dplyd	Not reported		
																								Passenger	Lap/Shldr	None		
																								Witness	Not Reported	Not reported		
																									Witness	Not Reported	Not reported	

[Excel Download](#)

HDL
Lake Otis & 020
AM Peak

Weather: Rain
Counter: 3025/2200
Counted by: HDL

File Name : Lake Otis & 020_AM_Final
Site Code : 05270901
Start Date : 5/27/2009
Page No : 1

Groups Printed- 1 - Unshifted

Start Time	Lake Otis Southbound						020 Westbound						Lake Otis Northbound						020 Eastbound					
	Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total	
	1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0		
07:00 AM	0	110	1	1	112		0	0	19	0	19		1	63	0	1	65		8	0	2	1	11	
07:15 AM	2	113	0	0	115		5	0	23	0	28		3	107	6	0	116		19	0	5	0	24	
07:30 AM	0	148	0	0	148		4	0	25	0	29		2	87	4	1	94		17	0	5	0	22	
07:45 AM	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Total	3	577	1	2	583		12	1	109	0	122		13	413	11	3	440		70	0	15	2	87	
08:00 AM	0	126	1	0	127		3	0	22	0	25		6	124	3	0	133		14	1	2	0	17	
08:15 AM	0	112	1	0	113		0	0	15	0	15		7	91	3	2	103		14	0	3	0	17	
08:30 AM	0	115	1	0	116		4	1	21	0	26		9	100	3	1	113		10	2	6	0	18	
08:45 AM	0	140	0	0	140		1	0	24	0	25		8	114	6	0	128		16	3	5	0	24	
Total	0	493	3	0	496		8	1	82	0	91		30	429	15	3	477		54	6	16	0	76	
Grand Total	3	1070	4	2	1079		20	2	191	0	213		43	842	26	6	917		124	6	31	2	163	
Approach %	0.3	99.2	0.4	0.2			9.4	0.9	89.7	0.0			4.7	91.8	2.8	0.7			76.1	3.7	19.0	1.2		
Total %	0.1	45.1	0.2	0.1	45.5		0.8	0.1	8.1	0.0	9.0		1.8	35.5	1.1	0.3	38.7		5.2	0.3	1.3	0.1	6.9	

Start Time	Lake Otis Southbound						020 Westbound						Lake Otis Northbound						020 Eastbound					
	Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total		Right	Thru	Left	Peds	App. Total	
	1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0			1.0	1.0	1.0	1.0		
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1	3	593	1	1	598		15	1	112	0	128		18	474	14	2	508		76	1	15	1	93	
Intersection 07:15 AM	0.5	99.2	0.2	0.2			11.7	0.8	87.5	0.0			3.5	93.3	2.8	0.4			81.7	1.1	16.1	1.1		
07:45 Volume	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Peak Factor																								
High Int. 07:45 AM	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Volume	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Peak Factor					0.719						0.696						0.770						0.775	
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1	3	593	1	1	598		15	1	112	0	128		18	474	14	2	508		76	1	15	1	93	
By Approach 07:15 AM	0.5	99.2	0.2	0.2			11.7	0.8	87.5	0.0			3.5	93.3	2.8	0.4			81.7	1.1	16.1	1.1		
Volume	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Percent	0.5	99.2	0.2	0.2			11.7	0.8	87.5	0.0			3.5	93.3	2.8	0.4			81.7	1.1	16.1	1.1		
High Int. 07:45 AM	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Volume	1	206	0	1	208		3	1	42	0	46		7	156	1	1	165		26	0	3	1	30	
Peak Factor					0.719						0.696						0.770						0.775	

HDL
Lake Otis & 020
PM Peak

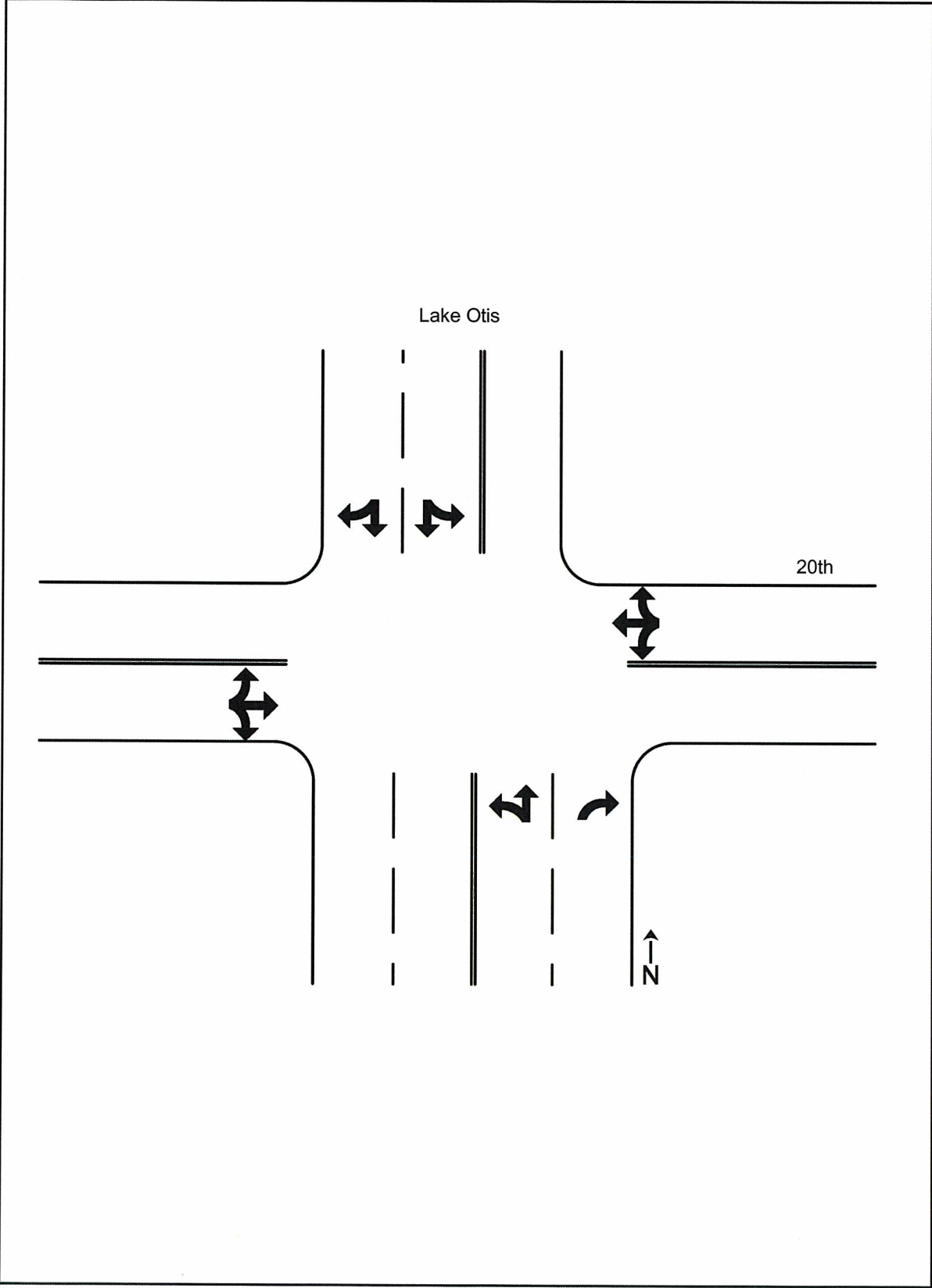
Weather: Rain
Counter: 3025/2200
Counted by: HDL

File Name : Lake Otis & 020_PM_Final
Site Code : 05270903
Start Date : 5/27/2009
Page No : 1

Groups Printed- 1 - Unshifted

Start Time	Lake Otis Southbound						Lake Otis Northbound						020 Westbound						020 Eastbound											
	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor						
	04:00 PM	5	149	2	0	156	1.0	3	0	14	0	17	1.0	20	163	13	0	196	1.0	13	1	3	0	17	1.0	13	1	3	0	196
04:15 PM	2	176	2	0	180	1.0	1	0	16	2	19	1.0	30	193	8	2	233	1.0	30	0	1	0	4	1.0	30	0	1	0	4	1.0
04:30 PM	7	178	1	1	187	1.0	2	2	17	3	24	1.0	30	151	12	0	193	1.0	13	2	2	1	18	1.0	13	2	2	1	18	1.0
04:45 PM	4	174	1	2	181	1.0	1	0	23	1	25	1.0	31	200	13	3	247	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0
Total	18	677	6	3	704	1.0	7	2	70	6	85	1.0	111	707	46	5	869	1.0	39	7	10	1	57	1.0	39	7	10	1	57	1.0
05:00 PM	5	219	4	3	231	1.0	2	1	23	0	26	1.0	49	195	19	0	263	1.0	12	0	3	1	16	1.0	12	0	3	1	16	1.0
05:15 PM	3	201	8	0	212	1.0	7	3	23	1	34	1.0	31	188	15	2	236	1.0	10	1	1	0	12	1.0	10	1	1	0	12	1.0
05:30 PM	10	203	3	2	218	1.0	3	1	24	2	30	1.0	38	195	15	2	250	1.0	7	4	4	0	15	1.0	7	4	4	0	15	1.0
05:45 PM	5	149	7	0	161	1.0	4	0	21	0	25	1.0	37	183	13	0	233	1.0	14	2	3	0	19	1.0	14	2	3	0	19	1.0
Total	23	772	22	5	822	1.0	16	5	91	3	115	1.0	155	761	62	4	982	1.0	43	7	11	1	62	1.0	43	7	11	1	62	1.0
Grand Total	41	1449	28	8	1526	1.0	23	7	161	9	200	1.0	266	1468	108	9	1851	1.0	82	14	21	2	119	1.0	82	14	21	2	119	1.0
Approach Total %	2.7	95.0	1.8	0.5	41.3	1.1	11.5	3.5	80.5	4.5	5.4	7.2	14.4	79.3	5.8	0.5	50.1	2.2	68.9	11.8	17.6	1.7	3.2	0.4	2.2	0.4	0.6	0.1	0.1	0.1

Start Time	Lake Otis Southbound						Lake Otis Northbound						020 Westbound						020 Eastbound											
	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor	Right	Thru	Left	Peds	App. Total	Factor						
	04:00 PM	22	797	16	7	842	1.0	13	5	93	4	115	1.0	149	778	62	7	996	1.0	39	9	12	1	61	1.0	39	9	12	1	61
05:00 PM	2.6	94.7	1.9	0.8	231	1.0	11.3	4.3	80.9	3.5	26	15.0	78.1	6.2	0.7	263	1.0	63.9	14.8	19.7	1.6	16	0.939	63.9	14.8	19.7	1.6	16	0.939	
Peak Factor	5	219	4	3	231	1.0	2	1	23	0	26	1.0	49	195	19	0	263	1.0	12	0	3	1	16	1.0	12	0	3	1	16	1.0
High Int. Volume	5	219	4	3	231	1.0	7	3	23	1	34	1.0	49	195	19	0	263	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0
Peak Factor	5	219	4	3	231	1.0	7	3	23	1	34	1.0	49	195	19	0	263	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1	22	797	16	7	842	1.0	13	5	93	4	115	1.0	149	778	62	7	996	1.0	39	9	12	1	61	1.0	39	9	12	1	61	1.0
By Approach	2.6	94.7	1.9	0.8	231	1.0	11.3	4.3	80.9	3.5	26	15.0	78.1	6.2	0.7	263	1.0	63.9	14.8	19.7	1.6	16	0.939	63.9	14.8	19.7	1.6	16	0.939	
Volume	5	219	4	3	231	1.0	7	3	23	1	34	1.0	49	195	19	0	263	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0
Percent	2.6	94.7	1.9	0.8	231	1.0	11.3	4.3	80.9	3.5	26	15.0	78.1	6.2	0.7	263	1.0	63.9	14.8	19.7	1.6	16	0.939	63.9	14.8	19.7	1.6	16	0.939	
High Int. Volume	5	219	4	3	231	1.0	7	3	23	1	34	1.0	49	195	19	0	263	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0
Peak Factor	5	219	4	3	231	1.0	7	3	23	1	34	1.0	49	195	19	0	263	1.0	10	4	4	0	18	1.0	10	4	4	0	18	1.0



HCS+: Signalized Intersections Release 5.4

Analyst: Alex Prosak, P.E. Inter.: Lake Otis & 20th
 Agency: HDL Area Type: All other areas
 Date: 12/31/2009 Jurisd: MOA
 Period: AM Peak (7:15 to 8:15) Year : 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	1	0	2	0
LGConfig	LTR			LTR			LT R			LTR		
Volume	15	1	76	112	1	15	14	474	18	1	593	3
Lane Width	12.0			12.0			12.0 12.0			12.0		
RTOR Vol	38			5			9			0		

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left		P			NB Left	P	P	
Thru		P			Thru	P	P	
Right		P			Right		P	
Peds					Peds			
WB Left		P			SB Left		P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	26.7	0.0			10.0	32.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 80.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios		Lane Group		Approach	
			v/c	g/C	Delay	LOS	Delay	LOS
Eastbound								
LTR	505	1514	0.14	0.33	19.2	B	19.2	B
Westbound								
LTR	413	1238	0.40	0.33	23.4	C	23.4	C
Northbound								
LT	841	1793	0.78	0.54	22.1	C	22.0	C
R	628	1526	0.02	0.41	14.0	B		
Southbound								
LTR	1368	3327	0.59	0.41	20.2	C	20.2	C

Intersection Delay = 21.1 (sec/veh) Intersection LOS = C

Phone: Fax:
 E-Mail:

 OPERATIONAL ANALYSIS

Analyst: Alex Prosak, P.E.
 Agency/Co.: HDL
 Date Performed: 12/31/2009
 Analysis Time Period: AM Peak (7:15 to 8:15)
 Intersection: Lake Otis & 20th
 Area Type: All other areas
 Jurisdiction: MOA
 Analysis Year: 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

 VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	15	1	76	112	1	15	14	474	18	1	593	3
% Heavy Veh	2	2	2	2	2	2	2	2	2	2	2	2
PHF	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
PK 15 Vol	5	1	26	38	1	5	5	160	6	1	200	1
Hi Ln Vol												
% Grade		-3			1			2			-2	
Ideal Sat		1850			1850			1850	1850		1850	
ParkExist												
NumPark												
No. Lanes	0	1	0	0	1	0	0	1	1	0	2	0
LGConfig		LTR			LTR			LT R			LTR	
Lane Width		12.0			12.0			12.0 12.0			12.0	
RTOR Vol			38			5			9			0
Adj Flow		72			166			660 12			806	
%InSharedLn												
Prop LTs		0.278			0.910			0.029			0.001	
Prop RTs		0.708			0.084			0.000 1.000			0.005	
Peds Bikes	1			0			2			1		
Buses		0			0			0	0		0	
%InProtPhase							0.0					
Duration	0.25											
				Area Type: All other areas								

 OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0			0.0			0.0 0.0			0.0	
Arriv. Type		3			3			3 3			3	
Unit Ext.		3.0			3.0			3.0 3.0			3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time		2.0			2.0			2.0 2.0			2.0	
Ext of g		2.0			2.0			2.0 2.0			2.0	
Ped Min g		3.2			3.2			3.2			3.2	

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
EB Left	P					NB Left	P	P	
Thru	P					Thru	P	P	
Right	P					Right		P	
Peds						Peds			
WB Left	P					SB Left		P	
Thru	P					Thru		P	
Right	P					Right		P	
Peds						Peds			
NB Right						EB Right			
SB Right						WB Right			
Green	26.7	0.0				10.0	32.9	0.0	
Yellow	3.0					0.0	3.6		
All Red	2.3					0.0	1.5		

Cycle Length: 80.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	15	1	76	112	1	15	14	474	18	1	593	3
PHF	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Adj flow	20	1	51	151	1	14	19	641	12	1	801	4
No. Lanes	0	1	0	0	1	0	0	1	1	0	2	0
Lane group	LTR			LTR			LT		R	LTR		
Adj flow	72			166			660		12	806		
Prop LTs	0.278			0.910			0.029			0.001		
Prop RTs	0.708			0.084			0.000		1.000	0.005		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound		Southbound		
LG	LTR			LTR			LT	R	LTR		
So	1850			1850			1850	1850	1850		
Lanes 0	1	0	0	1	0	0	1	1	0	2	0
fW	1.000			1.000			1.000	1.000	1.000		
fHV	0.980			0.980			0.980	0.980	0.980		
fG	1.015			0.995			0.990	0.990	1.010		
fP	1.000			1.000			1.000	1.000	1.000		
fBB	1.000			1.000			1.000	1.000	1.000		
fA	1.000			1.000			1.000	1.000	1.000		
fLU	1.000			1.000			1.000	1.000	0.952		
fRT	0.904			0.989			1.000	0.850	0.999		
fLT	0.909			0.694			0.999		0.955		
Sec.							0.857				
fLpb	1.000			1.000			1.000		1.000		
fRpb	1.000			1.000			1.000	1.000	1.000		
S	1514			1238			1793	1526	3327		
Sec.							1538				

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	72	1514	0.05	0.33	505	0.14
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	166	1238	# 0.13	0.33	413	0.40
Right							
Northbound							
Prot							
Perm							
Left							
Prot		110	1793	# 0.06	0.061	110	1.00
Perm		550	1538	# 0.36	0.475	731	0.75
Thru	LT	660			0.54	841	0.78
Right	R	12	1526	0.01	0.41	628	0.02
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	806	3327	0.24	0.41	1368	0.59
Right							

Sum of flow ratios for critical lane groups, $Yc = \text{Sum (v/s)} = 0.55$
Total lost time per cycle, $L = 10.40 \text{ sec}$
Critical flow rate to capacity ratio, $Xc = (Yc)(C)/(C-L) = 0.64$

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios		Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group		Approach	
	v/c	g/C							Delay	LOS	Delay	LOS
Eastbound												
LTR	0.14	0.33	18.6	1.000	505	0.50	0.6	0.0	19.2	B	19.2	B
Westbound												
LTR	0.40	0.33	20.5	1.000	413	0.50	2.9	0.0	23.4	C	23.4	C
Northbound												
LT	0.78	0.54	14.9	1.000	841	0.50	7.3	0.0	22.1	C	22.0	C
R	0.02	0.41	14.0	1.000	628	0.50	0.1	0.0	14.0	B		
Southbound												
LTR	0.59	0.41	18.3	1.000	1368	0.50	1.9	0.0	20.2	C	20.2	C

Intersection delay = 21.1 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET

for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT				
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET

for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C				
Total actual green time for LT lane group, G (s)	26.7	26.7	42.9	32.9
Effective permitted green time for LT lane group, g(s)	26.7	26.7	38.0	32.9
Opposing effective green time, go (s)	26.7	26.7	32.9	42.9
Number of lanes in LT lane group, N	1	1	1	2

Number of lanes in opposing approach, No	1	1	2	1
Adjusted LT flow rate, VLT (veh/h)	20	151	19	1
Proportion of LT in LT lane group, PLT	0.278	0.910	0.029	0.001
Proportion of LT in opposing flow, PLTo	0.91	0.28	0.00	0.03
Adjusted opposing flow rate, Vo (veh/h)	166	72	806	660
Lost time for LT lane group, tL	5.30	5.30	5.10	5.10
Computation				
LT volume per cycle, LTC=VLTC/3600	0.44	3.36	0.42	0.02
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	3.69	1.60	9.41	14.67
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g	10.6	0.0	10.5	26.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.00	1.00
Opposing Queue Ratio, gro=Max[1-Rpo(go/C),0]	0.67	0.67	0.59	0.46
gq, (see Exhibit C16-4,5,6,7,8)	3.39	0.00	14.48	6.38
gu=g-gq if gq>=gf, or = g-gf if gq<gf	16.07	26.70	23.52	6.94
n=Max(gq-gf)/2,0)	0.00	0.00	2.01	0.00
PTHo=1-PLTo	0.09	0.72	1.00	0.97
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.28	0.91	0.03	0.00
EL1 (refer to Exhibit C16-3)	1.64	1.49	3.22	2.69
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.00	2.01	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.10	0.14	0.05	0.06
gdifff=max(gq-gf,0)	0.00	0.00	4.03	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.91	0.69	0.86	1.00
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdifff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.909	0.694	0.857	0.955

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

_____SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_____

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
 OCCr
 Number of cross-street receiving lanes, Nrec
 Number of turning lanes, Nturn
 ApbT
 Proportion right-turns, PRT
 Proportion right-turns using protected phase, PRTA
 Right turn adjustment, fRpb

-----SUPPLEMENTAL UNIFORM DELAY WORKSHEET-----

	EBLT	WBLT	NBLT	SBLT
Cycle length, C	80.0			
Adj. LT vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Protected phase effective green interval, g (s)				
Opposing queue effective green interval, gq				
Unopposed green interval, gu				
Red time $r=(C-g-gq-gu)$				
Arrival rate, $qa=v/(3600(\max[X,1.0]))$				
Protected ph. departure rate, $Sp=s/3600$				
Permitted ph. departure rate, $Ss=s(gq+gu)/(gu*3600)$				
XPerm				
XProt				
Case				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, d1				

-----DELAY/LOS WORKSHEET WITH INITIAL QUEUE-----

Appr/ Lane Group	Initial	Dur.	Uniform Delay		Initial	Final	Initial	Lane
	Unmet Demand Q veh	Unmet Demand t hrs.	Unadj. ds	Adj. d1 sec	Queue Param. u	Unmet Demand Q veh	Queue Delay d3 sec	Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	26.6	18.6	0.00	0.0	0.0	19.2
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	26.6	20.5	0.00	0.0	0.0	23.4
	0.0						0.0	
Northbound								
	0.0						0.0	
LT	0.0	0.00	18.5	14.9	0.00	0.0	0.0	22.1
R	0.0	0.00	23.5	14.0	0.00	0.0	0.0	14.0
Southbound								
	0.0						0.0	
LTR	0.0	0.00	23.5	18.3	0.00	0.0	0.0	20.2
	0.0						0.0	

Intersection Delay	21.1	sec/veh	Intersection LOS	C
--------------------	------	---------	------------------	---

	Eastbound		Westbound		Northbound		Southbound	
LaneGroup	LTR		LTR		LT	R	LTR	
Init Queue	0.0		0.0		0.0	0.0	0.0	
Flow Rate	72		166		660	12	423	
So	1850		1850		1850	1850	1850	
No.Lanes	0	1	0	1	0	1	1	0
SL	1514		1238		1567	1526	1747	
LnCapacity	505		413		841	628	718	
Flow Ratio	0.0		0.1		0.4	0.0	0.2	
v/c Ratio	0.14		0.40		0.78	0.02	0.59	
Grn Ratio	0.33		0.33		0.54	0.41	0.41	
I Factor	1.000		1.000		1.000		1.000	
AT or PVG	3		3		3	3	3	
Pltn Ratio	1.00		1.00		1.00	1.00	1.00	
PF2	1.00		1.00		1.00	1.00	1.00	
Q1	1.1		2.8		7.1	0.2	7.3	
kB	0.7		0.6		0.9	0.8	0.8	
Q2	0.1		0.4		3.0	0.0	1.2	
Q Average	1.2		3.2		10.1	0.2	8.5	
Q Spacing	25.0		25.0		25.0	25.0	25.0	
Q Storage	0		0		0	0	0	
Q S Ratio								
70th Percentile Output:								
fB%	1.3		1.3		1.2	1.3	1.2	
BOQ	1.6		4.0		12.3	0.2	10.3	
QSRatio								
85th Percentile Output:								
fB%	1.6		1.6		1.4	1.7	1.5	
BOQ	2.0		5.0		14.6	0.3	12.3	
QSRatio								
90th Percentile Output:								
fB%	1.9		1.8		1.6	2.0	1.6	
BOQ	2.3		5.7		15.9	0.3	13.5	
QSRatio								
95th Percentile Output:								
fB%	2.4		2.1		1.7	2.6	1.8	
BOQ	2.9		6.8		17.6	0.4	15.1	
QSRatio								
98th Percentile Output:								
fB%	2.9		2.5		1.9	3.1	2.0	
BOQ	3.5		8.0		19.2	0.5	16.7	
QSRatio								

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst: Alex Prosak, P.E. Inter.: Lake Otis & 20th
 Agency: HDL Area Type: All other areas
 Date: 12/31/2009 Jurisd: MOA
 Period: PM Peak (4:45 to 5:45) Year : 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	0	1	1	0	2	0
LGConfig	LTR			LTR			LT R			LTR		
Volume	12	9	39	93	5	13	62	778	149	16	797	22
Lane Width	12.0			12.0			12.0 12.0			12.0		
RTOR Vol	19			2			74			1		

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left		P			NB Left	P	P	
Thru		P			Thru	P	P	
Right		P			Right		P	
Peds					Peds			
WB Left		P			SB Left		P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	27.7	0.0			10.0	111.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 160.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios		Lane Group		Approach	
			v/c	g/C	Delay	LOS	Delay	LOS
Eastbound								
LTR	271	1565	0.16	0.17	57.6	E	57.6	E
Westbound								
LTR	228	1318	0.51	0.17	67.9	E	67.9	E
Northbound								
LT	1079	1789	0.83	0.76	19.7	B	18.7	B
R	1067	1526	0.07	0.70	7.8	A		
Southbound								
LTR	2250	3217	0.39	0.70	10.5	B	10.5	B

Intersection Delay = 18.8 (sec/veh) Intersection LOS = B

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P				NB Left	P	P	
Thru	P				Thru	P	P	
Right	P				Right		P	
Peds					Peds			
WB Left	P				SB Left		P	
Thru	P				Thru		P	
Right	P				Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	27.7	0.0			10.0	111.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 160.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	12	9	39	93	5	13	62	778	149	16	797	22
PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj flow	13	10	21	99	5	12	66	828	80	17	848	22
No. Lanes	0	1	0	0	1	0	0	1	1	0	2	0
Lane group	LTR			LTR			LT		R	LTR		
Adj flow	44			116			894		80	887		
Prop LTs	0.295			0.853			0.074			0.019		
Prop RTs	0.477			0.103			0.000		1.000	0.025		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound		Southbound		
LG	LTR			LTR			LT	R	LTR		
So	1850			1850			1850	1850	1850		
Lanes 0	1	0	0	1	0	0	1	1	0	2	0
fW	1.000			1.000			1.000	1.000	1.000		
fHV	0.980			0.980			0.980	0.980	0.980		
fG	1.015			0.995			0.990	0.990	1.010		
fP	1.000			1.000			1.000	1.000	1.000		
fBB	1.000			1.000			1.000	1.000	1.000		
fA	1.000			1.000			1.000	1.000	1.000		
fLU	1.000			1.000			1.000	1.000	0.952		
fRT	0.936			0.986			1.000	0.850	0.996		
fLT	0.909			0.740			0.996		0.926		
Sec.							0.780				
fLpb	1.000			1.000			1.000		1.000		
fRpb	1.000			1.000			1.000	1.000	1.000		
S	1565			1318			1789	1526	3217		
Sec.							1400				

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	44	1565	0.03	0.17	271	0.16
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	116	1318	# 0.09	0.17	228	0.51
Right							
Northbound							
Prot							
Perm							
Left							
Prot		55	1789	# 0.03	0.031	55	1.00
Perm		839	1400	# 0.60	0.731	1024	0.82
Thru	LT	894			0.76	1079	0.83
Right	R	80	1526	0.05	0.70	1067	0.07
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	887	3217	0.28	0.70	2250	0.39
Right							

Sum of flow ratios for critical lane groups, $Yc = \text{Sum (v/s)} = 0.72$
Total lost time per cycle, $L = 10.40 \text{ sec}$
Critical flow rate to capacity ratio, $Xc = (Yc)(C)/(C-L) = 0.77$

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios		Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group		Approach	
	v/c	g/C							Delay	LOS	Delay	LOS
Eastbound												
LTR	0.16	0.17	56.3	1.000	271	0.50	1.3	0.0	57.6	E	57.6	E
Westbound												
LTR	0.51	0.17	60.0	1.000	228	0.50	7.9	0.0	67.9	E	67.9	E
Northbound												
LT	0.83	0.76	12.3	1.000	1079	0.50	7.4	0.0	19.7	B	18.7	B
R	0.07	0.70	7.6	1.000	1067	0.50	0.1	0.0	7.8	A		
Southbound												
LTR	0.39	0.70	10.0	1.000	2250	0.50	0.5	0.0	10.5	B	10.5	B

Intersection delay = 18.8 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET

for exclusive lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C				
Total actual green time for LT lane group, G (s)				
Effective permitted green time for LT lane group, g(s)				
Opposing effective green time, go (s)				
Number of lanes in LT lane group, N				
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT				
Proportion of LT in opposing flow, PLTo				
Adjusted opposing flow rate, Vo (veh/h)				
Lost time for LT lane group, tL				
Computation				
LT volume per cycle, LTC=VLTC/3600				
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)				
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g				
Opposing platoon ratio, Rpo (refer Exhibit 16-11)				
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]				
gq, (see Exhibit C16-4,5,6,7,8)				
gu=g-gq if gq>=gf, or = g-gf if gq<gf				
n=Max(gq-gf)/2,0)				
PTHo=1-PLTo				
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]				
EL1 (refer to Exhibit C16-3)				
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g				
gdiff=max(gq-gf,0)				
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)				
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT				

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET

for shared lefts

Input

	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C				
Total actual green time for LT lane group, G (s)	27.7	27.7	121.9	111.9
Effective permitted green time for LT lane group, g(s)	27.7	27.7	117.0	111.9
Opposing effective green time, go (s)	27.7	27.7	111.9	121.9
Number of lanes in LT lane group, N	1	1	1	2

Number of lanes in opposing approach, No	1	1	2	1
Adjusted LT flow rate, VLT (veh/h)	13	99	66	17
Proportion of LT in LT lane group, PLT	0.295	0.853	0.074	0.019
Proportion of LT in opposing flow, PLTo	0.85	0.30	0.02	0.07
Adjusted opposing flow rate, Vo (veh/h)	116	44	887	894
Lost time for LT lane group, tL	5.30	5.30	5.10	5.10
Computation				
LT volume per cycle, LTC=VLTC/3600	0.58	4.40	2.93	0.76
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	5.16	1.96	20.70	39.73
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g	9.8	0.0	6.6	49.3
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.00	1.00
Opposing Queue Ratio, gro=Max[1-Rpo(go/C),0]	0.83	0.83	0.30	0.24
gq, (see Exhibit C16-4,5,6,7,8)	8.80	1.44	16.80	22.50
gu=g-gq if gq>=gf, or = g-gf if gq<gf	17.93	26.26	100.20	
n=Max(gq-gf)/2,0)	0.00	0.72	5.10	0.00
PTHo=1-PLTo	0.15	0.70	0.98	0.93
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.30	0.85	0.07	0.05
EL1 (refer to Exhibit C16-3)	1.56	1.44	3.50	3.37
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.00	4.90	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.09	0.13	0.02	0.02
gdifff=max(gq-gf,0)	0.00	1.44	10.19	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.91	0.74	0.78	0.94
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdifff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00) or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.909	0.740	0.780	0.926

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.
For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

_____SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_____

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
 OCCr
 Number of cross-street receiving lanes, Nrec
 Number of turning lanes, Nturn
 ApbT
 Proportion right-turns, PRT
 Proportion right-turns using protected phase, PRPA
 Right turn adjustment, fRpb

-----SUPPLEMENTAL UNIFORM DELAY WORKSHEET-----

	EBLT	WBLT	NBLT	SBLT
Cycle length, C	160.0			
Adj. LT vol from Vol Adjustment Worksheet, v				
v/c ratio from Capacity Worksheet, X				
Protected phase effective green interval, g (s)				
Opposing queue effective green interval, gq				
Unopposed green interval, gu				
Red time $r=(C-g-gq-gu)$				
Arrival rate, $qa=v/(3600(\max[X,1.0]))$				
Protected ph. departure rate, $Sp=s/3600$				
Permitted ph. departure rate, $Ss=s(gq+gu)/(gu*3600)$				
XPerm				
XProt				
Case				
Queue at beginning of green arrow, Qa				
Queue at beginning of unsaturated green, Qu				
Residual queue, Qr				
Uniform Delay, dl				

-----DELAY/LOS WORKSHEET WITH INITIAL QUEUE-----

Appr/ Lane Group	Initial	Dur.	Uniform Delay		Initial	Final	Initial	Lane
	Unmet Demand Q veh	Unmet Demand t hrs.	Unadj. ds	Adj. dl sec	Queue Param. u	Unmet Demand Q veh	Queue Delay d3 sec	Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	66.2	56.3	0.00	0.0	0.0	57.6
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	66.2	60.0	0.00	0.0	0.0	67.9
	0.0						0.0	
Northbound								
	0.0						0.0	
LT	0.0	0.00	19.1	12.3	0.00	0.0	0.0	19.7
R	0.0	0.00	24.0	7.6	0.00	0.0	0.0	7.8
Southbound								
	0.0						0.0	
LTR	0.0	0.00	24.0	10.0	0.00	0.0	0.0	10.5
	0.0						0.0	

Intersection Delay	18.8	sec/veh	Intersection LOS	B
--------------------	------	---------	------------------	---

	Eastbound		Westbound		Northbound		Southbound	
LaneGroup	LTR		LTR		LT	R	LTR	
Init Queue	0.0		0.0		0.0	0.0	0.0	
Flow Rate	44		116		894	80	465	
So	1850		1850		1850	1850	1850	
No.Lanes	0	1 0	0	1 0	0	1 1	0	2 0
SL	1565		1318		1415	1526	1689	
LnCapacity	271		228		1079	1067	1181	
Flow Ratio	0.0		0.1		0.6	0.1	0.3	
v/c Ratio	0.16		0.51		0.83	0.07	0.39	
Grn Ratio	0.17		0.17		0.76	0.70	0.70	
I Factor	1.000		1.000		1.000		1.000	
AT or PVG	3		3		3	3	3	
Pltn Ratio	1.00		1.00		1.00	1.00	1.00	
PF2	1.00		1.00		1.00	1.00	1.00	
Q1	1.7		4.7		9.7	1.1	8.6	
kB	0.7		0.6		1.8	1.8	1.9	
Q2	0.1		0.6		6.7	0.1	1.2	
Q Average	1.8		5.3		16.4	1.3	9.8	
Q Spacing	25.0		25.0		25.0	25.0	25.0	
Q Storage	0		0		0	0	0	
Q S Ratio								
70th Percentile Output:								
fB%	1.3		1.2		1.2	1.3	1.2	
BOQ	2.3		6.5		19.8	1.6	11.9	
QSRatio								
85th Percentile Output:								
fB%	1.6		1.5		1.4	1.6	1.4	
BOQ	2.9		7.9		23.2	2.1	14.1	
QSRatio								
90th Percentile Output:								
fB%	1.8		1.7		1.5	1.9	1.6	
BOQ	3.3		8.8		25.0	2.4	15.4	
QSRatio								
95th Percentile Output:								
fB%	2.3		1.9		1.6	2.4	1.7	
BOQ	4.1		10.3		26.9	3.0	17.1	
QSRatio								
98th Percentile Output:								
fB%	2.7		2.2		1.8	2.9	1.9	
BOQ	4.9		11.7		28.9	3.6	18.7	
QSRatio								

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst: Alex Prosak, P.E. Inter.: Lake Otis & 20th
 Agency: HDL Area Type: All other areas
 Date: 12/31/2009 Jurisd: MOA
 Period: AM Peak (7:15 to 8:15) Year : 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
LGConfig	LTR			LTR			L	TR		L	TR	
Volume	15	1	76	112	1	15	14	474	18	1	593	3
Lane Width	12.0			12.0			12.0	12.0		12.0	12.0	
RTOR Vol	38			5			0			0		

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left		P			NB Left	P	P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
WB Left		P			SB Left	P	P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	26.7	0.0			10.0	32.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 80.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios		Lane Group		Approach	
			v/c	g/C	Delay	LOS	Delay	LOS
Eastbound								
LTR	505	1514	0.14	0.33	19.2	B	19.2	B
Westbound								
LTR	413	1238	0.40	0.33	23.4	C	23.4	C
Northbound								
L	408	1752	0.05	0.60	8.0	A		
TR	734	1786	0.91	0.41	39.0	D	38.1	D
Southbound								
L	324	1787	0.00	0.60	11.2	B		
TR	1433	3485	0.56	0.41	19.6	B	19.6	B

Intersection Delay = 27.3 (sec/veh) Intersection LOS = C

Phone:
E-Mail:

Fax:

OPERATIONAL ANALYSIS

Analyst: Alex Prosak, P.E.
 Agency/Co.: HDL
 Date Performed: 12/31/2009
 Analysis Time Period: AM Peak (7:15 to 8:15)
 Intersection: Lake Otis & 20th
 Area Type: All other areas
 Jurisdiction: MOA
 Analysis Year: 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	15	1	76	112	1	15	14	474	18	1	593	3
% Heavy Veh	2	2	2	2	2	2	2	2	2	2	2	2
PHF	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
PK 15 Vol	5	1	26	38	1	5	5	160	6	1	200	1
Hi Ln Vol												
% Grade		-3			1			2			-2	
Ideal Sat		1850			1850		1900	1850		1900	1850	
ParkExist												
NumPark												
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
LGConfig		LTR			LTR		L	TR		L	TR	
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			38			5			0			0
Adj Flow		72			166		19	665		1	805	
%InSharedLn												
Prop LTs		0.278			0.910		1.000	0.000		1.000	0.000	
Prop RTs		0.708			0.084			0.036			0.005	
Peds Bikes	1			0			2			1		
Buses		0			0		0	0		0	0	
%InProtPhase							0.0			0.0		
Duration	0.25											
				Area Type: All other areas								

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0			0.0		0.0	0.0		0.0	0.0	
Arriv. Type		3			3		3	3		3	3	
Unit Ext.		3.0			3.0		3.0	3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time		2.0			2.0		2.0	2.0		2.0	2.0	
Ext of g		2.0			2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.2			3.2			3.2			3.2	

PHASE DATA

Phase Combination	1	2	3	4		5	6	7	8
EB Left	P				NB Left	P	P		
Thru	P				Thru		P		
Right	P				Right		P		
Peds					Peds				
WB Left	P				SB Left	P	P		
Thru	P				Thru		P		
Right	P				Right		P		
Peds					Peds				
NB Right					EB Right				
SB Right					WB Right				
Green	26.7	0.0				10.0	32.9	0.0	
Yellow	3.0					0.0	3.6		
All Red	2.3					0.0	1.5		

Cycle Length: 80.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	15	1	76	112	1	15	14	474	18	1	593	3
PHF	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Adj flow	20	1	51	151	1	14	19	641	24	1	801	4
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
Lane group	LTR			LTR			L	TR		L	TR	
Adj flow	72			166			19	665		1	805	
Prop LTs	0.278			0.910			1.000 0.000			1.000 0.000		
Prop RTs	0.708			0.084			0.036			0.005		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	LTR			LTR			L	TR		L	TR	
So	1850			1850			1900	1850		1900	1850	
Lanes 0	1	0	0	1	0	0	1	1	0	1	2	0
fW	1.000			1.000			1.000 1.000			1.000 1.000		
fHV	0.980			0.980			0.980 0.980			0.980 0.980		
fG	1.015			0.995			0.990 0.990			1.010 1.010		
fP	1.000			1.000			1.000 1.000			1.000 1.000		
fBB	1.000			1.000			1.000 1.000			1.000 1.000		
fA	1.000			1.000			1.000 1.000			1.000 1.000		
fLU	1.000			1.000			1.000 1.000			1.000 0.952		
fRT	0.904			0.989			0.995			0.999		
fLT	0.909			0.694			0.950 1.000			0.950 1.000		
Sec.							0.216			0.113		
fLpb	1.000			1.000			1.000 1.000			1.000 1.000		
fRpb	1.000			1.000			1.000			1.000		
S	1514			1238			1752 1786			1787 3485		
Sec.							398			212		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	72	1514	0.05	0.33	505	0.14
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	166	1238	# 0.13	0.33	413	0.40
Right							
Northbound							
Prot		19	1752	# 0.01	0.125	219	0.09
Perm		0	398	0.00	0.475	189	0.00
Left	L	19			0.60	408	0.05
Prot							
Perm							
Thru	TR	665	1786	# 0.37	0.41	734	0.91
Right							
Southbound							
Prot		1	1787	0.00	0.125	223	0.00
Perm		0	212	0.00	0.475	101	0.00
Left	L	1			0.60	324	0.00
Prot							
Perm							
Thru	TR	805	3485	0.23	0.41	1433	0.56
Right							

Sum of flow ratios for critical lane groups, $Y_c = \text{Sum (v/s)} = 0.52$

Total lost time per cycle, $L = 15.50 \text{ sec}$

Critical flow rate to capacity ratio, $X_c = (Y_c)(C)/(C-L) = 0.64$

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios		Unf Del	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Res Del d2	Res Del d3	Lane Group		Approach	
	v/c	g/C	d1						Delay	LOS	Delay	LOS
Eastbound												
LTR	0.14	0.33	18.6	1.000	505	0.50	0.6	0.0	19.2	B	19.2	B
Westbound												
LTR	0.40	0.33	20.5	1.000	413	0.50	2.9	0.0	23.4	C	23.4	C
Northbound												
L	0.05	0.60	7.8	1.000	408	0.50	0.2	0.0	8.0	A		
TR	0.91	0.41	22.1	1.000	734	0.50	16.9	0.0	39.0	D	38.1	D
Southbound												
L	0.00	0.60	11.2	1.000	324	0.50	0.0	0.0	11.2	B		
TR	0.56	0.41	18.0	1.000	1433	0.50	1.6	0.0	19.6	B	19.6	B

Intersection delay = 27.3 (sec/veh) Intersection LOS = C

SUPPLEMENTAL PERMITTED LT WORKSHEET

for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C			80.0	sec
Total actual green time for LT lane group, G (s)			42.9	42.9
Effective permitted green time for LT lane group, g(s)			38.0	38.0
Opposing effective green time, go (s)			32.9	32.9
Number of lanes in LT lane group, N			1	1
Number of lanes in opposing approach, No			2	1
Adjusted LT flow rate, VLT (veh/h)			19	1
Proportion of LT in LT lane group, PLT			1.000	1.000
Proportion of LT in opposing flow, PLTo			0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)			805	665
Lost time for LT lane group, tL			5.10	5.10
Computation				
LT volume per cycle, LTC=VLTC/3600			0.42	0.02
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			9.40	14.78
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g			0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.59	0.59
gq, (see Exhibit C16-4,5,6,7,8)			14.46	27.60
gu=g-gq if gq>=gf, or = g-gf if gq<gf			23.54	10.40
n=Max(gq-gf)/2,0)			7.23	13.80
PTHo=1-PLTo			1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			1.00	1.00
EL1 (refer to Exhibit C16-3)			2.87	2.43
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.11	0.11
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.22	0.11
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.216	0.113

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET

for shared lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C			80.0	sec
Total actual green time for LT lane group, G (s)	26.7	26.7		
Effective permitted green time for LT lane group, g(s)	26.7	26.7		
Opposing effective green time, go (s)	26.7	26.7		
Number of lanes in LT lane group, N	1	1		

Number of lanes in opposing approach, No	1	1		
Adjusted LT flow rate, VLT (veh/h)	20	151		
Proportion of LT in LT lane group, PLT	0.278	0.910	0.000	0.000
Proportion of LT in opposing flow, PLTo	0.91	0.28		
Adjusted opposing flow rate, Vo (veh/h)	166	72		
Lost time for LT lane group, tL	5.30	5.30		
Computation				
LT volume per cycle, LTC=VLTC/3600	0.44	3.36		
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	3.69	1.60		
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g	10.6	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00		
Opposing Queue Ratio, gro=Max[1-Rpo(go/C),0]	0.67	0.67		
gq, (see Exhibit C16-4,5,6,7,8)	3.39	0.00		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	16.07	26.70		
n=Max(gq-gf)/2,0)	0.00	0.00		
PTHo=1-PLTo	0.09	0.72		
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.28	0.91		
EL1 (refer to Exhibit C16-3)	1.64	1.49		
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.00		
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.10	0.14		
gdiff=max(gq-gf,0)	0.00	0.00		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.91	0.69		
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.909	0.694		

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

-----SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET-----

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
 OCCr
 Number of cross-street receiving lanes, Nrec
 Number of turning lanes, Nturn
 ApbT
 Proportion right-turns, PRT
 Proportion right-turns using protected phase, PRTA
 Right turn adjustment, fRpb

-----SUPPLEMENTAL UNIFORM DELAY WORKSHEET-----

	EBLT	WBLT	NBLT	SBLT
Cycle length, C	80.0			
Adj. LT vol from Vol Adjustment Worksheet, v			19	1
v/c ratio from Capacity Worksheet, X			0.05	0.00
Protected phase effective green interval, g (s)			10.0	10.0
Opposing queue effective green interval, gq			14.46	27.60
Unopposed green interval, gu			23.54	10.40
Red time r=(C-g-gq-gu)			32.0	32.0
Arrival rate, qa=v/(3600(max[X,1.0]))			0.01	0.00
Protected ph. departure rate, Sp=s/3600			0.487	0.496
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.18	0.22
XPerm			0.05	0.00
XProt			0.05	0.00
Case			1	1
Queue at beginning of green arrow, Qa			0.17	0.01
Queue at beginning of unsaturated green, Qu			0.08	0.01
Residual queue, Qr			0.00	0.00
Uniform Delay, dl			7.8	11.2

-----DELAY/LOS WORKSHEET WITH INITIAL QUEUE-----

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay		Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
			Unadj. ds	Adj. dl sec				
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	26.6	18.6	0.00	0.0	0.0	19.2
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	26.6	20.5	0.00	0.0	0.0	23.4
	0.0						0.0	
Northbound								
L	0.0	0.00		7.8	0.00	0.0	0.0	8.0
TR	0.0	0.00	23.5	22.1	0.00	0.0	0.0	39.0
	0.0						0.0	
Southbound								
L	0.0	0.00		11.2	0.00	0.0	0.0	11.2
TR	0.0	0.00	23.5	18.0	0.00	0.0	0.0	19.6
	0.0						0.0	

Intersection Delay	27.3	sec/veh	Intersection LOS	C
--------------------	------	---------	------------------	---

	Eastbound		Westbound		Northbound		Southbound	
LaneGroup	LTR		LTR		L	TR	L	TR
Init Queue	0.0		0.0		0.0	0.0	0.0	0.0
Flow Rate	72		166		19	665	1	422
So	1850		1850		1900	1850	1900	1850
No.Lanes	0	1	0	1	0	1	1	0
SL	1514		1238		680	1786	540	1830
LnCapacity	505		413		408	734	324	752
Flow Ratio	0.0		0.1		0.0	0.4	0.0	0.2
v/c Ratio	0.14		0.40		0.05	0.91	0.00	0.56
Grn Ratio	0.33		0.33		0.60	0.41	0.60	0.41
I Factor	1.000		1.000			1.000		1.000
AT or PVG	3		3		3	3	3	3
Pltn Ratio	1.00		1.00		1.00	1.00	1.00	1.00
PF2	1.00		1.00		1.00	1.00	1.00	1.00
Q1	1.1		2.8		0.2	13.9	0.0	7.2
kB	0.7		0.6		0.5	0.8	0.4	0.9
Q2	0.1		0.4		0.0	5.1	0.0	1.1
Q Average	1.2		3.2		0.2	19.0	0.0	8.3
Q Spacing	25.0		25.0		25.0	25.0	25.0	25.0
Q Storage	0		0		150	0	150	0
Q S Ratio					0.0		0.0	
70th Percentile Output:								
fB%	1.3		1.3		1.3	1.2	1.3	1.2
BOQ	1.6		4.0		0.3	22.8	0.0	10.1
QSRatio					0.0		0.0	
85th Percentile Output:								
fB%	1.6		1.6		1.7	1.4	1.7	1.5
BOQ	2.0		5.0		0.3	26.7	0.0	12.0
QSRatio					0.1		0.0	
90th Percentile Output:								
fB%	1.9		1.8		2.0	1.5	2.0	1.6
BOQ	2.3		5.7		0.4	28.7	0.0	13.2
QSRatio					0.1		0.0	
95th Percentile Output:								
fB%	2.4		2.1		2.6	1.6	2.6	1.8
BOQ	2.9		6.8		0.5	30.8	0.0	14.8
QSRatio					0.1		0.0	
98th Percentile Output:								
fB%	2.9		2.5		3.1	1.7	3.2	2.0
BOQ	3.5		8.0		0.6	32.9	0.0	16.4
QSRatio					0.1		0.0	

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.4

Analyst: Alex Prosak, P.E. Inter.: Lake Otis & 20th
 Agency: HDL Area Type: All other areas
 Date: 12/31/2009 Jurisd: MOA
 Period: PM Peak (4:45 to 5:45) Year : 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
LGConfig	LTR			LTR			L	TR		L	TR	
Volume	12	9	39	93	5	13	62	778	149	16	797	22
Lane Width	12.0			12.0			12.0	12.0		12.0	12.0	
RTOR Vol	19			2			4			1		

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4	5	6	7	8
EB Left		P			NB Left	P	P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
WB Left		P			SB Left	P	P	
Thru		P			Thru		P	
Right		P			Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	27.7	0.0			10.0	111.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 160.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios		Lane Group		Approach	
			v/c	g/C	Delay	LOS	Delay	LOS
Eastbound								
LTR	271	1565	0.16	0.17	57.6	E	57.6	E
Westbound								
LTR	228	1318	0.51	0.17	67.9	E	67.9	E
Northbound								
L	489	1752	0.13	0.79	5.0	A		
TR	1226	1753	0.80	0.70	22.0	C	20.9	C
Southbound								
L	326	1787	0.05	0.79	14.5	B		
TR	2430	3475	0.36	0.70	10.1	B	10.1	B

Intersection Delay = 19.7 (sec/veh) Intersection LOS = B

Phone:
E-Mail:

Fax:

OPERATIONAL ANALYSIS

Analyst: Alex Prosak, P.E.
 Agency/Co.: HDL
 Date Performed: 12/31/2009
 Analysis Time Period: PM Peak (4:45 to 5:45)
 Intersection: Lake Otis & 20th
 Area Type: All other areas
 Jurisdiction: MOA
 Analysis Year: 2009
 Project ID: Lake Otis & 20th Signal Evaluation
 E/W St: 20th Avenue N/S St: Lake Otis Parkway

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	12	9	39	93	5	13	62	778	149	16	797	22
% Heavy Veh	2	2	2	2	2	2	2	2	2	2	2	2
PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
PK 15 Vol	3	3	10	25	2	4	16	207	40	4	212	6
Hi Ln Vol												
% Grade		-3			1			2			-2	
Ideal Sat		1850			1850		1900	1850		1900	1850	
ParkExist												
NumPark												
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
LGConfig		LTR			LTR		L	TR		L	TR	
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			19			2			4			1
Adj Flow		44			116		66	982		17	870	
%InSharedLn												
Prop LTs		0.295			0.853		1.000	0.000		1.000	0.000	
Prop RTs		0.477			0.103			0.157			0.025	
Peds Bikes	1			4			7			7		
Buses		0			0		0	0		0	0	
%InProtPhase							0.0			0.0		
Duration	0.25			Area Type: All other areas								

OPERATING PARAMETERS

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Init Unmet		0.0			0.0		0.0	0.0		0.0	0.0	
Arriv. Type		3			3		3	3		3	3	
Unit Ext.		3.0			3.0		3.0	3.0		3.0	3.0	
I Factor		1.000			1.000			1.000			1.000	
Lost Time		2.0			2.0		2.0	2.0		2.0	2.0	
Ext of g		2.0			2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.2			3.2			3.3			3.3	

PHASE DATA

Phase Combination	1	2	3	4	5	6	7	8
EB Left	P				NB Left	P	P	
Thru	P				Thru		P	
Right	P				Right		P	
Peds					Peds			
WB Left	P				SB Left	P	P	
Thru	P				Thru		P	
Right	P				Right		P	
Peds					Peds			
NB Right					EB Right			
SB Right					WB Right			
Green	27.7	0.0			10.0	111.9	0.0	
Yellow	3.0				0.0	3.6		
All Red	2.3				0.0	1.5		

Cycle Length: 160.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume, V	12	9	39	93	5	13	62	778	149	16	797	22
PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj flow	13	10	21	99	5	12	66	828	154	17	848	22
No. Lanes	0	1	0	0	1	0	1	1	0	1	2	0
Lane group	LTR			LTR			L TR			L TR		
Adj flow	44			116			66 982			17 870		
Prop LTs	0.295			0.853			1.000 0.000			1.000 0.000		
Prop RTs	0.477			0.103			0.157			0.025		

Saturation Flow Rate (see Exhibit 16-7 to determine the adjustment factors)

	Eastbound			Westbound			Northbound			Southbound		
LG	LTR			LTR			L TR			L TR		
So	1850			1850			1900 1850			1900 1850		
Lanes 0	1	0	0	1	0	0	1	1	0	1	2	0
fW	1.000			1.000			1.000 1.000			1.000 1.000		
fHV	0.980			0.980			0.980 0.980			0.980 0.980		
fG	1.015			0.995			0.990 0.990			1.010 1.010		
fP	1.000			1.000			1.000 1.000			1.000 1.000		
fBB	1.000			1.000			1.000 1.000			1.000 1.000		
fA	1.000			1.000			1.000 1.000			1.000 1.000		
fLU	1.000			1.000			1.000 1.000			1.000 0.952		
fRT	0.936			0.986			0.976			0.996		
fLT	0.909			0.740			0.950 1.000			0.950 1.000		
Sec.							0.281			0.155		
fLpb	1.000			1.000			1.000 1.000			1.000 1.000		
fRpb	1.000			1.000			1.000			1.000		
S	1565			1318			1752 1753			1787 3475		
Sec.							518			292		

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity

Appr/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	44	1565	0.03	0.17	271	0.16
Right							
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	116	1318	# 0.09	0.17	228	0.51
Right							
Northbound							
Prot		66	1752	# 0.04	0.063	110	0.60
Perm		0	518	0.00	0.731	379	0.00
Left	L	66			0.79	489	0.13
Prot							
Perm							
Thru	TR	982	1753	# 0.56	0.70	1226	0.80
Right							
Southbound							
Prot		17	1787	0.01	0.063	112	0.15
Perm		0	292	0.00	0.731	214	0.00
Left	L	17			0.79	326	0.05
Prot							
Perm							
Thru	TR	870	3475	0.25	0.70	2430	0.36
Right							

Sum of flow ratios for critical lane groups, $Y_c = \text{Sum (v/s)} = 0.69$
Total lost time per cycle, $L = 15.50 \text{ sec}$
Critical flow rate to capacity ratio, $X_c = (Y_c)(C)/(C-L) = 0.76$

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios		Unf Del	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Res Del d2	Res Del d3	Lane Group		Approach	
	v/c	g/C	d1						Delay	LOS	Delay	LOS
Eastbound												
LTR	0.16	0.17	56.3	1.000	271	0.50	1.3	0.0	57.6	E	57.6	E
Westbound												
LTR	0.51	0.17	60.0	1.000	228	0.50	7.9	0.0	67.9	E	67.9	E
Northbound												
L	0.13	0.79	4.5	1.000	489	0.50	0.6	0.0	5.0	A		
TR	0.80	0.70	16.4	1.000	1226	0.50	5.6	0.0	22.0	C	20.9	C
Southbound												
L	0.05	0.79	14.2	1.000	326	0.50	0.3	0.0	14.5	B		
TR	0.36	0.70	9.6	1.000	2430	0.50	0.4	0.0	10.1	B	10.1	B

Intersection delay = 19.7 (sec/veh) Intersection LOS = B

SUPPLEMENTAL PERMITTED LT WORKSHEET

for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C			160.0	sec
Total actual green time for LT lane group, G (s)			121.9	121.9
Effective permitted green time for LT lane group, g(s)			117.0	117.0
Opposing effective green time, go (s)			111.9	111.9
Number of lanes in LT lane group, N			1	1
Number of lanes in opposing approach, No			2	1
Adjusted LT flow rate, VLT (veh/h)			66	17
Proportion of LT in LT lane group, PLT			1.000	1.000
Proportion of LT in opposing flow, PLTo			0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)			870	982
Lost time for LT lane group, tL			5.10	5.10
Computation				
LT volume per cycle, LTC=VLTC/3600			2.93	0.76
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			20.31	43.64
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g			0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.30	0.30
gq, (see Exhibit C16-4,5,6,7,8)			16.36	57.74
gu=g-gq if gq>=gf, or = g-gf if gq<gf			100.64	
n=Max(gq-gf)/2,0)			8.18	28.87
PTHo=1-PLTo			1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			1.00	1.00
EL1 (refer to Exhibit C16-3)			3.06	3.26
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.03	0.03
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.28	0.16
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT			0.281	0.155

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm.

For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

SUPPLEMENTAL PERMITTED LT WORKSHEET

for shared lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C			160.0	sec
Total actual green time for LT lane group, G (s)	27.7	27.7		
Effective permitted green time for LT lane group, g(s)	27.7	27.7		
Opposing effective green time, go (s)	27.7	27.7		
Number of lanes in LT lane group, N	1	1		

Number of lanes in opposing approach, No	1	1		
Adjusted LT flow rate, VLT (veh/h)	13	99		
Proportion of LT in LT lane group, PLT	0.295	0.853	0.000	0.000
Proportion of LT in opposing flow, PLTo	0.85	0.30		
Adjusted opposing flow rate, Vo (veh/h)	116	44		
Lost time for LT lane group, tL	5.30	5.30		
Computation				
LT volume per cycle, LTC=VLTC/3600	0.58	4.40		
Opposing lane util. factor, fLUo	1.000	1.000	0.952	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	5.16	1.96		
gf=G[exp(- a * (LTC ** b))]-tL, gf<=g	9.8	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00		
Opposing Queue Ratio, gro=Max[1-Rpo(go/C),0]	0.83	0.83		
gq, (see Exhibit C16-4,5,6,7,8)	8.80	1.44		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	17.93	26.26		
n=Max(gq-gf)/2,0)	0.00	0.72		
PTHo=1-PLTo	0.15	0.70		
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.30	0.85		
EL1 (refer to Exhibit C16-3)	1.56	1.44		
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.00		
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.09	0.13		
gdiff=max(gq-gf,0)	0.00	1.44		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.91	0.74		
flt=fm=[gf/g]+[gu/g]/[1+PL(EL1-1)]+[gdiff/g]/[1+PL(EL2-1)], (fmin<=fm<=1.00)				
or flt=[fm+0.91(N-1)]/N**				
Left-turn adjustment, fLT	0.909	0.740		

For special case of single-lane approach opposed by multilane approach, see text.

* If Pl>=1 for shared left-turn lanes with N>1, then assume de-facto left-turn lane and redo calculations.

** For permitted left-turns with multiple exclusive left-turn lanes, flt=fm. For special case of multilane approach opposed by single-lane approach or when gf>gq, see text.

_____SUPPLEMENTAL PEDESTRIAN-BICYCLE EFFECTS WORKSHEET_____

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Pedestrian flow rate, Vpedg (p/h)				
OCCpedg				
Opposing queue clearing green, gq (s)				
Eff. ped. green consumed by opp. veh. queue, gq/gp				
OCCpedu				
Opposing flow rate, Vo (veh/h)				
OCCr				
Number of cross-street receiving lanes, Nrec				
Number of turning lanes, Nturn				
ApbT				
Proportion of left turns, PLT				
Proportion of left turns using protected phase, PLTA				
Left-turn adjustment, fLpb				
Permitted Right Turns				
Effective pedestrian green time, gp (s)				
Conflicting pedestrian volume, Vped (p/h)				
Conflicting bicycle volume, Vbic (bicycles/h)				
Vpedg				
OCCpedg				
Effective green, g (s)				
Vbicg				

OCCbicg
 OCCr
 Number of cross-street receiving lanes, Nrec
 Number of turning lanes, Nturn
 ApbT
 Proportion right-turns, PRT
 Proportion right-turns using protected phase, PRPA
 Right turn adjustment, fRpb

-----SUPPLEMENTAL UNIFORM DELAY WORKSHEET-----

	EBLT	WBLT	NBLT	SBLT
Cycle length, C	160.0			sec
Adj. LT vol from Vol Adjustment Worksheet, v			66	17
v/c ratio from Capacity Worksheet, X			0.13	0.05
Protected phase effective green interval, g (s)			10.0	10.0
Opposing queue effective green interval, gq			16.36	57.74
Unopposed green interval, gu			100.64	
Red time r=(C-g-gq-gu)			33.0	33.0
Arrival rate, qa=v/(3600(max[X,1.0]))			0.02	0.00
Protected ph. departure rate, Sp=s/3600			0.487	0.496
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.17	0.16
XPerm			0.13	0.06
XProt			0.16	0.04
Case			1	1
Queue at beginning of green arrow, Qa			0.61	0.16
Queue at beginning of unsaturated green, Qu			0.30	0.27
Residual queue, Qr			0.00	0.00
Uniform Delay, dl			4.5	14.2

-----DELAY/LOS WORKSHEET WITH INITIAL QUEUE-----

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay		Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
			Unadj. ds	Adj. dl sec				
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	66.2	56.3	0.00	0.0	0.0	57.6
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	66.2	60.0	0.00	0.0	0.0	67.9
	0.0						0.0	
Northbound								
L	0.0	0.00		4.5	0.00	0.0	0.0	5.0
TR	0.0	0.00	24.0	16.4	0.00	0.0	0.0	22.0
	0.0						0.0	
Southbound								
L	0.0	0.00		14.2	0.00	0.0	0.0	14.5
TR	0.0	0.00	24.0	9.6	0.00	0.0	0.0	10.1
	0.0						0.0	

 Intersection Delay 19.7 sec/veh Intersection LOS B

	Eastbound		Westbound		Northbound		Southbound	
LaneGroup	LTR		LTR		L	TR	L	TR
Init Queue	0.0		0.0		0.0	0.0	0.0	0.0
Flow Rate	44		116		66	982	17	456
So	1850		1850		1900	1850	1900	1850
No.Lanes	0	1	0	1	0	1	1	0
SL	1565		1318		615	1753	410	1825
LnCapacity	271		228		489	1226	326	1276
Flow Ratio	0.0		0.1		0.1	0.6	0.0	0.2
v/c Ratio	0.16		0.51		0.13	0.80	0.05	0.36
Grn Ratio	0.17		0.17		0.79	0.70	0.79	0.70
I Factor	1.000		1.000			1.000		1.000
AT or PVG	3		3		3	3	3	3
Pltn Ratio	1.00		1.00		1.00	1.00	1.00	1.00
PF2	1.00		1.00		1.00	1.00	1.00	1.00
Q1	1.7		4.7		0.6	29.8	0.2	8.1
kB	0.7		0.6		1.0	2.0	0.8	2.0
Q2	0.1		0.6		0.2	6.5	0.0	1.1
Q Average	1.8		5.3		0.8	36.4	0.2	9.2
Q Spacing	25.0		25.0		25.0	25.0	25.0	25.0
Q Storage	0		0		0	0	0	0
Q S Ratio								
70th Percentile Output:								
fB%	1.3		1.2		1.3	1.2	1.3	1.2
BOQ	2.3		6.5		1.0	43.6	0.3	11.2
QSRatio								
85th Percentile Output:								
fB%	1.6		1.5		1.7	1.4	1.7	1.4
BOQ	2.9		7.9		1.3	50.9	0.3	13.4
QSRatio								
90th Percentile Output:								
fB%	1.8		1.7		1.9	1.5	2.0	1.6
BOQ	3.3		8.8		1.5	54.6	0.4	14.6
QSRatio								
95th Percentile Output:								
fB%	2.3		1.9		2.5	1.6	2.6	1.8
BOQ	4.1		10.3		1.9	58.2	0.5	16.2
QSRatio								
98th Percentile Output:								
fB%	2.7		2.2		3.0	1.7	3.1	1.9
BOQ	4.9		11.7		2.3	61.9	0.6	17.9
QSRatio								

ERROR MESSAGES

No errors to report.

Appendix B
Engineers Estimate

**MUNICIPALITY OF ANCHORAGE
PROJECT MANAGEMENT & ENGINEERING DEPARTMENT
LAKE OTIS PARKWAY 20TH AVENUE SIGNAL MODIFICATIONS**

BASIC BID

ITEM NO.	SPEC. NO.	WORK DESCRIPTION	ESTIMATED QUANTITY	UNIT BID PRICE	TOTAL BID PRICE
A-1	20.02	Storm Water Pollution Prevention Plan per LS	1	\$ 5,000.00	\$ 5,000.00
A-2	20.07	Remove Sidewalk per SY	233	\$ 20.00	\$ 4,660.00
A-3	20.08	Remove Curb and Gutter per LF	405	\$ 15.00	\$ 6,075.00
A-4	20.09	Remove Pavement per SY	515	\$ 6.00	\$ 3,090.00
A-5	20.10	Unusable Excavation per CY	30	\$ 30.00	\$ 900.00
A-6	20.13	Trench Excavation and Backfill per LF	60	\$ 35.00	\$ 2,100.00
A-7	20.21	Type II-A Classified Fill and Backfill per TN	20	\$ 35.00	\$ 700.00
A-8	20.22	Leveling Course per TN	55	\$ 55.00	\$ 3,025.00
A-9	20.28	Reconstruct Driveway Asphalt per SY	90	\$ 40.00	\$ 3,600.00
A-10	30.02	P.C.C. Curb and Gutter (All Types) per LF	400	\$ 40.00	\$ 16,000.00
A-11	30.03	P.C.C. Sidewalk 4" Thick, Broom Finish per SY	220	\$ 65.00	\$ 14,300.00
A-12	30.04	P.C.C. Curb Ramp per SY	7	\$ 150.00	\$ 1,050.00
A-13	30.04	Detectable Warning per SF	10	\$ 50.00	\$ 500.00
A-14	40.06	A.C. Pavement (Class D) per TN	55	\$ 130.00	\$ 7,150.00
A-15	55.02	Furnish, Install, and Televiser Pipe 18" Type S CPEP per LF	60	\$ 65.00	\$ 3,900.00

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS

**MUNICIPALITY OF ANCHORAGE
PROJECT MANAGEMENT & ENGINEERING DEPARTMENT
LAKE OTIS PARKWAY 20TH AVENUE SIGNAL MODIFICATIONS**

BASIC BID

ITEM NO.	SPEC. NO.	WORK DESCRIPTION	ESTIMATED QUANTITY	UNIT BID PRICE	TOTAL BID PRICE
A-16	55.05	Construct Curb Inlet Box per EA	1	\$ 4,000.00	\$ 4,000.00
A-17	55.11	Remove Curb Inlet Box per EA	2	\$ 800.00	\$ 1,600.00
A-18	65.02	Construction Survey Measurement per LS	1	\$ 10,000.00	\$ 10,000.00
A-19	65.02	Existing Monument Search per LS	1	\$ 800.00	\$ 800.00
A-20	65.02	Two-Person Survey Crew per Hour	10	\$ 250.00	\$ 2,500.00
A-21	70.07 95.04	Remove Pipe per LF	112	\$ 30.00	\$ 3,360.00
A-22	70.10	Traffic Markings per LS	1	\$ 10,000.00	\$ 10,000.00
A-23	70.11	Standard Sign per SF	45	\$ 100.00	\$ 4,500.00
A-24	70.12	Traffic Maintenance per LS	1	\$ 35,000.00	\$ 35,000.00
A-25	75.03	Topsoil (4-inch depth) per MSF	2	\$ 850.00	\$ 1,700.00
A-26	75.04	Seeding per MSF	2	\$ 350.00	\$ 700.00
A-27	80.02	Trench & Backfill per LF	250	\$ 13.00	\$ 3,250.00
A-28	80.04	Pedestrian Pushbutton Pole Foundation per EA	1	\$ 1,700.00	\$ 1,700.00
A-29	80.04	Signal Mast Arm Pole Foundation per EA	2	\$ 8,000.00	\$ 16,000.00
A-30	80.04	Type 1A Load Center Foundation per EA	1	\$ 5,300.00	\$ 5,300.00

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS

**MUNICIPALITY OF ANCHORAGE
PROJECT MANAGEMENT & ENGINEERING DEPARTMENT
LAKE OTIS PARKWAY 20TH AVENUE SIGNAL MODIFICATIONS**

BASIC BID

ITEM NO.	SPEC. NO.	WORK DESCRIPTION	ESTIMATED QUANTITY	UNIT BID PRICE	TOTAL BID PRICE
A-31	80.05	Combination Signal/Luminaire Pole, 40ft MH per EA	2	\$ 18,000.00	\$ 36,000.00
A-32	80.05	Pedestrian Pushbutton Pole per EA	1	\$ 2,900.00	\$ 2,900.00
A-33	80.06	Signal Mast Arm, 45' Length per EA	2	\$ 7,500.00	\$ 15,000.00
A-34	80.07	2" Steel Conduit per LF	250	\$ 21.50	\$ 5,375.00
A-35	80.07	3" Steel Conduit per LF	250	\$ 28.00	\$ 7,000.00
A-36	80.08	Type 1A J-box per EA	8	\$ 950.00	\$ 7,600.00
A-37	80.08	Type 2 J-Box per EA	1	\$ 1,700.00	\$ 1,700.00
A-38	80.08	Type 3 J-Box per EA	1	\$ 2,600.00	\$ 2,600.00
A-39	80.10	Conductor, 7PR #18 AWG per LF	1,060	\$ 5.30	\$ 5,618.00
A-40	80.10	Conductor, 3C #6 AWG per LF	100	\$ 5.10	\$ 510.00
A-41	80.10	Conductor, 3C #8 AWG per LF	180	\$ 4.60	\$ 828.00
A-42	80.10	Conductor, 3C #14 AWG per LF	1,230	\$ 2.50	\$ 3,075.00
A-43	80.10	Conductor, 5C #14 AWG per LF	820	\$ 3.30	\$ 2,706.00
A-44	80.10	Conductor, 7C #14 AWG per LF	1,050	\$ 3.70	\$ 3,885.00
A-45	80.10	Conductor, 3C #20 AWG Opticom per LF	410	\$ 2.50	\$ 1,025.00

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS

**MUNICIPALITY OF ANCHORAGE
PROJECT MANAGEMENT & ENGINEERING DEPARTMENT
LAKE OTIS PARKWAY 20TH AVENUE SIGNAL MODIFICATIONS**

BASIC BID

ITEM NO.	SPEC. NO.	WORK DESCRIPTION	ESTIMATED QUANTITY	UNIT BID PRICE	TOTAL BID PRICE
A-46	80.14	Single Meter Pad-Mount Load Center, Type 1A per EA	1	\$ 7,700.00	\$ 7,700.00
A-47	80.17	Opticom w/ Confirmation Light Model 721 per EA	4	\$ 2,000.00	\$ 8,000.00
A-48	80.18	Install Loop Detector, Existing Pavement per EA	17	\$ 1,500.00	\$ 25,500.00
A-49	80.19	3-Section Signal Heads per EA	4	\$ 2,300.00	\$ 9,200.00
A-50	80.19	5-Section Signal Heads per EA	2	\$ 2,300.00	\$ 4,600.00
A-51	80.20	Pedestrian Countdown LED Signal Heads per EA	8	\$ 2,100.00	\$ 16,800.00
A-52	80.21	Pedestrian Pushbuttons per EA	4	\$ 550.00	\$ 2,200.00
A-53	80.23	LED Roadway Luminaire, 11385 lumens, Type 3 per EA	2	\$ 3,000.00	\$ 6,000.00
A-54	80.28	Remove Signal Pole per EA	2	\$ 1,500.00	\$ 3,000.00

TOTAL SCHEDULE A: \$ 351,282.00

CONTRACTOR: _____

DATE: _____

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS