Village of La Grange

VILLAGE OF LA GRANGE

SPECIAL MEETING OF THE
VILLAGE BOARD OF TRUSTEES

Village Hall Auditorium
53 South La Grange Road
La Grange, IL 60525

Tuesday, January 25, 2011
(immediately following the regular Village Board meeting)

AGENDA

1. CALL TO ORDER AND ROLL CALL

2. TRAFFIC AND PEDESTRIAN SAFETY WORKSHOP

   A. Overview and Introductions
      Liz Asperger, Village President

   B. Presentation of the following study findings, draft policy and recommendations intended to enhance traffic and pedestrian safety within the Village:

      i) Feasibility study to re-configure 47th Street from a four-lane cross-section to a three-lane cross-section;

      ii) Traffic Origination and Destination study of the 47th Street corridor;

      iii) Feasibility study to signalize the intersection of 47th Street and East Avenue;

      iv) Operational effectiveness of the enhanced pedestrian crossing at 47th Street and 9th Avenue;

      v) Draft policy governing the use of in-street pedestrian crossing signage.

53 South La Grange Road P.O. Box 668 La Grange, Illinois 60525 (708) 579-2300 Fax (708) 579-0980

vi) Village-wide Stop Sign Study

Robert Pilipiszyn, Village Manager
Ryan Gillingham, Director of Public Works
Luay Aboona, Principal, KLOA
Eric Russell, Principal, KLOA

C. Discussion
Village Board, Village Staff and Consultants

D. Village Board Consensus and Direction to Village Staff
Liz Asperger, Village President

3. ADJOURNMENT

Individuals with disabilities and who require certain accommodations to participate at this meeting are requested to contact the ADA Coordinator at (708) 579-2315 to allow the Village to make reasonable accommodations.

VILLAGE OF LA GRANGE
Administrative Offices

EXECUTIVE COMMITTEE REPORT

TO: Village President, Village Clerk, Board of Trustees, and Village Attorney

FROM: Robert J. Pilipiszyn, Village Manager

DATE: January 25, 2011

RE: **TRAFFIC AND PEDESTRIAN SAFETY WORKSHOP**

The Village is actively engaged in a strategic evaluation of opportunities to calm traffic and improve pedestrian safety throughout the Village. Particular emphasis has been given to the 47th Street corridor because of its unique characteristics, including its jurisdictional designation as an unmarked state route, and its function as a four-lane, east-west arterial, the combination of which geographically, physically and operationally bi-sects La Grange in a north-south fashion.

The purpose of this workshop is threefold. First, the Village Board has committed significant financial and staff resources towards this strategic priority. We have been awaiting the results of three significant and inter-related traffic engineering studies for the 47th Street corridor. It would now be appropriate to dedicate an entire workshop in order for the Village Board to discuss and fully understand the consultant's findings, opinions and recommendations.

Second, discuss policies related to several pedestrian crossing projects and the use of in-street pedestrian crossing signs.

Finally, consider a staff recommendation to conduct a Village-wide stop sign study, the data from which will also be useful for establishing baseline information for the 47th Street proposal.

We have framed the workshop accordingly.

47th STREET

By way of background, the Village successfully petitioned the Illinois Department of Transportation (IDOT) in 2009 to reduce the posted speed limit from 35 mph to 30 mph. A subsequent speed study commissioned independently by the Village confirmed that this was an appropriate reduction in the rate of speed for the corridor. The significance in referencing this study is that Koening, Lindgren, O'Hara, Aboona, Inc. (KLOA), the Village's traffic consultant, also observed at that time, that the Village's concept of reducing travel lanes on 47th Street had merit. (A copy of that study, which was previously transmitted to the Village Board in January

2010, is attached hereto for your reference as Appendix "A"). The Village also successfully received approval from IDOT at about the same time to enhance the existing pedestrian crossing at the intersection of 47th and 9th Avenue.

In 2010, the Village engaged KLOA to conduct several technical studies to further evaluate traffic calming opportunities within the corridor. They were as follows;

1. A traffic engineering study to determine if it is feasible to re-configure 47th Street from a four-lane cross-section to a three-lane cross-section. (Appendix "B-1")

2. A traffic origination and destination study to ascertain the utilization characteristics of 47th Street as either a regional transportation arterial, a local east-west arterial or some combination of both. (Appendix "B-2")

3. A traffic engineering study to determine if it is feasible to signalize the intersection of 47th Street and East Avenue. (Appendix "B-3")

These three planning studies have been completed, delivered and transmitted to the Village Board well in advance of this workshop to provide sufficient time for careful consideration of this complex traffic, public safety and land use proposal.

Public Works Director Ryan Gillingham and KLOA will present the findings and recommendations of these studies in an integrated fashion. An Executive Summary of these three reports has been prepared by Ryan and is attached for your reference as (Appendix "B")

As the Village Board begins to synthesize these reports, the staff-consultant presentation, citizen input, and thoughts are exchanged between one another, I would like to provide the following additional information for further consideration and request the direction being sought by staff at the conclusion of the discussion, as follows:

1. Village staff is requesting direction on the reconfiguration of 47th Street as either: (a) proceed with further planning efforts or (b) no further action is required.

   To aid the Village Board in responding to this request for consensus direction, the Village Board may want to think about the decision-making point in this manner: (i) if a majority of the Village Board feels comfortable with 47th Street as it exists today, then no further policy direction is required; (ii) if, however, a majority of the Village Board does not feel comfortable with 47th Street as it exists today, and it would like to see (traffic and pedestrian) improvements to the corridor, then it would be appropriate to consider the staff recommendation or articulate alternative solution(s) that can be discussed and subsequently analyzed for technical feasibility if appropriate.

   It may also help the Village Board to know that Village staff desires to broadly seek citizen input on this complex proposal. Assuming you concur, we will come back with a specific plan to accomplish that objective.

If the consensus direction of the Village Board is in general support of the staff recommendation, we note for planning purposes that the preliminary draft of the proposed budget for FY 2011-12 has earmarked $500,000 for "demonstration" improvements to the 47th Street corridor. We also note for planning purposes that the "demonstration" improvements would allow us to change the operation of 47th Street without a financial and capital investment to the underlying infrastructure. All of this is subject to IDOT approval. If implemented and subsequent citizen input and further good judgment cause the Village Board to rethink the configuration of 47th Street as a three-lane cross section, these temporary "demonstration" improvements can be reversed.

This estimate of cost includes additional monies for engineering work to finalize design plans in a format acceptable for consideration by IDOT.

We will also plan to advise and coordinate these "demonstration" improvements with our municipal neighbors.

Finally, we recommend that the Village hold off on initiating a request for a jurisdictional transfer of 47th Street from IDOT to La Grange until after we have assessed the results of the demonstration project. We also note that the State is not positioned financially at this time to rebuild the roadway at their expense, as is customary with such transfers. We will also continue to informally gauge the interest of Western Springs in pursuing a joint request for a jurisdictional transfer of the roadway.

2. According to the Origination-Destination Study prepared by KLOA, approximately 20% of the traffic volume on 47th Street is through traffic; the remaining 80% is a combination of local traffic or traffic from outside the Village coming to La Grange as a destination (shopping, employment, educational institutions, health care facilities, etc.).

   This is important policy-making and planning information to know going forward for the following reasons:

   a. If the profile of 47th Street is reduced, we can demonstrate to our municipal neighbors that we are not shifting the burden of regional traffic volume onto them.

   b. We do not expect that the proposed change in profile will result in unintended consequences such as a significant increase in cut-through traffic, because destination patterns have generally been established. For example, if a School District 204 employee who works at Lyons Township High School North Campus commutes into La Grange using westbound 47th Street, and they regularly divert off of 47th Street to avoid the traffic signal at 47th Street and Brainard Avenue, they will most likely continue to divert off of 47th Street under a reduced cross-section scenario.

   c. We will now be able to more effectively target educational campaigns regarding traffic safety at key destinations within the Village and to users of those destinations.

3. As the intersection of 47th Street and East Avenue, along with others, has been identified by IDOT for potential improvement using proceeds from the settlement involving the segmented closure of Joliet Road, we would recommend that the Village coordinate its efforts with that process (including working with our municipal neighbors) and IDOT as the (primary) funding source.

   During these regional surface transportation planning sessions, we would present and discuss the findings from the Origination-Destination Study that a reduced cross-section of 47th Street would not adversely shift traffic volume onto our neighbors.

4. The same intersection has been identified as a priority intersection for roadway — rail separation under CREATE. The preliminary separation plan is for a roadway underpass. The timing and funding for this undertaking is uncertain. Due to engineering requirements, several hundred feet of the eastern-most portion of 47th Street will need to be rebuilt below grade. Retaining walls will be necessary, cross-street connections will need to be re-engineered, additional right-of-way may be required and so on, all of which would undermine the very character of 47th Street that we are attempting to preserve, build upon and enhance.

   For long-term planning purposes, we suggest that conceptual consideration be given to eliminating the 47th Street grade crossing in its entirety, but retain the "spur"/frontage road segment between 47th Street and East Avenue for limited Village ingress and egress.

ENHANCED PEDESTRIAN CROSSING — 47TH STREET AND 9TH AVENUE

In 2009, the Village Board approved the construction of an enhanced pedestrian crossing at the existing pedestrian crosswalk at 47th Street and 9th Avenue, consisting of pedestrian-activated flashing yellow beacons, pavement markings and advance warning signage.

Village resident feedback and staff/consultant observations as to the effectiveness of the enhanced crossing has been mixed. It has fallen short of expectations which were to have resulted in a demonstrable increase in utilization, confidence expressed by users, and observed change in driver behavior.

As part of the citizen feedback process including that of individual Trustee comments, we have received from time-to-time inquiries as to why the flashing beacons cannot be converted from yellow to red, and thus eliminate any ambiguity for pedestrians and motorists alike, especially with the passage of recent state legislation that motorists must stop (rather than just yield) for pedestrians in a crosswalk.

We have asked KLOA to be able to comment on this matter for purposes of clarification to both the public and the Village Board as a whole at this time.

For the reasons cited above as well as its cost-benefit, we do not recommend that an enhanced pedestrian crossing be installed at 47th Street and Waiola Avenue (and at 52nd Street and La Grange Road) at this time. A reconfiguration of 47th Street would alternatively address the need for such an additional device within the overall corridor.

We recommend that the enhanced pedestrian crossing at 47th Street and 9th Avenue remain in place to be made available to residents for its use and, as a fixed appurtenance, to maintain an increased level of safety awareness for the motoring public.

IN-STREET PEDESTRIAN CROSSING SIGNAGE

The Village currently uses in-street pedestrian crossing signs, predominately in the Central Business District (CBD) on weekends and during special events. Village staff believes that these signs, given their measured use, has heightened driver awareness and thus has increased pedestrian safety. We also believe that these signs, used in conjunction with the enhanced pedestrian crossing signal system (which includes the new count down display) has further increased pedestrian safety.

These signs were also used on a temporary basis, in part due to citizen and Trustee feedback, in the West End Business District last year during METRA's reconstruction project of the platforms at the Stone Avenue train station.

These signs are popular based on feedback received by Village staff and the several requests received to add more signage such as within the Cossitt Avenue roadway at the Lyons Township High School (LTHS) North Campus and to re-install/make permanent the signs utilized in the West End Business District last year.

Village staff is aware that there are differences of opinion among members of the Village Board as to appropriate location, frequency of deployment and perhaps even text/symbols of these signs (e.g. — stop sign symbol in conflict with the primary traffic control device at a signalized intersection which is the traffic signal). The new state law requiring motorists to stop for pedestrians in a crosswalk has added somewhat to the confusion.

Upon a review of applicable standards, the Manual for Uniform Traffic Control Devices (MUTCD) does not permit conflicting signs at signalized intersections. We subsequently modified the sign text to read "Watch for Pedestrians" and eliminated the use of any symbol.

Some members of the Village Board believe that these in-street signs should not be placed in the crosswalk of signalized intersections, as a matter of local policy.

To address these various issues, Village staff has formulated a draft policy governing the use of in-street pedestrian crossing signs for your consideration with input from KLOA (Appendix "C"). KLOA who will already be in attendance at the meeting, will be a resource available to the Village Board as part of its discussion on this subject.

STOP SIGN STUDY

From time-to-time, Village staff receives resident requests for (additional) stop signs. Most of these requests are denied because they are not warranted by established traffic engineering standards, including our existing stop sign policy. Moreover, when reviewing these requests, we cannot identify unique or changed conditions to support an engineering judgment to justify a(n) (additional) stop sign.

To address citizen concerns and frustrations on a more comprehensive basis, we will be recommending a Village-wide stop sign study as part of the proposed Village budget for the fiscal year beginning May 1, 2011. The project scope will be to evaluate existing traffic control on residential streets and recommend modifications as determined to be appropriate. The study will also provide a go-forward baseline for responding to future stop sign requests.

A secondary benefit of this study is that it would provide the Village with a data set of existing traffic patterns and volumes. This information could be used, if necessary, to evaluate the impacts of cut-through traffic before and after any improvements to 47^{th} Street.

For these reasons, we recommend that we commence with this study as soon as possible.

_______________//_______________

Traffic management and pedestrian safety is a high-order strategic priority for the Village Board. We are pleased to have the opportunity to dedicate an entire workshop discussion to consider several significant planning and policy matters related to this subject. We look forward to the conversation with both the Village Board and the community.

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APPENDIX "A"

47TH Street Speed Study

VILLAGE OF LA GRANGE
Administrative Offices

EXECUTIVE MEMO

TO: Village President, Village Clerk, Board of Trustees and Village Attorney

FROM: Robert J. Pilipiszyn, Village Manager

DATE: January 7, 2010

RE: **TRAFFIC MANAGEMENT AND PEDESTRIAN SAFETY — 47TH STREET SPEED STUDY**

Attached for your review is the 47th Street speed study, which was recently completed by KLOA. Also attached is an executive summary and proposed course of action from Director of Public Works Ryan Gillingham.

Strategically, it appears that we can affect, in concept, a reconfigured roadway by reducing the cross-section of 47th Street from four lanes to three lanes of (east-west) traffic without significant consequence. Furthermore, KLOA also suggests that the reconfiguration will further aid in the calming of traffic speeds and reduce the frequency of accidents.

What Ryan recommends, and I concur, is additional analysis to engineer the proposed improvement(s). What has yet to be determined is if an unintended consequence of congestion on intersecting residential side streets will be created for local traffic attempting to cross or make left-hand turn movements, as the stacking distances and clearance times will be that much greater on 47th Street. This was not part of the scope of the speed study. However, a preliminary opinion from KLOA is that if such congestion were to occur it would most likely be limited to peak travel periods. What we do not know is the degree of magnitude. I would expect, however and by way of example, that some element of congestion is going to occur on 47th Street under a reduced cross section and on intersecting side streets near the two enhanced pedestrian crossings on school days during the evening rush hours. If these various movements can occur safely and with reasonable efficiency, then perhaps the broader community benefits to be achieved by a reduced cross section on 47th Street would offset the (foreseen but limited) congestion which could occur on those intersecting residential block segments, especially between La Grange Road and Brainard Avenue. This is one of several threshold decisions to be made by the Village Board as it considers a jurisdictional transfer and reconfiguration of the 47th Street roadway.

We also do not know what impact if any the reduced cross-section would have on the regional arterial transportation network.

These two planning issues, along with more routine technical analysis (e.g. — re-signalization of traffic lights) would be evaluated as part of the engineering phase as recommended by Ryan.

I am very encouraged thus far and recommend that we solicit a proposal from KLOA for traffic engineering services as it relates to a reduced cross section of 47^{th} Street. This is the same phased project approach we applied to the YMCA redevelopment project-concept, engineering and construction.

If you have any questions concerning this report and recommendation, please do not hesitate to contact me or Ryan directly.

If there are no strong objections to the proposed course of action, we will post the KLOA report on-line with a corresponding news article generally consistent with Ryan's memorandum.

c: Ryan Gillingham, Public Works Director
Andri Peterson, Assistant Village Manager

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VILLAGE OF LA GRANGE
Department of Public Works

MEMORANDUM

TO: Robert Pilipiszyn

FROM: Ryan Gillingham

DATE: January 6, 2010

RE: 47th Street Speed Study
Review and Analysis

The purpose of this memorandum is to transmit the 47th Street Speed Study recently completed by KLOA, Inc., highlight the major findings of the report and discuss the next steps associated with modifications to the 47th Street corridor. The 47th Street Speed Study was initiated as part of the Village's overall strategy of evaluating and improving pedestrian safety throughout the Village. Part of the process of improving pedestrian safety involves assessing vehicle speed limits and traffic volume to achieve the right balance between efficient traffic management and pedestrian safety.

The first part of the study included collecting data related to traffic volume, vehicle classification, vehicle speed, pedestrian activity, accident data, and roadway geometry. Data was collected both east and west of La Grange Road to assess any differences in traffic. The data collected is detailed and summarized in the attached report. The following are several highlights from the data collected:

1. The Average Annual Daily Traffic is 13,720 vehicles per day east of La Grange Road, and 16,034 vehicles per day west of La Grange Road.
2. The 85th percentile speed is approximately 38 mph, while the average speed is approximately 33 mph.
3. Semi-trailer truck traffic on both sides of La Grange Road is approximately 0.2% of the total traffic volume.
4. One third of vehicle accidents occurred at either the 47th Street / East Avenue intersection or the 47th Street / La Grange Road intersection.

Standard practice is to set the speed limit close to the 85th percentile speed, which is approximately 38 mph for 47th Street. However, speed limits are typically adjusted in urbanized areas to account for other factors such as the number of driveways and intersections, pedestrian activity, accident history, etc. Based on the data collected, adjustment factors for 47th Street, and application of generally accepted traffic engineering practices, KLOA recommends that the speed limit on 47th Street remain at 30 mph.

KLOA identified several reasons why the observed speeds are higher including a minimal volume of truck traffic, traffic volumes that are below the capacity of a four-lane roadway, signalized intersection spacing, and the design of the roadway. The issue of traffic volumes being below the capacity of a four-lane roadway provides context for the discussion related to the reconfiguration of the entire 47th Street corridor in order to improve pedestrian safety and connectivity of the community. KLOA recommends that consideration be given to reducing the cross section of the roadway to three lanes, which would consist of one lane in each direction with a center turn lane. Furthermore, KLOA has indicated in order to definitively state that a three lane cross section is appropriate for 47th Street, additional analysis, data collection, and coordination with IDOT would need to be performed in order to determine feasibility.

Changing to a three lane cross section would have impacts on many different components of the roadway. For example, reducing to a three lane cross section would require reconfiguring the signals at the intersections of 47th Street with Brainard and Edgewood since a left turn lane does not currently exist at these intersections. If the Village desires to reconfigure the roadway throughout the 47th Street corridor, I recommend that a feasibility study for this project be initiated, which would include the following activities:

1. Perform a traffic analysis to assess the existing and future uses of the roadway and impacted intersections to determine the operational efficiency of the three-lane section.
2. Assess alternatives including the evaluation of roadway configuration, traffic control devices, bike lanes, sidewalks, parkways, lighting, drainage, and other utilities including water mains, sewers, and other private utilities.
3. Develop concept plans and cross sections of various alternatives.
4. Coordinate with IDOT on the process for implementing changes.
5. Initiate a community involvement process to solicit input.
6. Develop preliminary cost estimates and schedule.
7. Identify funding sources for selected alternatives.

Since 47th Street is under IDOT control, coordination with this agency should be established early in the process to determine the appropriate process for initiating any changes to the roadway, including the discussion of a possible jurisdictional transfer of this roadway. Please let me know if a feasibility study for reconfiguring 47th Street is desired, and I will coordinate the development of a proposal for presentation to the Village Board.

Kenig, Lindgren, O'Hara, Aboona, Inc.

9575 West Higgins Road, Suite 400 Rosemont, Illinois 60018
p: 847-518-9990 f: 847-518-9987

MEMORANDUM TO: Ryan Gillingham, P.E.
Director of Public Works
Village of La Grange

FROM: Eric D. Russell, P.T.P.
Neil S. Kenig, P.E.

DATE: January 6, 2010

SUBJECT: 47th Street Speed Study

This memorandum summarizes the results of a Traffic Speed Study of 47th Street in the Village of La Grange. The study area for 47th Street extends a distance of 1.5 miles from the east Village limits at East Avenue to the west Village limits at Gilbert Avenue. The current posted speed limit on 47th Street was recently reduced by the Illinois Department of Transportation (IDOT) from 35 miles per hour (mph) to 30 mph.

Section 5/11-601 of the Illinois Vehicle Code defines the statutory speed limit to be 30 mph for streets and highways within urban districts. State statutes and the *Illinois Manual on Uniform Traffic Control Devices* allow the Illinois Department of Transportation (IDOT) to alter certain of the statutory speeds either up or down based on an engineering and traffic investigation. The procedures for this investigation are documented in the *IDOT Policy on Establishing and Posting Speed Limits on the State Highway System (May 2002)* and are based on valid engineering principles. These procedures, which are applied in the performance of a traffic speed study, are used to determine altered speed limits on streets and highways under IDOT jurisdiction. For streets under the jurisdiction of local agencies, these procedures are recommended but are not required.

The traffic speed study is to be performed over a three day period on both directions of a roadway. The study is used to determine the speed of vehicles on the roadway, and also provide data on the volume of traffic on the roadway and the composition of that traffic (i.e., cars, trucks, buses, etc.). The determination of the prevailing speed of free-flowing traffic, rounded to the nearest 5 mph, is the basic step in establishing an altered speed limit. This is based on the nationally accepted premise that a majority of the drivers will drive at a speed which they judge to be safe and proper. The prevailing speed is the computed average of the 85th-percentile speed, upper limit of the 10 mph pace, and the average (50-percentile) speed. Traffic engineers use this data, along with other relative factors such as crash history, pedestrian activity, on-street parking restrictions and the number of access locations, to determine appropriate speed limits or warrants for the use of traffic calming devices.

The purpose of this study was to provide guidance to the Village as it considers whether to petition IDOT to further reduce the posted speed limit to 25 mph.

As part of this study, the following tasks were completed by KLOA, Inc.:

1. Field reconnaissance of the 47th Street corridor to identify roadway design features, parking restrictions, access locations, pedestrian features, etc.
2. Review existing roadway plans and typical sections prepared by Heuer and Associates.
3. Review of school boundary maps, documented Safe Walking Routes to School that cross 47th Street, and available pedestrian volume data on 47th Street.
4. Collect traffic volumes, vehicle classification and travel speed data at two locations on 47th Street, one east of La Grange Road and one west of La Grange Road, over a 3-day period.
5. Determine the 85th-percentile travel speed, 10 mph pace and average travel speed on 47th Street.
6. Obtain and review historic traffic crash report data from IDOT and the Village of La Grange Police Department.
7. Utilize the IDOT speed evaluation matrix.
8. Document the findings and recommendations from the speed study in a technical memorandum.

Roadway Characteristics

47th Street is an unmarked state route that is under the jurisdiction of the Illinois Department of Transportation (IDOT). It is also a Federal Aid Urban Route (FAU 1504). It is classified by the Village of La Grange as a minor arterial roadway and is one of only three east-west arterial roadways serving the Village, which emphasizes its importance in the Village's transportation system. Arterial roadways are intended to provide a high degree of mobility and function as the primary travel routes through urban areas. They typically have posted speed limits that range from 30-45 mph. 47th Street is the only east-west arterial roadway serving the central portion of La Grange. The other nearest east-west arterials serving the Village are Ogden Avenue (US Route 34), located 0.9 miles away at the north edge of the Village, and 55th Street, located one mile away at the south edge of the Village.

The existing right-of-way along 47th Street is 66 feet and 47th Street is basically a four-lane roadway through the Village with an approximately 42-foot wide travelway and 5-foot wide sidewalks within the parkway on each side of the roadway. As noted above, the current posted speed limit is 30 mph, having recently been lowered by IDOT from 35 mph. The intersections of 47th Street with Gilbert Avenue, Edgewood Avenue, Brainard Avenue and La Grange Road are all under traffic signal control with pedestrian signals and crosswalks on all legs of the intersections. The intersection of 47th Street with East Avenue is under all-way stop control and there are no crosswalks at the intersection. There are separate left-turn lanes on 47th Street at its intersections with Gilbert Avenue, La Grange Road and East Avenue. An upgraded mid-block crosswalk was recently installed on 47th at 9th Avenue.

The land uses that adjoin 47th Street are primarily residential with numerous driveways along the roadway serving single-family homes. There are also two parks along 47th Street (Sedgwick Park, Waiola Park), one school (St. John's Lutheran School), a church (St. John's Lutheran Church), and a few small commercial businesses. Parking is not permitted on 47th Street.

Traffic Volumes, Vehicle Classification and Travel Speeds

Traffic counts, vehicle classification data, and travel speeds were collected over a 3-day period at two locations along 47th Street, as shown in Figure 1. The first location was between 7th Avenue and 8th Avenue, with the data collected between Tuesday, September 22, 2009 and Thursday, September 24, 2009. The second location was between Kensington Avenue and Catherine Avenue, with the data collected between Tuesday, September 15, 2009 and Thursday, September 17, 2009. These two locations were selected as they are approximately midway between signalized intersections and thus best replicate free-flow travel speeds on 47th Street both to the east and west of La Grange Road. The 3-day count period spans the three most uniform travel days during the week (i.e., Tuesday-Thursday) and avoids the daily variations in traffic that tend to occur around the weekend periods. The traffic volume, classification and speed data is summarized in Table 1 and is included in the Appendix.

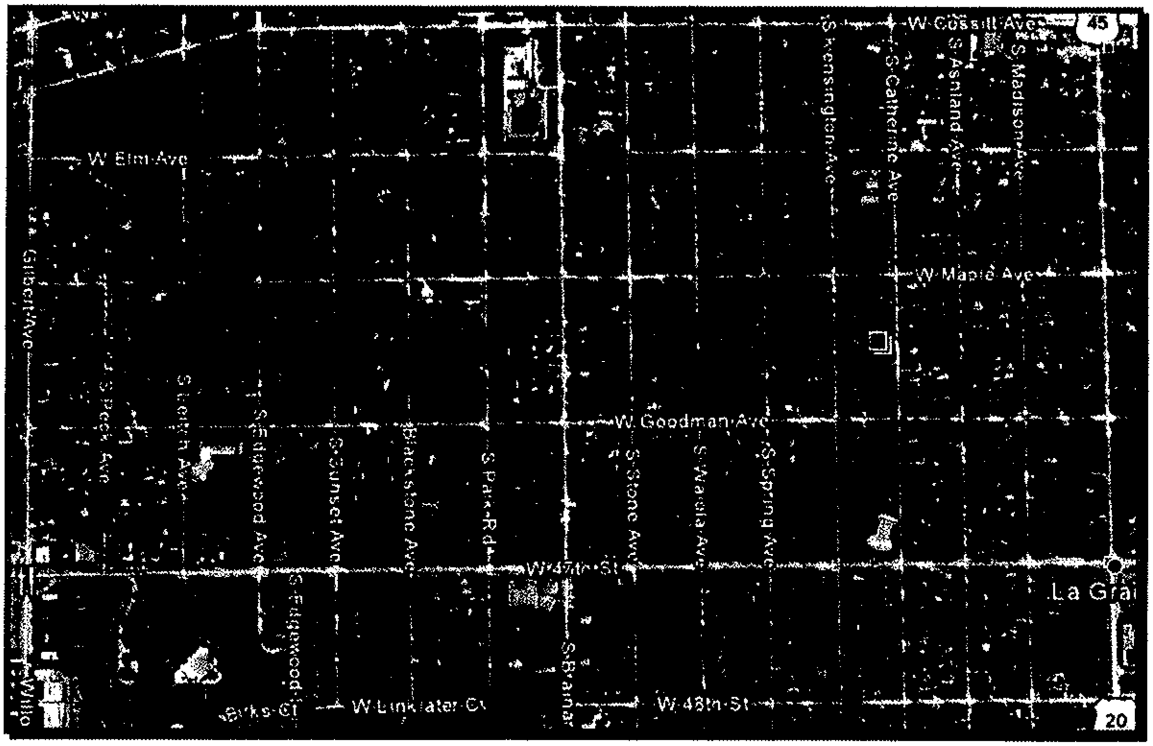
As shown in Table 1, 47th Street carries approximately 13,700 vehicles per day (vpd) east of La Grange Road and 16,000 vpd west of La Grange Road. The 85th-percentile travel speed ranges from 37.7 to 38.6 mph. The 10 mph pace is 30-39 mph and the average travel speed ranged from 32 to 34 mph. Of interest is that approximately 77.5 percent of the traffic on 47th Street presently travels at speeds that exceed the posted 30 mph speed limit. One primary reason for the high volume of drivers exceeding the speed limit is the high percentage of automobile traffic (over 98 percent) on 47th Street. Typically, roadways that carry higher volumes of large vehicles such as trucks and buses have lower average travel speeds than comparable roadways with low volumes of trucks and buses. Other factors include the four-lane design of the roadway, traffic volumes that are below the capacity of a four-lane roadway, signalized intersection spacing, and the fact that 47th Street up until recently had a 35 mph posted speed limit. As a note, the typical capacity of a four-lane roadway similar to 47th Street ranges from 25,000-30,000 vehicles per day. The typical capacity of a three-lane roadway with similar characteristics as 47th Street would be approximately 15,000 vehicles per day.

Pedestrian Volumes

Pedestrian volume data was not collected along 47th Street as part of this study nor were pedestrian counts available from the Village for any of the intersections along 47th Street. However, in general, pedestrian crossing volumes along 47th Street are believed to be light. 47th Street is the boundary between School District 105 and School District 102, so children attending the public elementary and middle schools that walk to school would not need to cross 47th Street. Pedestrian crossings are more likely to occur on 47th Street adjacent to the public parks and St. John's Lutheran School and Church.

Traffic Crash Data

Traffic crash data was obtained from IDOT and the Village of La Grange for the years between 2004 and 2008. Data for 2009 was not available at the time that this report was prepared. The IDOT summaries for 2004-2008 are shown in Table 2 and indicate that there was an average of 87 intersection-related crashes per year between Gilbert Avenue and East Avenue over the 5-year period. During that 5-year period, one person was killed and 127 were injured. One-third of all of the crashes occurred at either the 47th Street/East Avenue or 47th Street/La Grange Road intersections.



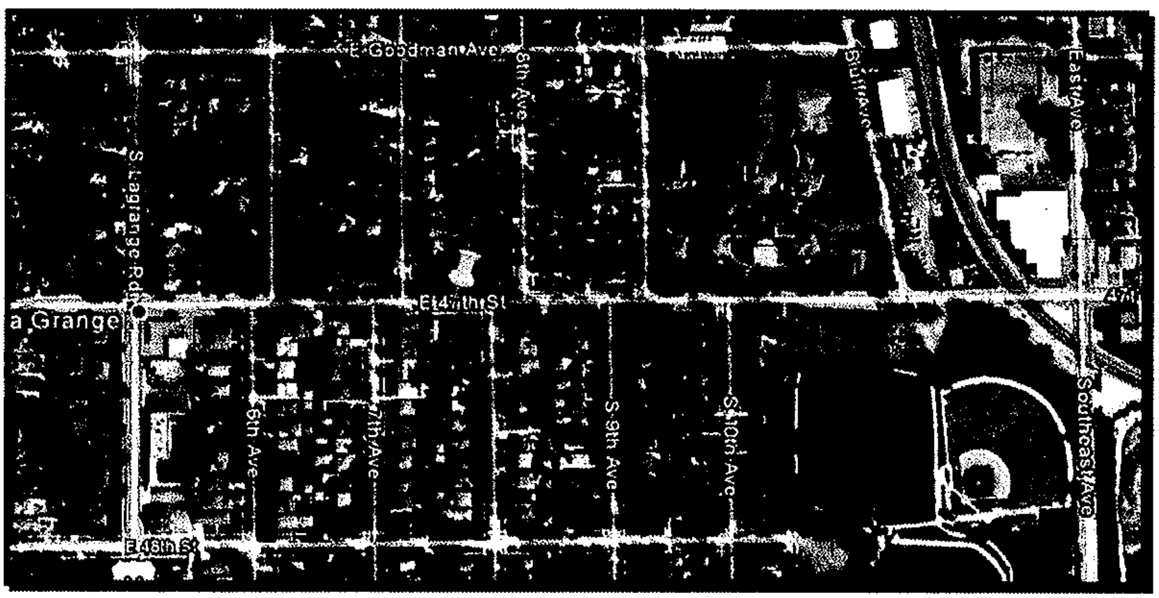


Figure 1
Traffic Count Locations

Table 1
47th STREET SPEED STUDY RESULTS

	Volume	Vehicle Travel Speed			Vehicle Classification			
Roadway Section	AADT	85th-Percentile Speed	10 mph Pace	Average Speed	Passenger Cars	Small Trucks/Vans	Trucks/ Buses	Semi-Trailer Trucks
Between 7th Ave and 8th Ave								
Eastbound 47th Street	6,994	38.2 mph	30-39 mph	33 mph	98.3%	1.2%	0.3%	0.2%
Westbound 47th Street	6,726	38.5 mph	30-39 mph	33 mph	98.2%	1.4%	0.3%	0.1%
Total Two-Way Traffic	13,720							
Between Kensington Ave and Catherine Ave								
Eastbound 47th Street	7,710	37.7 mph	30-39 mph	32 mph	98.4%	1.1%	0.3%	0.2%
Westbound 47th Street	8,324	38.6 mph	30-39 mph	34 mph	98.5%	1.1%	0.3%	0.1%
Total Two-Way Traffic	16,034							

Notes: AADT = Annual Average Daily Traffic
mph = miles per hour

Table 2

TRAFFIC CRASH HISTORY ON 47TH STREET (GILBERT AVENUE TO EAST AVENUE)

Year	Total Accidents	Fatal Accidents	Injury Crashes	Property Damage Crashes	People Killed	People Injured
2004	80	0	16	64	0	24
2005	84	1	16	63	1	25
2006	96	0	24	72	0	33
2007	88	0	21	67	0	23
2008	88	0	15	73	0	22
Totals	436	1	92	339	1	127
Average/Year	87.2	0.2	18.4	68.6	0.2	25.4
Percent at 47th St/La Grange Rd Intersection	13%	0	12%	13%	0	7%
Percent at 47th St/East Ave Intersection	21%	0	23%	21%	0	20%

Table 3 provides a more detailed breakdown of the types of traffic crashes that occurred during the 2004-2008 period. As shown, three types of crashes were most prevalent—turning vehicle collisions (34.4%), rear end collisions (27.3%) and right-angle collisions (20.2%). These three collision types account for approximately 82 percent of the crashes.

Rear end collisions are typically associated with signalized or all-way stop controlled intersections. At least one-third of these collisions occurred at the 47th Street/La Grange Road and 47th Street/ East Avenue intersections. Turning collisions can be a result of a lack of separate turn lanes, inadequate sight distance, disobeyance of traffic controls, etc. Almost 25 percent of this collision type occurred at the 47th Street/East Avenue intersection. Right-angle collisions typically occur at intersections controlled by traffic signals or all-way stop control. Fifty percent of the right angle collisions occurred at the 47th Street/East Avenue intersection, primarily as a result of the all-way stop control, high volume of traffic, and multiple lanes on each of the intersection approaches, which makes it confusing for motorists to discern which driver has the right-of-way. KLOA, Inc. is presently in the process of conducting a traffic signal warrant study at this intersection.

Another crash statistic of importance is the number of sideswipe collisions occurring between vehicles traveling in the same direction. One cause for this type of collision is the lack of left-turn lanes where motorists are suddenly caught behind a left-turning vehicle and attempt to change lanes to avoid having to slow down for the vehicle ahead to turn.

Evaluation

Standard practice is to set the speed limit close to the 85th-percentile speed based on the speed data. The 85th-percentile speed is the speed at which 85 percent of the motorists drive at or below. The 10 mph pace is the 10 mph range in speeds in which the highest number of observations were recorded. The average speed is the arithmetic mean of the speeds of all vehicles recorded.

The argument has been made by traffic engineers that 85 percent of motorists drive at a safe and reasonable speed for the road conditions. National studies have shown that the lowest accident rate occurs when the speed limit is set near the 85th-percentile speed. Posting speed limits much higher or lower than the 85th-percentile speed can produce two groups of drivers – those attempting to observe the speed limit and those who drive at a speed that they feel to be safe and reasonable. These differences in speeds may result in increased accidents due to tailgating, improper passing and reckless driving. Inappropriate speed limits can also foster disregard for other speed limits and traffic signs in the community, can contribute to driver disobedience and frustration, and can result in cut-through traffic in adjoining neighborhoods. As a result, it is typically recommended that the posted speed limit should not be more than 3 mph below the upper limit of the pace or the 85th-percentile speed, whichever is lower.

Table 3

TYPE OF CRASH (47^{TH} STREET - GILBERT TO EAST AVENUE) 2004-2008

Type of Crash	2004	2005	2006	2007	2008	Total	Average/Year	Percent
Rear End	18	25	26	25	25	119	23.8	27.3%
Turning	34	29	39	29	19	150	30.0	34.4%
Pedestrian	0	1	0	1	3	5	1.0	1.2%
Angle	19	12	22	15	20	88	17.6	20.2%
Sideswipe Same Direction	5	8	3	7	12	35	6.4	8.0%
Fixed Object	2	8	2	8	5	25	5.0	5.7%
Pedal Cyclist	2	1	2	3	2	10	2.0	2.3%
Sideswipe Opposite Direction	0	0	0	0	1	1	0.2	0.2%
Head On	0	0	0	0	1	1	0.2	0.2%
Parked Motor Vehicle	0	0	2	0	0	2	0.4	0.5%
Totals	80	84	96	88	88	436	86.6	100%

The speed at which motorists find to be safe and reasonable (i.e., 85th-percentile speed) is primarily dependent on the physical road conditions and topography, including the width of the street, number of travel lanes, hills, curves, roadway surface and traffic controls. Agencies such as IDOT and the Cook County Highway Department, as well as several municipalities in the greater Chicago area, consider additional factors in determining the appropriate speed limit. Using the 85th-percentile, top of the 10 mph pace, and the average speed as a basis, the use of "adjustment factors" is also considered in the speed study. The adjustment factors are based on the following operational characteristics:

- Number of roadway access locations (i.e., driveways, intersecting streets)
- Pedestrian activity
- On-street parking restrictions
- Crash history

The adjustment factors ultimately can reduce the recommended speed limit for a street, but in no cases shall the reduction exceed 20 percent of the prevailing speed or 9 mph, whichever is less. A description of the reduction factors is contained in the Appendix of this memorandum. The application of these adjustment factors to the prevailing speed, which is the computed average of the 85th-percentile speed, upper limit of the 10 mph pace, and the average speed is shown in the Matrix table in the Appendix. A reduction of 15 percent was applied to the prevailing speed, resulting in an adjusted prevailing speed of 31.2 mph. Since this speed is only slightly higher than the current 30 mph posted speed limit on 47th Street, it is recommended that the speed limit remain at 30 mph.

Conclusions and Recommendations

The findings of the speed study indicated that the 85th-percentile speed along 47th Street was slightly higher than 38 mph. This can primarily be attributed to a minimal volume of truck traffic (less than 2%), traffic volumes that are below the capacity of a four-lane roadway, signalized intersection spacing, and the design of the roadway. Also, the fact that the roadway had a posted speed limit of 35 mph up until October 2009 contributes to driver behavior.

Most of the traffic crashes along 47th Street are occurring at the signalized intersection (as expected) and at the 47th Street/East Avenue intersection (all-way stop controlled). Many of these crashes are not as a result of speeding, but more related to the intersection's operation. As an example, at East Avenue where 21 percent of the crashes are occurring, the use of all-way stop control on multiple-lane approaches to the intersection results in motorist confusion and a propensity for turning collisions.

Based on this speed study evaluation, it is our professional opinion that the current 30 mph speed limit on 47th Street is appropriate for this Village-serving minor arterial facility located beyond the limits of the central business district and should not be lowered further at this time. Rather, efforts should be made to reduce the 85th-percentile travel speeds to levels below 35 mph. This can initially be accomplished with passive traffic calming measures such as resident education campaigns (see Exhibit 1), increased police enforcement, and use of electronic traffic speed monitors (Exhibit 2). We further recommend, as an ultimate improvement, that consideration be given to converting 47th Street to a three-lane cross section (two through lanes and a center left-turn lane). This design would reduce the number and types of traffic crashes that occur along 47th Street (i.e., rear end, turning movement, sideswipe), reduce pedestrian crossing distances, and likely result in slower travel speeds as eastbound and westbound traffic would each be consolidated into a single travel lane.

Exhibit 1

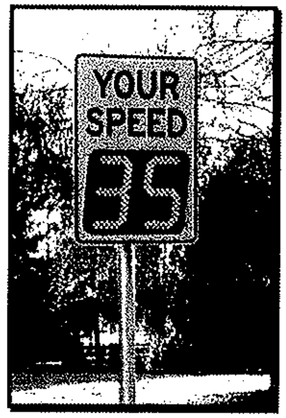


Exhibit 2

APPENDIX

Description of Adjustment Factors Applied to Prevailing Speeds per *IDOT Policy on Establishing and Posting Speed Limits*

The selected Altered Speed Limit may differ from the established prevailing speed (not the proposed posted speed) by up to 20 percent or 9 mph, whichever is less, when justified by further investigation. Such investigations shall be limited to studying any or all of the following four conditions:

Access Locations

The effect of driveways and other entrances is determined by using an "access conflict number." Driveways to single-family homes shall have a conflict number of 1. Minor commercial driveways, driveways serving multi-family residential units, and minor street intersections shall have a conflict number of 5. Major commercial driveways, driveways serving large multi-family developments, and major street intersections shall have a conflict number of 10. If the total access conflict number for the street under study exceeds those on the following table, the prevailing speed may be reduced by the percentages indicated.

Conflicts per mile	% Reduction
0-40	0
41-44	5
45-48	6
49-52	7
53-56	8
57-60	9
61 or more	10

Pedestrian Activity

Where no sidewalks are provided or where sidewalks are located immediately behind the curb and the total pedestrian traffic exceeds 10 per hour for any 3 hours within any 8-hour period, the prevailing speed may be reduced by the percentages indicated on the following table. Established crossing points adjacent to high pedestrian locations (schools, parks, churches, etc.) not protected by any traffic control (stop sign, yield sign, traffic signals) automatically qualify for a 5% reduction.

% of no sidewalk, sidewalk behind curb	% Reduction
0-9	0
10-29	1
30-49	2
50-69	3
70-89	4
90-100	5
High pedestrian crossing location not protected	
by intersection control	5

On-Street Parking Restrictions

The prevailing speed may be reduced by the percentages indicated on the following table where parking is permitted adjacent to the traffic lanes.

% of on-street parking permitted	% Reduction
0-9	0
10-29	1
30-49	2
50-69	3
70-89	4
90-100	5

Crash History

If the crash rate, based on all reportable crashes (both intersection and non-intersection), along the street is at least 50 percent higher than average crash rate for the Village or the Statewide average crash rate for the same classification of roadway, the prevailing speed may be reduced by the percentages indicated on the following table. A reduction in speed may reduce the severity of those crashes that occur but normally will not significantly reduce the number of crashes.

Individual Street Rate / Village Rate	% Reduction
0-1.49	0
1.5-1.54	5
1.55-1.64	6
1.65-1.74	7
1.75-1.84	8
1.85-1.99	9
2 or more	10

Speed Limit Study Evaluation Matrix
per *IDOT Policy on Establishing and Posting Speed Limits*

Route 47th Street
From East Avenue
To Gilbert Avenue
Distance 1.5 miles

I. Spot Speed Studies			
	85th-Percentile Speed (mph)	Top of 10 mph Pace (mph)	Average Speed (mph)
Eastbound 47th St (7th Ave-8th Ave)	38.2	39 mph	33
Westbound 47th St (7th Ave-8th Ave)	38.5	39 mph	33
Eastbound 47th St (Kensington-Catherine)	37.7	39 mph	32
Westbound 47th St (Kensington-Catherine)	38.6	39 mph	34

II. Prevailing Speed	
85th-Percentile (Average of both directions)	38.25
Top of 10 mph Pace (Average of both directions)	39
Average Speed (Average of both directions)	33
Prevailing Speed	36.75

III. Existing Speed Limit	
Route Being Studied	30 mph
Adjacent Stretch/Route:	
[redacted] or W (Goodman Avenue)	25 mph
Length	1.4 miles
[redacted] or E (48th Street)	25 mph
Length	0.85 miles

IV. Driveway Conflicts		
Residential Drives	48 x 1 =	48
Minor Commercial/Multi-Family Development Drives	12 x 5 =	60
Large Commercial/Multi-Family Development Drives	0 x 10 =	0
Minor Streets	24 x 5 =	120
Major Streets	5 x 10 =	50
Drive Conflict #	(sum)	278
Drive Conflict # / Distance (miles)	278 / 1.5	185.3

V. Miscellaneous Factors	
Pedestrians: % street missing sidewalk or sidewalk behind curb	0
Established unprotected crossing points	X Yes ____ No
Crash Ratio: Route Village or Statewide Average	 87.2 / 1.5 miles = 1.18 49.13 / mile
Parking Permitted	____ Yes X No

VI. Prevailing Speed Adjustment	
Driveway Adjustment	10 %
Pedestrian Adjustment	5 %
Crash Ratio Adjustment	0 %
Parking Adjustment	0 %
Total (max. adjustment 20%)	15 %
Prevailing Speed x Adjustment	36.75 mph x 15 % = 5.51 (max. 20% or 9)
Adjusted Prevailing Speed	31.2 mph

VII. Revised Speed Limit	
Recommended Speed Limit	30 mph
Recommended by	KLOA, Inc.
Approved by	
Date	

Summary of Spot Speed/Volume/Classification Data

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: La Grange
Street: 47th St: 7th Ave to 8th Ave

EB Lanes

A study of vehicle traffic was conducted with HI-STAR unit number 6640. The study was done in the EB lane at 47th St: 7th Ave to 8th Ave in La Grange, IL in Cook county. The study began on Sep/22/2009 at 12:00:00 AM and concluded on Sep/25/2009 at 12:00:00 AM, lasting a total of 72.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 20981 vehicles passed through the location with a peak volume of 229 on Sep/22/2009 at [17:15-17:30] and a minimum volume of 0 on Sep/24/2009 at [02:45-03:00]. The AADT count for this study was 6,994.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 30 - 35 MPH range or lower. The average speed for all classifed vehicles was 33 MPH with 30.91% vehicles exceeding the posted speed of 30 MPH. The HI-STAR found 0.26 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 30MPH and the 85th percentile was 38.22 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
0	41	168	625	3977	9684	5189	1006	148	49	38	19	13	8	15					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin. Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 20621 which represents 98 percent of the total classified vehicles. The number of Vans & Pickups in the study was 257 which represents 1 percent of the total classified vehicles. The number of Busses & Trucks in the study was 66 which represents 0 percent of the total classified vehicles. The number of Tractor Tailers in the study was 36 which represents 0 percent of the total classified vehicles.

< to 20	21 to 27	28 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to >												
20125	496	257	66	28	8	0	0												

CHART 2

HEADWAY

During the peak traffic period, on Sep/22/2009 at [17:15-17:30] the average headway between vehicles was 3.913 seconds. During the slowest traffic period, on Sep/24/2009 at [02:45-03:00] the average headway between vehicles was 900 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 66.00 and 83.00 degrees F. The HI-STAR determined that the roadway surface was Dry 100.00% of the time.

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: La Grange
Street: 47th St: 7th Ave to 8th Ave

WB Lanes

A study of vehicle traffic was conducted with HI-STAR unit number 4904. The study was done in the WB lane at 47th St: 7th Ave to 8th Ave in La Grange, IL in Cook county. The study began on Sep/22/2009 at 12:00:00 AM and concluded on Sep/25/2009 at 12:00:00 AM, lasting a total of 72.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 20177 vehicles passed through the location with a peak volume of 216 on Sep/22/2009 at [17:15-17:30] and a minimum volume of 0 on Sep/22/2009 at [01:15-01:30]. The AADT count for this study was 6,726.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 30 - 35 MPH range or lower. The average speed for all classifed vehicles was 33 MPH with 34.28% vehicles exceeding the posted speed of 30 MPH. The HI-STAR found 0.19 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 30MPH and the 85th percentile was 38.51 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
0	32	149	620	3351	9107	5541	1076	182	52	28	14	11	7	6					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin. Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 19812 which represents 98 percent of the total classified vehicles. The number of Vans & Pickups in the study was 286 which represents 1 percent of the total classified vehicles. The number of Busses & Trucks in the study was 57 which represents 0 percent of the total classified vehicles. The number of Tractor Tailers in the study was 21 which represents 0 percent of the total classified vehicles.

< to 20	21 to 27	28 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to >												
19223	589	286	57	16	3	2	0												

CHART 2

HEADWAY

During the peak traffic period, on Sep/22/2009 at [17:15-17:30] the average headway between vehicles was 4.147 seconds. During the slowest traffic period, on Sep/22/2009 at [01:15-01:30] the average headway between vehicles was 900 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 66.00 and 85.00 degrees F. The HI-STAR determined that the roadway surface was Dry 100.00% of the time.

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: La Grange
Street: 47thSt: Kensington to Catherine

EB Lanes

A study of vehicle traffic was conducted with HI-STAR unit number 5295. The study was done in the EB lane at 47thSt: Kensington to Catherine in , IL in Cook county. The study began on Sep/15/2009 at 12:00:00 AM and concluded on Sep/18/2009 at 12:00:00 AM, lasting a total of 72.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 23129 vehicles passed through the location with a peak volume of 207 on Sep/15/2009 at [17:15-17:30] and a minimum volume of 0 on Sep/16/2009 at [03:45-04:00]. The AADT count for this study was 7,710.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 30 - 35 MPH range or lower. The average speed for all classifed vehicles was 32 MPH with 26.52% vehicles exceeding the posted speed of 30 MPH. The HI-STAR found 0.15 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 30MPH and the 85th percentile was 37.68 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
0	83	224	1073	4837	10772	4960	888	171	47	30	14	10	5	6					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin. Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 22759 which represents 98 percent of the total classified vehicles. The number of Vans & Pickups in the study was 253 which represents 1 percent of the total classified vehicles. The number of Busses & Trucks in the study was 65 which represents 0 percent of the total classified vehicles. The number of Tractor Tailers in the study was 43 which represents 0 percent of the total classified vehicles.

< to 20	21 to 27	28 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to >												
22276	483	253	65	34	7	1	1												

CHART 2

HEADWAY

During the peak traffic period, on Sep/15/2009 at [17:15-17:30] the average headway between vehicles was 4.327 seconds. During the slowest traffic period, on Sep/16/2009 at [03:45-04:00] the average headway between vehicles was 900 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 60.00 and 99.00 degrees F. The HI-STAR determined that the roadway surface was Dry 100.00% of the time.

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: La Grange
Street: 47thSt: KensingtontoCatherineAve

WB LANES

A study of vehicle traffic was conducted with HI-STAR unit number 3608. The study was done in the WB lane at 47thSt: KensingtontoCatherineAve in , IL in Cook county. The study began on Sep/15/2009 at 12:00:00 AM and concluded on Sep/18/2009 at 12:00:00 AM, lasting a total of 72.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 24973 vehicles passed through the location with a peak volume of 236 on Sep/15/2009 at [07:15-07:30] and a minimum volume of 0 on Sep/16/2009 at [01:45-02:00]. The AADT count for this study was 8,324.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 30 - 35 MPH range or lower. The average speed for all classifed vehicles was 34 MPH with 34.53% vehicles exceeding the posted speed of 30 MPH. The HI-STAR found 0.21 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 30MPH and the 85th percentile was 38.59 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
0	56	169	726	3998	11399	6796	1434	258	47	36	17	11	17	7					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin.
Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 24601 which represents 99 percent of the total classified vehicles. The number of Vans & Pickups in the study was 279 which represents 1 percent of the total classified vehicles. The number of Busses & Trucks in the study was 60 which represents 0 percent of the total classified vehicles. The number of Tractor Tailers in the study was 31 which represents 0 percent of the total classified vehicles.

< to 20	21 to 27	28 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to >												
24063	538	279	60	22	7	1	1												

CHART 2

HEADWAY

During the peak traffic period, on Sep/15/2009 at [07:15-07:30] the average headway between vehicles was 3.797 seconds. During the slowest traffic period, on Sep/16/2009 at [01:45-02:00] the average headway between vehicles was 900 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 64.00 and 107.00 degrees F. The HI-STAR determined that the roadway surface was Dry 100.00% of the time.

APPENDIX "B"

Staff Transmittal of Traffic Engineering Studies Involving the 47TH Street Corridor

VILLAGE OF LA GRANGE
Department of Public Works

MEMORANDUM

TO: Robert Pilipiszyn

FROM: Ryan Gillingham

DATE: December 29, 2010

RE: Traffic Engineering Studies - 47th Street Corridor Review and Analysis

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The purpose of this memorandum is to transmit the following traffic engineering studies related to 47th Street recently completed by KLOA, Inc.

1. 47th Street Origin- Destination Study
2. 47th Street Design Feasibility Study
3. 47th Street and East Avenue Traffic Signal Evaluation

These reports are attached to this memorandum for your reference and are being transmitted together since they are interrelated to the overall traffic management and potential redesign of the 47th Street corridor. Below you will find a summary of these reports and recommendations for the next steps associated with potential enhancements to the 47th Street corridor.

<u>47th Street Origin-Destination Study</u>

The purpose of the origin and destination study was to identify the primary users of 47th Street, calculate the volume of non-local traffic on 47th Street, and quantify the number of trips to and from local destinations.

In September, KLOA conducted a license plate survey of vehicles entering and exiting the major facilities and roadways. From this data, KLOA was able to estimate the number of vehicles utilizing 47th Street that travel to and from local destinations and the number of vehicles utilizing 47th Street as a regional access way through the Village. Please note that the data and subsequent calculations are subject to some error due to the difficulty of recording license plates on heavily traveled roadways such as 47th Street and La Grange Road. With that understanding, the information as presented should be used for general policy discussions rather than as precise measurements of traffic movements on 47th Street.

KLOA estimated the number of vehicles coming from outside the Village to local destinations or vice versa ranged between 11 and 19%. Additionally the number of vehicles utilizing 47th Street as a through roadway varied from 8 to 18%. KLOA then summarized that the group most affected by any proposed changes would be those that have origins or destinations within the Village rather than regional through traffic.

The results of this study can be utilized as follows:

1. Assist the Village in determining the most appropriate cross section for 47th Street for future resurfacing or reconstruction projects.
2. Provide quantitative data to IDOT, if necessary, regarding regional implications of any modifications to the roadway.
3. Identify stakeholders for input should future modifications occur.
4. Allow Village to better target traffic safety educational campaigns.

47th Street Feasibility Study

The Village Board recently identified improvements to the 47th Street Corridor as a short term complex strategic objective. The overall goal of these improvements is to calm traffic throughout the corridor, improve north-south community connectivity, enhance pedestrian safety, replace fatigued utilities that are beyond their useful life, and assess other features such as lighting, sidewalks and bicycle access.

As part of 47th Street Speed Study KLOA identified that the traffic volumes on 47th Street were below the capacity of a four-lane cross section and recommend that that consideration be given to reducing the cross section of the roadway to three lanes, which would consist of one lane in each direction with a center turn lane. The purpose of exploring a lane reduction is the potential traffic safety benefits that could be realized, which include more uniform traffic speeds, reduction in vehicle speed, reduction in the number and severity of crashes, improved sight lines and improved pedestrian and bicycle safety.

The Village hired KLOA to perform a preliminary traffic engineering study to determine the feasibility of reducing the cross section of the 47th Street from four lanes to three. The goals of the study were as follows:

1. Determine whether the projected volume of traffic on 47th Street and the resulting operating levels of service are conducive to a three-lane roadway design.
2. Analyze operational efficiency of three lane cross section at 47th Street intersections
3. Assess anticipated changes to traffic patterns and impacts on local roadways
4. Prepare a typical cross section of 47th Street as a three-lane roadway and develop a conceptual roadway striping plan for 47th Street that depicts how the roadway would be modified to accommodate a left-turn lane, median and bike lanes given existing right-of-way limitations.
5. Provide estimated construction costs for alternatives.

Based on a number of factors including existing and projected traffic volumes, roadway geometry, and accepted traffic engineering standards, KLOA determined a three lane cross section is a feasible alternative for 47th Street. Specifically KLOA compared the traffic volumes on 47th Street to published engineering studies on lane reductions and determined that the existing and projected volumes on 47th Street fall within the accepted thresholds for three-lane feasibility. KLOA determined that there will be a corresponding increase in travel times through the corridor, however they estimate these impacts to be minimal. Additionally, KLOA stated that the potential for vehicle traffic to divert off of 47th Street onto other parallel roadways is low.

KLOA also analyzed the existing geometry of the roadway and available right-of-way within the 47th Street corridor. They determined that a three lane cross section with bike lanes can be supported within the existing right-of-way and curb lines of the roadway. The practical impact of this geometry assessment is that a four to three lane conversion can occur without the need for curb and gutter reconstruction. This presents an opportunity for the Village to consider different short-term and long-term alternatives for the 47th Street corridor.

As a short term option the Village could reconfigure the roadway within the existing curb lines to a three lane cross section with relatively minor roadway and traffic signal modifications. The benefits and impacts of a lane reduction could then be assessed with this short term option without, relatively speaking, a major investment. As a longer term solution, the Village could consider a jurisdictional transfer of the roadway from IDOT, which would include a full reconstruction of the roadway with improved sidewalks, parkways, lighting, utilities and other improvements. As a side note, the water main on 47th Street is need of replacement based on the existing condition and the number of water main breaks that have occurred on this line over the last several years, and should be planned for replacement as part of any major improvement along this corridor.

KLOA estimates that the cost of restriping the roadway to a three lane cross section to be approximately $500,000. This cost includes reconfiguring the traffic signals to accommodate the new lane configurations. If resurfacing of the roadway is required due to the inability to remove existing pavement markings without damaging the pavement, the estimated cost for the project becomes $2.5 million. The cost of a full reconstruction of the roadway, which includes new pavement, sidewalks, parkways, lighting, water main, and other improvements, is estimated to be $11.5 million. Please note these cost estimates do include costs of the improvements contemplated at the intersection of East Avenue and 47th Street discussed below.

Should the Village wish to pursue either of the options listed above, the next step would involve presenting the information contained in this report to IDOT. Most likely IDOT will require follow up engineering design studies including additional traffic operational analyses, Intersection Design Studies and Traffic Signal Modifications Plans. If the Village desires to initiate any of these follow up studies, funding for these studies would need to be allocated.

47th Street and East Avenue Traffic Signal Evaluation

The intersection of 47th Street and East Avenue is currently under all-way stop control and is in close proximity to the at-grade crossing of the Indiana Harbor Belt (IHB)

Railroad at the west and south legs of the intersection. This intersection receives a high volume of traffic from all directions, including significant truck traffic from the quarry and adjacent industries. Coupled with the railroad and frequent trains, this intersection can be difficult to manage for motorists and does not aid in the efficient movement of traffic through the Village. The Village therefore initiated a study with KLOA to determine if a traffic signal is warranted per current engineering guidelines and to develop recommendations regarding roadway improvements and/or modifications to accommodate traffic signalization and future traffic conditions at the intersection.

KLOA determined that the signalization of East Avenue and 47th Street is warranted by several different criteria including vehicle volumes and proximity of the adjacent railroad intersection. A computer traffic simulation of the intersection was also performed to determine the expected operating characteristics under signalization. From this analysis KLOA determined that a traffic signal at this intersection would improve the operating characteristics of this intersection.

KLOA also recommends that in addition to the signalization of the intersection, that the frontage road located south of the railroad tracks be converted to one-way traffic from 47th Street to East Avenue to improve traffic flow and reduce vehicle conflicts. Vehicles would still be able to make the north bound East Avenue to west bound 47th Street movement at the intersection. The anticipated costs for improvements to this intersection were estimated to be between $700,000 and $1.3 million.

For comparison, several examples of other intersections in the Chicago area that have similar roadway / railroad geometry that are signalized are also identified in the report. These other intersections while carrying higher numbers of traffic are noted to operate more efficiently than the intersection of 47th Street and East Avenue.

Finally, the intersection of East Avenue and 47th Street is unique in the number of jurisdictions and stakeholders that would be involved in any improvements. The agencies involved at a minimum would include the Villages of La Grange, Brookfield, and McCook, Cook County, Illinois Department of Transportation, Indiana Harbor Belt Railroad, and the Illinois Commerce Commission. It is also important to note that this project has been discussed as part of a regional plan associated with the settlement agreement related to the closing of Joliet Rd. We recommend the information contained within the report be used during the initial planning stages of the project to assist with defining the scope of work and advocating for funding opportunities as they become available.

APPENDIX "B-1"

Design Feasibility Study of 47th Street

47th Street
Design Feasibility Study

La Grange, Illinois

Prepared for the:

Village of La Grange

Prepared by:

KLOA
Kenig, Lindgren, O'Hara, Aboona, Inc.

December 2010

Contents

List of Figures and Tables

Figures

Tables

Executive Summary

Many communities nationwide are implementing lane reductions on four-lane roadways serving their communities. In the process, the roadways often become narrower, safer, more efficient, and multi-modal. Three-lane roadways have been demonstrated to operate at similar service levels as four-lane roadways, carry the same volume of traffic, and provide calmer and safer travel conditions for motorists, pedestrians and bicyclists.

The Village of La Grange retained Kenig, Lindgren, O'Hara, Aboona, Inc., (KLOA, Inc.) to conduct a feasibility study of a potential redesign of 47th Street to narrow the roadway from four lanes (two lanes in each direction) to three lanes (one lane in each direction with a center turn lane) from the east Village limits at East Avenue to the west Village limits at Gilbert Avenue.

The Village's strategic objective for this study is to determine whether the proposed lane reduction can maintain or improve the existing levels of service in the corridor without causing adverse impacts to other local or regional streets, while at the same time achieving certain traffic calming, pedestrian safety and "community connectivity" benefits within the corridor.

The focus of this study is on a near-term, cost-effective redesign of 47th Street within the existing curb-to-curb width of the roadway. A long-term strategy of the Village, which is not the basis of this study, could be the acquisition of 47th Street from the Illinois Department of Transportation (IDOT) via a jurisdictional transfer (JT), which would provide more local control over the roadway. However, the Village would likely request the full reconstruction of the roadway prior to the approval of the JT, which would include the relocation of the curbs to create a more permanent three lane configuration and a wider parkway that could be utilized for off-street bike trails, wider sidewalks, enhanced streetscaping and lighting, and new water main. It is unknown at this time when the Village and IDOT would be in the position to make this more substantial investment.

The principle findings of this study follow:

- 47th Street is one of only three east-west arterial roadways serving the Village of La Grange and the only one serving the central portion of the Village.
- The existing right-of-way along 47th Street is generally 66 feet, although the right-of-way widens to 71-78 feet at the west and east ends of the corridor, respectively.

- The cross section of 47th Street generally consists of a four-lane roadway with an approximately 42-foot wide travelway, 1.5-foot curb and gutter, and a parkway that varies in width from 9-11 feet and contains a 5-foot sidewalk on each side of the road. There are left-turn lanes on 47th Street at its intersections with Gilbert Avenue, La Grange Road and East Avenue, and the travelway at these locations widens to 50-55 feet.
- The speed limit on 47th Street is 30 mph, which was lowered from 35 mph in October 2009.
- There are 4 traffic signal controlled intersections along 47th Street (Gilbert Ave, Edgewood Ave, Brainard Ave, La Grange Rd) and one all-way stop controlled intersection (East Ave).
- An upgraded mid-block crosswalk with pedestrian-actuated flashers was recently installed on 47th Street at 9thAvenue.
- Parking is prohibited on 47th Street and there are no fixed-route public transportation services that operate along road.
- There are presently no signs or accommodations for bicycling on the road, despite IDOT's identification of 47th Street as an "unmarked roadway for bicycling with caution advised" and the Active Transportation Alliance's identification of 47th as a recommended on-street route.
- Land uses that adjoin 47th Street are primarily residential (with numerous driveway curb cuts), but also include parks (Sedgwick Park, Waiola Park), a school (St. John's Lutheran School), a church (St. John's Lutheran Church), and a few small commercial businesses.
- The annual average daily traffic (AADT) volume on 47th Street is approximately 13,700-16,000 vehicles per day (vpd) to the east and west of La Grange Road, respectively.
- Truck traffic represented less than two percent of the vehicles on 47th Street.
- The weekday peak hours of commuter traffic are 7:00-8:00 A.M. and 4:45-5:45 P.M.
- IDOT traffic crash data from 2004-2008 indicates that there was an average of 87 crashes per year between Gilbert Avenue and East Avenue. During that 5-year period, one person was killed and 127 were injured. One-third of all crashes occurred at the 47th Street/East Avenue or 47th Street/La Grange Road intersections. Turning vehicle collisions, rear end collisions and right-angle collisions accounted for 82 percent of all crashes. Sideswipe collisions by vehicles traveling in the same direction accounted for 8 percent of the crashes.
- Lane reductions from four lanes to three lanes can offer many benefits to both drivers and pedestrians, including a narrower travelway, more uniform traffic speeds, reductions in excessive speeding, reductions in the number and severity of crashes, improved sight lines, and more comfortable pedestrian crossings, among others.
- These benefits can be achieved with only modest decreases in average arterial travel speed (typically <5 mph) and minimal reductions in average travel times and roadway capacity.

- The purpose of the lane reduction on 47th Street is to further calm traffic and increase pedestrian and bicycle safety.
- The need for the lane reduction is created by several factors, including (1) the limited effect of the recent speed limit reduction to 30 mph which has resulted in the 85th-percentile speed along 47th Street being slightly higher than 38 mph, (2) the adjacency of several parks, schools and churches that result in pedestrian activity along and across 47th Street, and (3) the inadequacy of the design of 47th Street to safely operate as a shared facility. Given the residential nature of the area adjoining 47th Street and the pedestrian environment, travel speeds in excess of 30 mph do not seem appropriate or desirable to Village residents.
- Based on the current cross-section of 47th Street and the curb-to-curb dimensions, there is sufficient space to reduce the travelway to three lanes (one 11-foot through lane in each direction plus a 10-foot center left-turn lane) while utilizing the excess pavement for dedicated 5-foot bike lanes on both sides of the roadway.
- From an operational perspective, the daily (24-hour) and peak hour traffic volumes along 47th Street are within acceptable norms for roadways that make for successful conversions.
- Year 2030 traffic projections for 47th Street prepared by the Chicago Metropolitan Agency for Planning (CMAP) indicate that minimal growth in traffic is expected (0-0.1 percent per year) over the next 20 years.
- Sheets 1-7 in the Appendix illustrate the recommended pavement marking modifications and sign installations necessary to convert 47th Street to a three-lane cross section. The pavement markings define the bike lanes, left-turn lanes, medians and lane transitions. The new signs include bike lane and shared lane signs. The plan also includes identifies locations where traffic signal phasing and equipment modifications are necessary.
- The plan maintains the existing four-lane cross section on 47th Street at La Grange Road, East Avenue and Gilbert Avenue so that these intersections continue to operate at IDOT's level of service standard during the peak commuter hours and/or to provide an efficient transition to the existing four-lane cross section to the east and west of the Village limits.
- The potential for automobile and truck traffic to divert off of 47th Street onto parallel arterial, collector or local roadways upon implementation of the lane reduction on 47th Street is low due to several factors, including (1) the distance (one mile) to comparable arterials, (2) the higher volumes and more congested conditions on these arterials, (3) the similar speed limits on the arterials, (4) the two-lane design of the parallel collector roadways, (5) the lower speed limits and frequent stop sign controls on the local roadways, and (6) the minimal changes in average travel times projected along 47th Street. Thus, traffic diverting onto other roadway facilities will experience higher travel times than remaining on 47th Street.
- IDOT's recently completed resurfacing project of 47th Street potentially averts the need to resurface 47th Street again to convert the roadway to a three-lane design, particularly if the existing pavement markings can be removed/replaced without damaging the driving surface.

- The preliminary cost estimate to implement the lane reduction on 47th Street by re-striping the roadway without modifying the curb lines or resurfacing the roadway is $500,000. If roadway resurfacing is necessary, the preliminary cost estimate is $2,500,000.
- By comparison, the preliminary cost estimate for full reconstruction of 47th Street with new curb lines is $8,500,000.
- These cost estimates do not include the cost for the roadway reconfiguration and installation of traffic signal control at the 47th Street/East Avenue intersection.
- The traffic analysis results indicate that all intersections in the 47th Street corridor presently achieve IDOT's desired intersection level of service standard of C during the weekday peak hours, with the exception of 47th Street/Brainard Avenue in the morning peak hour and 47th Street/East Avenue in the evening peak hour.
- The analysis of projected 2030 traffic conditions under the three-lane roadway design indicates that all intersections, with the exception of the 47th Street/Brainard Avenue intersection in the morning peak hour, will continue to achieve IDOT's desired intersection level of service standard of C during the weekday peak hours.
- The 47th Street/Brainard Avenue intersection presently operates at level of service D in the morning peak hour under the four-lane roadway design and will continue to operate at the same level of service with a three-lane cross section.
- The 47th Street/East Avenue intersection presently warrants traffic signal control and will require the installation of traffic signals to achieve IDOT's level of service standard.
- The traffic analysis results also indicate that the conversion of the roadway from four lanes to three lanes has a minimal effect on the average travel times through the corridor and may result in travel time increases of 1-2 minutes for vehicles traveling the full 1.5-mile corridor. The travel time increases would be less for vehicles traveling only a portion of the corridor. The net effect of these travel time changes is a calmer travel environment along 47th Street with more uniform traffic speeds, which is a primary purpose of the roadway design change.

The findings from this study show that 47th Street appears to be an attractive candidate for conversion from a four-lane roadway to a three-lane roadway. The geometric conditions of the roadway are sufficient, the traffic volumes utilizing the roadway are within acceptable ranges, and projected traffic operations result in acceptable levels of service during the weekday peak hours. Furthermore, pedestrian safety will be enhanced and dedicated bicycle lanes will be developed, which will better connect key community destinations (i.e., parks, schools, churches) by non-motorized means, a clearly articulated desire of the Village.

With concurrence from the Village on the findings and recommendations of this feasibility study, the report should be forwarded to IDOT for review and to obtain guidance as to the required follow-up engineering design studies necessary for the conversion of 47th Street to three lanes.

1. Introduction

Kenig, Lindgren, O'Hara, Aboona, Inc. (KLOA, Inc.) was retained by the Village of La Grange to conduct a feasibility study of a potential redesign of 47th Street from the east Village limits at East Avenue to the west Village limits at Gilbert Avenue, as shown in Figure 1. Specifically, the study assesses the feasibility of narrowing this 1.5-mile section of 47th Street from a four-lane roadway (two lanes in each direction) to a three-lane roadway (one lane in each direction with a center turn lane), also referred to as a "lane reduction".

The Village initiated this feasibility study as a follow-up to a Speed Study performed for 47th Street by KLOA, Inc. in January 2010. The current posted speed limit on 47th Street is 30 miles per hour (mph). The speed study determined that the 85th-percentile speed along 47th Street was slightly higher than 38 mph with approximately 77.5 percent of the traffic on 47th Street traveling at speeds that exceed the posted speed limit. Reasons for the high volume of drivers exceeding the speed limit were attributed to (1) traffic volumes that are below the typical capacity of a four-lane roadway (25,000-30,000 vehicles per day), (2) a low volume of truck traffic (less than 2%), (3) the distance between the existing traffic signals, (4) the four-lane design of the roadway, and (5) the fact that the roadway had a posted speed limit of 35 mph up until October 2009.

It was KLOA, Inc.'s professional opinion that the current 30 mph speed limit on 47th Street is appropriate for this Village-serving minor arterial facility. Rather than appealing for a further speed limit reduction to the Illinois Department of Transportation (IDOT), which has jurisdiction over the roadway, efforts should be made to reduce the 85th-percentile travel speeds to levels below 35 mph through active traffic calming measures such as narrowing the roadway to a three lane cross section and passive measures such as resident education campaigns, increased police enforcement and use of electronic traffic speed monitors.

The Village's strategic objective for this study is to determine whether the proposed lane reduction can maintain or improve the existing levels of service in the corridor without causing adverse impacts to other local or regional streets, while at the same time achieving certain traffic calming, pedestrian safety and "community connectivity" benefits within the corridor.

The focus of this study is on a redesign opportunity within the existing curb-to-curb width of the roadway. Any improvements beyond the curbs or realignment of the curbs are beyond the scope of this feasibility study and would imply substantially higher construction costs. If determined to be appropriate, the Village may desire to acquire 47th Street from IDOT via a jurisdictional transfer (JT) as a long term strategy to provide more local control over the roadway. However, the Village would likely request the full reconstruction of the roadway prior to the approval of the JT. At such time in the future when the Village and IDOT are in the position to make this investment, reconstruction of 47th Street could include the relocation of the curbs to create a more permanent three lane configuration and a wider parkway that could be utilized for off-street bike trails, wider sidewalks, enhanced streetscaping, and new water main.

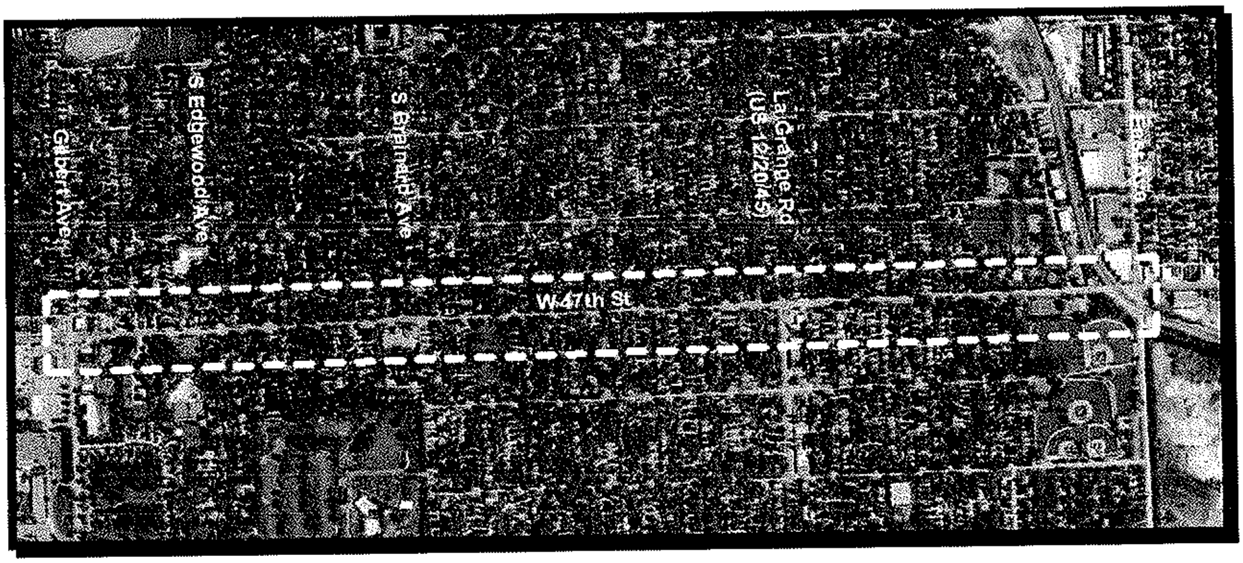


Figure 1
Study Area

2.
Existing Conditions

KLOA, Inc. conducted a field reconnaissance of the 47th Street corridor and environs to inventory and observe the current roadway design, traffic operations and controls, parking conditions, pedestrian safety measures and bicycle accommodations, truck routes, adjacent land uses, and public transit stops and amenities. The fieldwork also provided a database for analyzing existing and projected traffic conditions. Six general components of existing conditions are summarized below.

1. Geometric design of the roadway, including right-of-way, lane configuration, intersection traffic controls, pedestrian safety measures, and speed limits
2. On-street parking conditions
3. Bicycle accommodations
4. Public transportation services and amenities
5. Weekday traffic volumes
6. Traffic crash statistics

Roadway Geometrics

47th Street is an unmarked state route that is under the jurisdiction of the Illinois Department of Transportation (IDOT). It is also a Federal Aid Urban Route (FAU 1504), making it part of the National Highway System (NHS) and eligible for federal-aid funds for resurfacing, reconstruction, traffic management, bicycle/pedestrian, and operational improvement projects. It is classified by the Village of La Grange as a minor arterial roadway and is one of only three east-west arterial roadways serving the Village, which emphasizes its importance in the Village's transportation system. Arterial roadways are intended to provide a high degree of mobility and function as the primary travel routes through urban areas. They typically have posted speed limits that range from 30-45 mph. 47th Street is the only east-west arterial roadway serving the central portion of La Grange. The other nearest east-west arterials serving the Village are Ogden Avenue (US Route 34), located 0.9 miles away at the north edge of the Village, and 55th Street, located one mile away at the south edge of the Village.

KLOA, Inc. obtained computer-aided design and drafting (CADD) mapping files of 47th Street from Heuer & Associates, the Village's civil engineering consultant, to use as the base map for this feasibility study. These data files indicate that the existing right-of-way along 47th Street is 66 feet from Peck Avenue on the west to 9th Avenue on the east. Between Peck Avenue and Gilbert Avenue the right-of-way expands to 71 feet and between 9th Avenue and East Avenue the right-of-way expands to 78 feet. The cross section of 47th Street generally consists of a four-lane roadway through the Village with an approximately 42-foot wide travelway (edge of pavement-to-edge of pavement), 1.5-foot curb and gutter, and a parkway that varies in width from 9 to 11 feet and contains a 5-foot wide sidewalk on each side of the roadway. There are separate left-turn lanes on 47th Street at its intersections with Gilbert Avenue, La Grange Road and East Avenue, and the travelway at these locations widens to approximately 50-55 feet.

The current roadway configuration along 47th Street through the Village is shown in the top half of the page on Sheets 1-7 in the Appendix of this report. Figure 2 shows a typical cross section of an existing mid-block section of 47th Street, which corresponds to Section A-A on Sheet 2 in the Appendix.

As noted above, the current posted speed limit on 47th Street is 30 mph, having recently been lowered by IDOT from 35 mph. The intersections of 47th Street with Gilbert Avenue, Edgewood Avenue, Brainard Avenue and La Grange Road are all under traffic signal control with pedestrian signals and crosswalks on all legs of the intersections. The intersection of 47th Street with East Avenue is under all-way stop control and there are no crosswalks at the intersection. An upgraded mid-block crosswalk was recently installed on 47th at 9thAvenue.

The land uses that adjoin 47th Street are primarily residential with numerous driveways along the roadway serving single-family homes. There are also two parks along 47th Street (Sedgwick Park, Waiola Park), one school (St. John's Lutheran School), a church (St. John's Lutheran Church), and a few small commercial businesses.

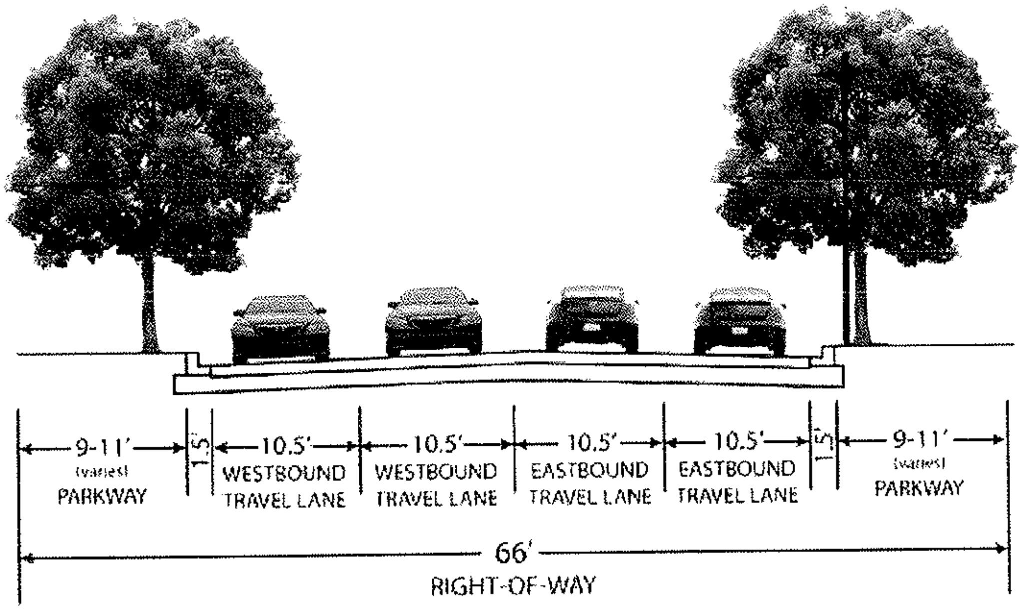
On-Street Parking

Parking is prohibited on both sides of 47th Street through the Village of La Grange.

Bicycle Accommodations

There are presently no accommodations for bicycling on 47th Street. IDOT identifies 47th Street as an unmarked roadway for bicycling with caution advised. The Active Transportation Alliance identifies 47th Street as a recommended on-street route for bicycling although there are presently no bike route signs posted along 47th Street.

EXISTING
SECTION A-A



PROJECT:	TITLE:	PROJECT NO: 10-076
47TH ST 3-LANE CONVERSION LA GRANGE, IL	EXISTING CROSS SECTION	KLOA
		FIGURE NO: 2

Public Transportation

There are no fixed-route public transportation services that operate along 47th Street. Pace Route 330 (Mannheim-La Grange Roads) is the nearest service that extends through the Village, operating along La Grange Road and crossing 47th Street. The nearest bus stops are located one block to the north of 47th Street (at Goodman Avenue) and one block to the south of 47th Street (at 48th Street).

Existing Traffic Volumes

While preparing the 47th Street speed study, KLOA, Inc. collected traffic volume data in September 2009 over a 72-hour period at the following two locations on 47th Street:

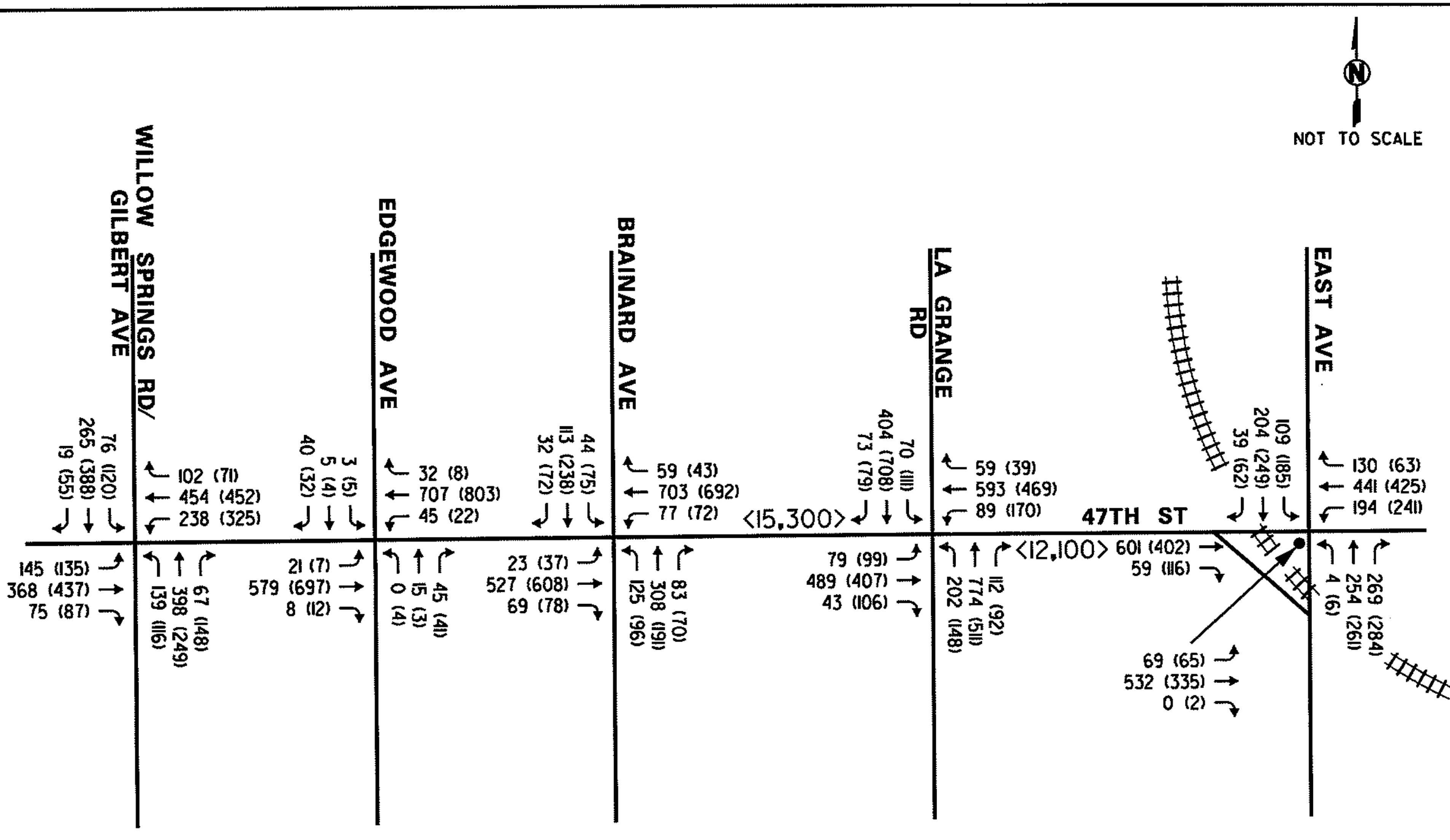
1. Between 7th Avenue and 8th Avenue
2. Between Kensington Avenue and Catherine Avenue

The 72-hour traffic count period spans the three most uniform travel days during the week (i.e., Tuesday-Thursday) and avoids the daily variations in traffic that tend to occur around the weekend periods. The 72-hour volume data was averaged to develop an annual average daily traffic (AADT) volume, which was determined to be approximately 16,000 vehicles per day (vpd) to the west of La Grange Road and approximately 13,700 vpd to the east of La Grange Road, as shown in Figure 3. Vehicle classification data was also collected at that time, which indicated that truck traffic represented less than two percent of the vehicles on 47th Street. The annual average daily truck traffic volumes are also shown in Figure 3.

To establish current traffic conditions at the major intersections along 47th Street during the peak weekday commuter periods, KLOA, Inc. conducted traffic counts at the following locations from 7:00 to 9:00 A.M. in the morning and from 4:00 to 6:00 P.M. in the evening. Based on the data collected, the peak hours were determined to be 7:00 to 8:00 A.M. in the morning and 4:45 to 5:45 P.M. in the evening.

- 47th Street / Gilbert Avenue
- 47th Street / Edgewood Avenue
- 47th Street / Brainard Avenue
- 47th Street / La Grange Road
- 47th Street / East Avenue

The traffic counts at the 47th Street intersections with Gilbert Avenue, Edgewood Avenue, Brainard Avenue and La Grange Road were conducted on Tuesday, August 31, 2010. The traffic counts at 47th Street and East Avenue were conducted on Tuesday, September 29, 2009. All schools in the La Grange School District 102, La Grange School District 105, and Lyons Township High School District 204 were in session at the time of the traffic counts. Figure 3 shows the weekday peak hour traffic volume data at the above intersections. Summaries of the traffic count data are contained in the Appendix of this report.



LEGEND

<0,000> - AVERAGE DAILY TRAFFIC

00 - AM PEAK HOUR (7:00-8:00 AM)

(00) - PM PEAK HOUR (4:45-5:45 PM)

PROJECT:	TITLE:	PROJECT NO: 10-076
47TH ST 3-LANE CONVERSION LA GRANGE, IL	EXISTING TRAFFIC VOLUMES	KLOA FIGURE NO: 3

Crash History

As part of the 47th Street Speed Study, traffic crash data was obtained from IDOT and the Village of La Grange for the years between 2004 and 2008. Data for 2009 was not available at the time that the speed study was prepared. The IDOT summaries for 2004-2008 are shown in Table 1 and indicate that there was an average of 87 intersection-related crashes per year between Gilbert Avenue and East Avenue over the 5-year period. During that 5-year period, one person was killed and 127 were injured. One-third of all of the crashes occurred at either the 47th Street/East Avenue or 47th Street/La Grange Road intersections.

Table 1
CRASH HISTORY ON 47TH STREET (GILBERT AVENUE TO EAST AVENUE)

Year	Total Accidents	Fatal Accidents	Injury Crashes	Property Damage Crashes	People Killed	People Injured
2004	80	0	16	64	0	24
2005	84	1	16	63	1	25
2006	96	0	24	72	0	33
2007	88	0	21	67	0	23
2008	88	0	15	73	0	22
Totals	436	1	92	339	1	127
Average/Year	87.2	0.2	18.4	68.6	0.2	25.4
Percent at 47th St/La Grange Rd Intersection	13%	0	12%	13%	0	7%
Percent at 47th St/East Ave Intersection	21%	0	23%	21%	0	20%

Table 2 provides a more detailed breakdown of the types of traffic crashes that occurred during the 2004-2008 period. As shown, three types of crashes were most prevalent—turning vehicle collisions (34.4%), rear end collisions (27.3%) and right-angle collisions (20.2%). These three collision types account for approximately 82 percent of the crashes.

Rear end collisions are typically associated with signalized or all-way stop controlled intersections. At least one-third of these collisions occurred at the 47th Street/La Grange Road and 47th Street/ East Avenue intersections. Turning collisions can be a result of a lack of separate turn lanes, inadequate sight distance, disobeyance of traffic controls, etc. Almost 25 percent of this collision type occurred at the 47th Street/East Avenue intersection. Right-angle collisions typically occur at intersections controlled by traffic signals or all-way stop control. Fifty percent of the right angle collisions occurred at the 47th Street/East Avenue intersection, primarily as a result of the all-way stop control, high volume of traffic, and multiple lanes on each of the intersection approaches, which makes it confusing for motorists to discern which driver has the right-of-way.

Another crash statistic of importance is the number of sideswipe collisions occurring between vehicles traveling in the same direction. One cause for this type of collision is the lack of left-turn lanes where motorists are suddenly caught behind a left-turning vehicle and attempt to change lanes to avoid having to slow down for the vehicle ahead to turn.

Table 2
TYPE OF CRASH (47TH STREET - GILBERT TO EAST AVENUE)

Type of Crash	2004	2005	2006	2007	2008	Total	Average/Year	Percent
Rear End	18	25	26	25	25	119	23.8	27.3%
Turning	34	29	39	29	19	150	30.0	34.4%
Pedestrian	0	1	0	1	3	5	1.0	1.2%
Angle	19	12	22	15	20	88	17.6	20.2%
Sideswipe (Same Direction)	5	8	3	7	12	35	6.4	8.0%
Fixed Object	2	8	2	8	5	25	5.0	5.7%
Pedal Cyclist	2	1	2	3	2	10	2.0	2.3%
Sideswipe (Opposite Direction)	0	0	0	0	1	1	0.2	0.2%
Head On	0	0	0	0	1	1	0.2	0.2%
Parked Vehicle	0	0	2	0	0	2	0.4	0.5%
Totals	80	84	96	88	88	436	86.6	100%

3.
Proposed Future Conditions

The proposed future traffic conditions along 47th Street reflect the roadway design requirements necessary to convert the roadway to a three-lane cross section based on an analysis of 20-year traffic projections (Year 2030) for the roadway and IDOT's level of service standard. The following describes the benefits of the lane reduction, the purpose and need for the roadway modification, the feasibility of converting the roadway, the projected 2030 traffic volumes in the corridor, the proposed cross-section and geometric configuration, an example of another local area three-lane conversion, and the potential traffic impacts of the redesign on the surrounding local and regional roadway system.

Benefits of Lane Reductions

The lane reduction from four lanes to three lanes can offer benefits to both drivers and pedestrians. On four-lane roadways, speeds can vary between lanes and drivers must slow or change lanes to bypass slower or turning vehicles, particularly those in the inside lanes waiting to make a left-turn. The change in travel speeds and lane changes create conditions that increase the propensity for sideswipe and rear-end crashes. In addition, on four-lane roadways the sight lines to pedestrians crossing the roadway can be blocked by vehicles in the adjoining lane, as can the sight lines to all lanes of traffic for motorists waiting on a side street to cross or turn onto the roadway. Furthermore, four-lane roadways can discourage mobility and access by transit users, pedestrians and bicyclists. In contrast, on three-lane roadways, speeds are limited by the speed of the lead vehicle in the through lanes, and through vehicles are separated from left-turning vehicles. Thus, lane reductions can reduce vehicle speeds and vehicle conflicts, which can reduce the frequency and severity of crashes. Three-lane roadways improve pedestrian safety as well by creating fewer lanes of traffic to cross and reducing the variation in vehicle speeds.

There are several advantages and a few disadvantages of converting a four-lane, undivided roadway to three lanes with a center left-turn lane, as summarized below.

Advantages

- Reduction of one lane of traffic for a narrower travelway.
- Modest decrease in average arterial travel speed (typically less than 5 mph)

- Minimal decrease in average travel times
- Minimal reduction in roadway capacity
- More uniform traffic speeds, creating a more predictable and consistent travel environment
- Typically results in a 60-70% reduction in excessive speeding (>5 mph over posted speed)
- Pedestrian crossings are more comfortable and perceived to be safer as pedestrians have fewer traffic lanes to cross and vehicle speeds are slower and easier to judge
- Less road noise
- Reduction in the number of vehicle conflicts
- Reduction in the number and severity of crashes and dangerous maneuvers, particularly left-turn and rear-end collisions.
- Improved sight distance
- Can make for a more multimodal facility
- Bicycle safety is enhanced by providing a dedicated bike lane instead of a traffic lane shared with motorists.
- Relatively inexpensive to implement, generally only requiring modifying lane striping and altering traffic signals.
- Does not adversely impact adjoining property
- Improve livability and quality of life

Disadvantages

- Perceived reduction in road capacity.
- Minimal increase in travel delays from more frequent stops or slowing behind right-turning vehicles, buses and trucks.
- Increased delays to minor street cross traffic due to fewer gaps in traffic flow
- Lack of passing opportunities
- Potential traffic diversions onto parallel routes

Purpose and Need

The purpose for converting 47th Street to three lanes is to further calm traffic on 47th Street and further increase pedestrian and bicycle safety. The need is created by several factors. First, the recent reduction of the posted speed limit from 35 mph to 30 mph has had relatively little effect on reducing the travel speeds on 47th Street, as noted in the 47th Street Speed Study were the 85th-percentile speed was determined to be slightly higher than 38 mph and the average speeds were around 33 mph. Second, the adjacency of 47th Street to several pedestrian activity areas such as Sedgwick Park, Waiola Park, St. John's Lutheran School and St. John's Lutheran Church results in pedestrian activity along and across 47th Street. La Grange residents continue to express concerns about crossing 47th Street, even after the installation of flashing crosswalk warning beacons and in-pavement crosswalk lights on 47th Street at 9th Avenue. Third, 47th Street is a primary east-west roadway that bisects the Village of La Grange and is a key component of a future Village-serving bicycle system. However, the roadway is presently too narrow (10.5-foot lanes) to safely operate as a shared facility, which is why IDOT recommends use of 47th Street for bicycling "with caution advised", a condition that does not appeal to all types of bicyclists. Given the residential nature of the area adjoining 47th Street and the pedestrian environment, travel speeds in excess of 30 mph do not seem appropriate and are not desirable to Village residents.

Feasibility

Based on the current cross-section of 47th Street and the curb-to-curb dimensions, there is sufficient space to reduce the travelway to three lanes (one through lane in each direction plus a center left-turn lane) while utilizing the excess pavement for dedicated bike lanes on both sides of the street. Typical cross sections of this design and a roadway pavement marking and sign plan for each segment of 47th Street are presented later in this chapter.

From an operational perspective, the daily (24-hour) and peak hour traffic volumes along 47th Street are within acceptable norms for roadways that make for successful conversions.

According to a study on lane reductions conducted by Dan Burden and Peter Lagerwey published in Walkable Communities, Inc., March 1999, the ideal roadway candidate for conversion is a four-lane road carrying 12-18,000 vehicles per day (vpd). The upper comfort range for roadway conversions to three lanes is 20,000-25,000 vpd. Presently, 47th Street carries from 13,700-16,000 vpd. Furthermore, the bi-directional traffic volumes on the various sections of 47th Street are less than 425 vehicles per hour per lane (vphpl), well within the thresholds for three-lane feasibility, as shown below. Roadways carrying less than 1,500 vphpl, such as 47th Street, are good candidates for lane reduction. Roadways carrying in excess of 1,750 vphpl are not good candidates as the volumes are approaching the typical saturation flow rates of urban arterial roadways, which range from 1,900-2,000 vphpl, and the lane reduction could result in more congested travel conditions.

Bi-directional Traffic Volumes per hour per lane (vphpl)	Feasibility
≤ 1,500	Probable
1,500 – 1,750	Exercise Caution
≥ 1,750	Less Likely

Projected 2030 Traffic Volumes

Year 2030 traffic projections for 47th Street were obtained from the Chicago Metropolitan Agency for Planning (CMAP), which developed the projections based on existing ADT data and the results from the most recent (March 2010) CMAP Regional Transportation Plan (RTP)/Transportation Improvement Program (TIP) Travel Demand Analysis, which is based on CMAP 2030 socioeconomic projections and assumes implementation of the 2030 RTP for the Northeastern Illinois area.

As mentioned previously, the KLOA traffic counts indicate that 47th Street presently carries 16,000 vehicles per day (vpd) between La Grange Road and Gilbert Avenue and 13,700 vpd between La Grange Road and East Avenue. The CMAP 2030 traffic projections (see Appendix) indicate that the average daily traffic (ADT) volumes to the west and east of La Grange Road will be 16,000 and 14,000 vpd, respectively, for a traffic growth rate that ranges from 0-0.1 percent per year over the next 20 years. Due to the minimal growth in traffic from these projections, the existing traffic volumes on 47th Street were not adjusted for the traffic analysis of the three-lane roadway design.

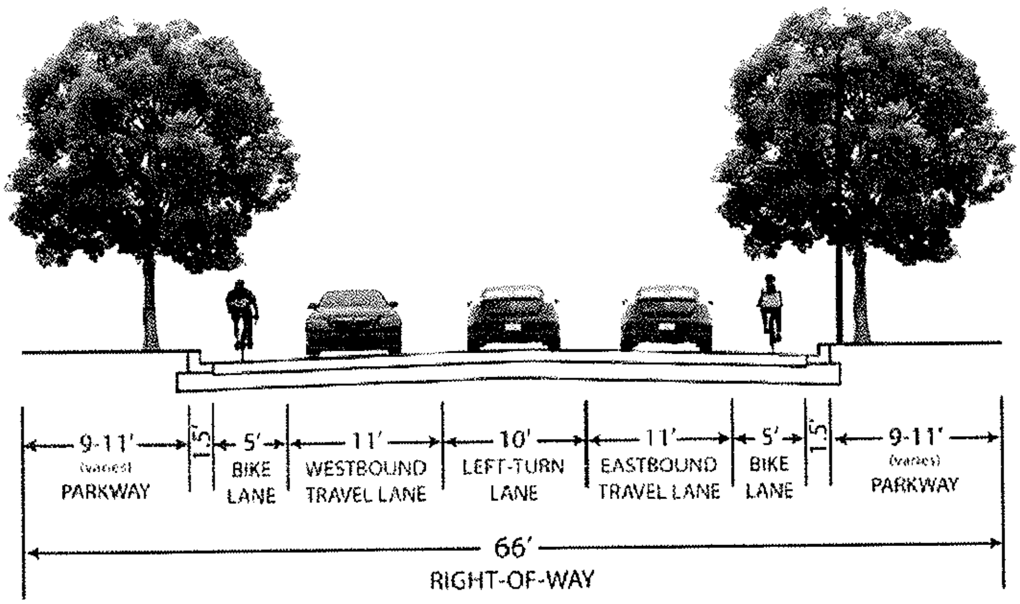
Proposed Geometric Reconfiguration

Figure 4 illustrates the typical cross section on 47th Street with the recommended modifications to a three-lane roadway. Section B-B corresponds with Sheet 2 in the Appendix and shows a typical three-lane section at an intersection where a center left-turn lane will be provided (e.g. Edgewood Avenue, Brainard Avenue, etc.). Section C-C corresponds with Sheet 5 in the Appendix and shows a typical mid-block three-lane section where a painted center median will be provided, such as at the offset cross-streets of 6th, 7th, 8th and 9th avenues. The existing four travel lanes are presently approximately 10.5 feet wide. The recommended cross section will provide one 11-foot wide through lane in each direction, a 10-foot wide center median/left-turn lane, and a 5-foot wide bike lane on both sides of the roadway.

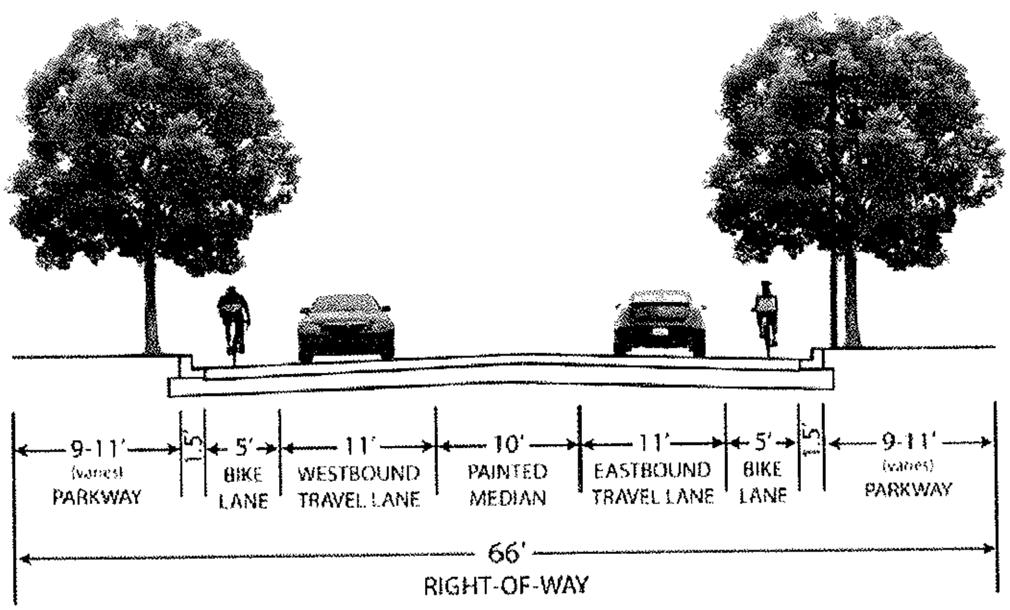
Sheets 1-7 in the Appendix illustrate the recommended pavement marking modifications and sign installations necessary to convert 47th Street to a three-lane cross section. The pavement markings define the bike lane markings, dedicated left-turn lanes, painted medians and lane transitions. The new signs include bike lane and shared lane signs. The plan also includes notations at the signalized intersections (Gilbert Avenue, Edgewood Avenue, Brainard Avenue) in which traffic signal phasing and equipment will need to be modified to control and align with the dedicated left-turn lanes. Modifications could include modified traffic signal phasing/timing plans, new or relocated signal heads, mast arm extensions, new or modified loop detectors, and upgraded pedestrian signals.

It is important to note that a four-lane cross section is maintained on 47th Street at La Grange Road, East Avenue and Gilbert Avenue. At La Grange Road, the traffic analysis (presented in the next chapter) indicated that four through lanes would need to be maintained on 47th Street at La Grange Road for this intersection to continue to operate at IDOT's level of service standard during the peak commuter hours. This is due in part to the higher volumes of traffic on La Grange Road and the traffic signal phasing splits that must be maintained at this intersection. At East Avenue, the traffic delays created by frequent train activity requires that four lanes be maintained to provide adequate storage capacity to prevent substantial traffic back-ups and to clear the intersection in a timely manner after the train events concludes. The four lanes are required at East Avenue regardless of whether traffic signals are installed at the intersection. At Gilbert Avenue, two through lanes are maintained on the westbound approach (east leg) only to provide for an efficient transition to the existing four-lane cross section to the west of the Village limits.

PROPOSED SECTION B-B



PROPOSED SECTION C-C



PROJECT:	TITLE:	PROJECT NO: 10-076
47TH ST 3-LANE CONVERSION LA GRANGE, IL	PROPOSED CROSS SECTIONS	KLOA
		FIGURE NO: 4

At the intersections where the existing cross section is maintained, the bike lane is dropped and a shared (vehicle and bike) lane is utilized, in accordance with the design guidelines of the American Association of State Highway and Transportation Officials' *Guide for the Development of Bicycle Facilities* and the Federal Highway Administration's *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD).

The following describes the recommended roadway modifications that will be required for various sections of 47th Street.

47th Street and Gilbert Avenue

As shown on Sheet 1 in the Appendix, the lane markings on 47th Street have been modified to create an efficient transition with the existing four-lane roadway on the west side of Gilbert Avenue, which is within the Village of Western Springs. The following changes would be made at this intersection:

- The west leg of the intersection would be re-striped with the curb lane converted from a through lane to a dedicated right-turn lane, leaving a single through lane on this approach.
- The east leg of the intersection would be re-striped to include an eastbound bike lane, lane transition markings, and a shorter westbound left-turn taper.
- To maintain the four lane transition on the east leg of the intersection, the bike lane would be dropped just west of Peck Avenue.
- Bike Lane Ahead signs, Bike Lane signs, Bike Lane Ends signs and Shared Lane Yield to Bikes signs would be posted as shown on Sheet 1.
- Modifications will likely be required to the traffic signal equipment and phasing/timings at this intersection.

47th Street – Peck Avenue to Leitch Avenue

As shown on Sheet 1 in the Appendix, the lane markings along this section of 47th Street have been modified as follows:

- Due to the need to maximize westbound left-turn stacking space at Gilbert Avenue, as well as the short distance from the private driveway on the south side of 47th Street and Peck Avenue and Leitch Avenue on the north side of 47th Street, a painted center median is utilized in place of dedicated left-turn lanes, which cannot be effectively provided within the spacing constraints.
- Bike lanes are provided on the north and south sides of 47th Street.
- Since the width of 47th Street tapers from 52 feet at Peck Avenue to 42 feet at Leitch Avenue, lane transition striping is utilized along the north and south edges of the roadway between the bike lanes and curb.

47th Street – Leitch Avenue to Madison Avenue

As shown on Sheets 1-5 in the Appendix, the lane markings along this section of 47th Street have been modified as follows:

- Dedicated left-turn lanes are provided at all intersections. The left-turn lane storage has generally been balanced between intersections except at the signalized intersections of Edgewood Avenue and Brainard Avenue where left-turn storage of no less than 100 feet has been provided.
- Bike lanes are provided on the north and south sides of 47th Street.
- Modifications will likely be required to the traffic signal equipment and phasing/timings at the Edgewood Avenue and Brainard Avenue intersections.

47th Street and La Grange Road

As shown on Sheet 5 in the Appendix, the lane markings on 47th Street have been modified to create an efficient transition between the proposed three-lane sections to the east and west of La Grange Road and the required four-lane section (plus turn lane) that will be maintained at La Grange Road. The following changes would be made at this intersection:

- On the east leg of the intersection, the left-turn lane storage length would be increased by 5 feet and the left-turn taper length would be reduced by 5 feet.
- On the west leg of the intersection, the left-turn lane storage would be reduced by 5 feet and the left-turn lane taper would be reduced by 45 feet to provide for a short westbound left-turn lane onto Madison Avenue.
- To maintain the four lane cross section on 47th Street at La Grange Road, the bike lanes would be dropped to the east and west of the intersection.
- Bike Lane Ahead signs, Bike Lane signs, Bike Lane Ends signs and Shared Lane Yield to Bikes signs would be posted as shown on Sheet 5.

47th Street – 6th Avenue to 10th Avenue

The offsets of 6th Avenue, 7th Avenue, 8th Avenue and 9th Avenue with 47th Street create unique challenges with accommodating left-turn movements in dedicated turn lanes. As shown on Sheets 5-6 in the Appendix, the lane markings along this section of 47th Street have been modified as follows:

- The short offsets create an inability to provide dedicated left-turn lanes for both eastbound and westbound turning movements onto the cross streets. As such, a continuous painted center median would be utilized from 6th Avenue to 10th Avenue with breaks in the median at the cross streets.
- Bike lanes are provided on the north and south sides of 47th Street.

47th Street – 10th Avenue to Bluff Avenue

As noted previously, a four-lane cross section must be maintained at the East Avenue intersection and in the vicinity of the railroad grade crossing. The section of 47th Street between 10th Avenue and Bluff Avenue would be utilized to provide the transition between the three-lane and four-lane roadway sections. As shown on Sheet 6 in the Appendix, the lane markings along this section of 47th Street have been modified as follows:

- The roadway width of 47th Street presently tapers from 52 feet at Bluff Avenue to 42 feet at 10th Avenue. To provide the transition from four lanes at Bluff Avenue to three lanes at 10th Street, a 228-foot lane drop taper and 150-foot lane shift/left-turn taper is utilized.
- Bike lanes are provided on the north and south sides of 47th Street but are dropped approximately 50 feet east of 10th Avenue.
- Bike Lane Ahead signs, Bike Lane signs, Bike Lane Ends signs and Shared Lane Yield to Bikes signs would be posted as shown on Sheet 6.

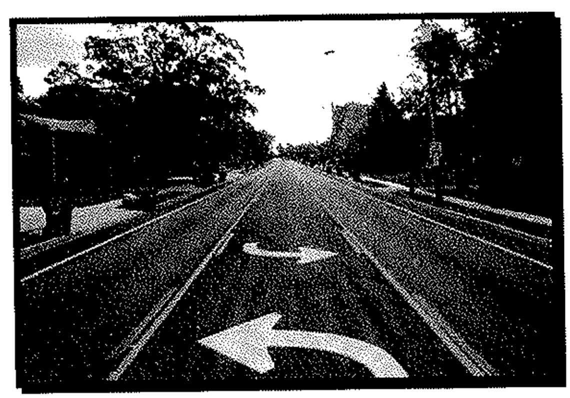
47th Street and East Avenue

The striping plan at East Avenue, shown on Sheets 6-7 in the Appendix, is the proposed plan that was developed in a traffic engineering study recently conducted for the Village by KLOA, Inc. (draft report dated April 26, 2010). This engineering study determined that a traffic signal should be installed at this intersection based on the satisfaction of several traffic signal warrants from the MUTCD. The plan maintains four travel lanes plus a left-turn lane on 47th Street.

Local Area Example

An example of a recent conversion of a four-lane undivided roadway to a three-lane roadway can be seen along 26th Street (1st Avenue to Des Plaines Avenue) in the nearby Village of North Riverside. "Before" and "after" photos of 26th Street are shown below.

Before Conversion



After Conversion

26th Street – North Riverside, IL

Potential Diversion of Auto and Truck Traffic

Published "before" and "after" case studies for roadways converted from four lanes to three were reviewed as part of this study. In almost every case, the ADT volumes carried on the roadways exhibited minimal to no change. Where the volumes did change, the range was modest from -10 to +15 percent, meaning volumes were either diverted to or attracted from other parallel roads.

In La Grange, the other parallel east-west arterial roadways that are comparable to 47th Street in function, design and volumes carried are Ogden Avenue and 55th Street, both located approximately one mile from 47th Street and both carrying traffic volumes ranging from 20,500-24,500 vpd. The posted speed limit on Ogden Avenue is 30 mph and the posted speed limit on 55th Street is 40 mph. Considering the distance these roadways are from 47th Street, and the fact that they carry higher volumes at similar travel speeds and are more congested, would suggest that traffic on 47th Street is less likely to divert to these arterial roadways as opposed to continuing to travel on 47th Street under the modified three-lane design.

Parallel east-west collector roadways in La Grange include Cossitt Avenue and Plainfield Road, located ½-mile to one mile from 47th Street. Plainfield Road is a two-lane roadway with left-turn lanes provided only at the signalized intersections with East Avenue, La Grange Road, 55th Street, Brainard Avenue and Gilbert Avenue. There are numerous cross streets and driveways that intersect with Plainfield Road at locations that do not have turn lanes. The posted speed limit on Plainfield Road is 35 mph and there is a 20 mph school speed zone north of 55th Street. Cossitt Avenue is a two-lane roadway with left turn lanes provided only at its signalized intersections with La Grange Road. There are several stop signs on Cossitt Avenue through the Village, including at intersections with East Avenue, Bluff Avenue, Madison Avenue, Ashland Avenue, Kensington Avenue, Brainard Avenue and Gilbert Avenue. There area also 20 mph school speed zones on Cossitt Avenue adjacent to Cossitt Avenue School and Lyons Township High School-North Campus. Based on the roadway design, speed limits and traffic controls on Plainfield Road and Cossitt Avenue, there does not appear to be any benefit or efficiencies gained for motorists to use these roadways as an alternative to 47th Street.

Most parallel east-west local streets in La Grange located within a couple of blocks of 47th Street are not continuous through the Village. Furthermore, they are all two-lane streets (no turn lanes) with posted speed limits of 25 mph. These streets (Maple Avenue, Goodman Avenue, 48th Street, 49th Street) are also controlled by stop signs, in most cases located every 2-3 blocks. The exception being along Maple Avenue where there are no stops for 5 blocks between Bluff Avenue and La Grange Road and no stops for 7 blocks between Gilbert Avenue and Brainard Avenue. In general, travel times on these local streets would be considerably higher for motorists electing to divert off of 47th Street.

As noted earlier, truck traffic represented less than two percent of the vehicles counted on 47th Street. The conversion of 47th Street to three lanes is expected to result in minimal diversions of truck traffic onto other roadways area roadways for the same reasons as discussed above. However, jurisdictional transfer of 47th Street to the Village would provide the Village with more control over the type of truck traffic using the roadway and could result in the diversion of truck traffic onto the other parallel arterial roadways.

Preliminary Cost Estimate

As mention previously, the focus of this study is on the redesign of 47th Street within the existing curb-to-curb width of the roadway. A preliminary cost estimate was prepared by Heuer & Associates in June 2009 for a design similar to that shown in the Appendix of this report. Many of the cost elements of the Heuer & Associates estimate revolved around the resurfacing of the roadway and associated drainage components. However, IDOT's recently completed resurfacing project of 47th Street potentially averts the need to resurface 47th Street again to convert the roadway to a three-lane design, particularly if the existing pavement markings can be removed and replaced without causing damage to the driving surface. The remaining cost elements to implement the three-lane design would be associated with new pavement markings, signs, traffic control modifications, design engineering and construction engineering.

As an alternative to converting the roadway to a three-lane design without modifying the curb lines, Heuer & Associates had also prepared a preliminary cost estimate for the full reconstruction of 47th Street to create a more permanent three-lane roadway, including the relocation of the curbs, creation of a wider parkway with enhanced streetscaping, construction of a separate (off-street) bicycle path within the parkway along the south side of the roadway, construction of a wider sidewalk along the north side of the roadway, improved roadway lighting, and the installation of new water main.

Three preliminary cost estimates are provided below for the proposed three-lane conversion of 47th Street. The first design alternative would be constructed within the existing curb-to-curb width of the roadway and assumes that pavement resurfacing can be avoided and that new pavement markings, signs and traffic control modifications are the only major changes that would be required. The second design alternative would be constructed within the existing curb-to-curb width of the roadway and assumes the need to resurface the roadway again. The third design alternative assumes full reconstruction of the roadway with new curb lines. These cost estimates reflect a combination of the preliminary cost estimates previously prepared by Heuer & Associates and the preliminary cost estimates prepared by KLOA, Inc. for the phasing and equipment modifications necessary to the existing traffic signals. These cost estimates do not include the cost for the roadway reconfiguration and installation of traffic signal control at the 47th Street/East Avenue intersection.

Three-Lane Design Alternative	Preliminary Estimate of Project Cost
1. With New Pavement Markings Only	$500,000
2. With Pavement Resurfacing	$2,500,000
3. With Full Reconstruction	$11,500,000

The advantage of implementing the three-lane design with new pavement markings only is that it could be implemented as an interim measure, at relatively low cost, as a test case. If successful, the Village could pursue the full reconstruction of the roadway with IDOT to establish the final ultimate design. If unsuccessful, the cost would be relatively low to convert the roadway back to its original (current) four-lane design.

4.
Traffic Operations Analysis

To evaluate existing traffic operations within the 47th Street corridor and to establish a baseline for comparison with the proposed redesign of the roadway, traffic analyses were performed for all key intersections along 47th Street during the weekday peak hours.

The traffic analyses were performed using HCS+ computer software which is based on the methodologies outlined in the Transportation Research Board's *Highway Capacity Manual (HCM), 2000*. Analyses were also performed using Synchro 6.0 and SimTraffic computer software, which aids in the analysis and visualization of corridor traffic progression and interconnected traffic signal systems, and was used to evaluate existing unsignalized operations at the 47th Street/East Avenue intersection.

The ability of an intersection to accommodate traffic flow is expressed in terms of level of service, which is assigned a letter grade from A to F based on the average control delay experienced by vehicles passing through the intersection. Control delay is that portion of the total delay attributed to the traffic signal or stop sign controlled operation and includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Level of Service A is the highest grade (best traffic flow and least delay), Level of Service E represents saturated or at-capacity conditions, and Level of Service F is the lowest grade (oversaturated conditions, extensive delays). For suburban two-way arterials such as 47th Street, IDOT geometric design criteria (Figure 48-6A from the BDE manual) indicates that a Level of Service C be achieved for roadway reconstruction projects.

For signal controlled intersections, levels of service are calculated for lane groups, intersection approaches, and the intersection as a whole. For two-way stop controlled (TWSC) intersections, levels of service are only calculated for the approaches controlled by a stop sign (not for the intersection as a whole). Level of Service F at TWSC intersections occur when there are not enough suitable gaps in the flow of traffic on the major (uncontrolled) street to allow minor street traffic to safely enter or cross the major street.

The *Highway Capacity Manual* definitions for levels of service and the corresponding control delay for signalized and unsignalized intersections are shown in Table 3.

Table 3
LEVEL OF SERVICE CRITERIA

Signalized Intersections

Level of Service	Interpretation	Average Control Delay (seconds per vehicle)
A	Very short delay, with extremely favorable progression. Most vehicles arrive during the green phase and do not stop at all.	≤10
B	Good progression, with more vehicles stopping than for Level of Service A, causing higher levels of average delay.	>10-20
C	Light congestion, with individual cycle failures beginning to appear. Number of vehicles stopping is significant at this level.	>20-35
D	Congestion is more noticeable, with longer delays resulting from combinations of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop, and the proportion of vehicles not stopping declines.	>35-55
E	High delays result from poor progression, high cycle lengths, and high V/C ratios.	>55-80
F	Unacceptable delays occurring, with oversaturation.	>80.0

Unsignalized Intersections

Level of Service	Average Control Delay (seconds per vehicle)
A	0-10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	>50

Source: Highway Capacity Manual, 2000.

Existing Intersection Operations

Table 4 summarizes the results of the HCS+ capacity analyses for the existing weekday morning and evening peak hour conditions. The results indicate that all intersections in the 47th Street corridor presently achieve IDOT's desired intersection level of service standard of C during the weekday peak hours, with the exception of 47th Street/Brainard Avenue in the morning peak hour and 47th Street/East Avenue in the evening peak hour. The capacity analysis worksheets are contained in the Appendix.

The existing traffic volumes through the 47th Street/East Avenue intersection are at levels that cannot be accommodated at desirable levels of service under the current all-way stop control. A traffic engineering study recently conducted for the Village by KLOA, Inc. for this intersection (draft report dated April 26, 2010) determined that a traffic signal should be installed at this intersection based on the satisfaction of several traffic signal warrants from the Federal Highway Administration's *Manual on Uniform Traffic Control Devices for Streets and Highways, 2009,* including Warrant 1 (Eight-Hour Vehicular Volume), Warrant 2 (Four-Hour Vehicular Volume), Warrant 3 (Peak Hour) and Warrant 9 (Intersection Near a Grade Crossing). The study also determined the necessary geometric modifications to this intersection to accommodate traffic signal control. These geometric modifications were incorporated into the recommended pavement marking plan for the three-lane design shown in the Appendix.

Table 4
HCS+ CAPACITY ANALYSIS RESULTS—EXISTING TRAFFIC CONDITIONS

	Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
Intersection	LOS	Delay	LOS	Delay
Signalized Intersections				
47th Street / Gilbert Avenue	C	33.1	C	30.7
47th Street / Edgewood Avenue	B	11.7	B	11.1
47th Street / Brainard Avenue	D	40.1	C	29.7
47th Street / La Grange Road	C	34.5	C	33.9
Unsignalized Intersections				
47th Street / East Avenue[1]	D	43.6	F	125.7

Note: LOS = Level of Service Delay = seconds/vehicle
[1]Represents all-way stop control. Analysis performed using SimTraffic.

Projected Intersection Operations

Table 5 summarizes the results of the HCS+ capacity analyses for the projected 2030 weekday morning and evening peak hour conditions under the three-lane roadway design. The results indicate that all intersections, with the exception of the 47th Street/Brainard Avenue intersection in the morning peak hour, will achieve IDOT's desired intersection level of service standard of C during the weekday peak hours. The 47th Street/Brainard Avenue intersection presently operates at level of service D in the morning peak hour under the four-lane roadway design and will continue to operate at the same level of service with a three-lane cross section. The analysis of projected conditions also assumes the signalization of the 47th Street/East Avenue intersection, which will substantially improve traffic operations at this intersection, reduce vehicle delays and enhance traffic safety. The capacity analysis worksheets are contained in the Appendix.

The minimal changes in intersection level of service and delays created by the three-lane conversion are another reason why traffic diversions from 47th Street onto other parallel roadways are expected to be minimal.

Table 5
HCS+ CAPACITY ANALYSIS RESULTS—PROJECTED 2030 TRAFFIC CONDITIONS

	Weekday A.M. Peak Hour		Weekday P.M. Peak Hour	
Intersection	LOS	Delay	LOS	Delay
Signalized Intersections				
47th Street / Gilbert Avenue	C	33.8	C	33.5
47th Street / Edgewood Avenue	B	17.0	B	17.1
47th Street / Brainard Avenue	D	39.6	C	31.3
47th Street / La Grange Road	C	34.5	C	33.9
47th Street / East Avenue	C	33.1	C	33.3

Note: LOS = Level of Service Delay = seconds/vehicle

Corridor Operations

SimTraffic software was utilized to evaluate progression along the 47th Street arterial corridor and determine average travel times on 47th Street during the weekday peak hours. Table 6 shows the results from the arterial analysis for both existing (four-lane roadway) and projected (three-lane roadway) conditions. The projected conditions were evaluated two ways: (1) with 47th Street/East Avenue under current all-way stop control, and (2) with signalization of the 47th Street/East Avenue intersection. The data shown in Table 6 represents the average travel times that a vehicle on 47th Street would experience if it were to traverse the entire 1.5-mile corridor between the east Village limit at East Avenue and the west Village limit at Gilbert Avenue. The travel time data reflects vehicular movements between intersections as well as vehicular delays from stops at intersections (when signals are red) and at the railroad (during train events when the gates are down). The SimTraffic corridor performance reports are contained in the Appendix.

Table 6
ARTERIAL ANALYSIS OF 47th STREET CORRIDOR-PROJECTED 2030 CONDITIONS

	Average Travel Time (Minutes)[1]	
	AM Peak Hour	PM Peak Hour
Eastbound 47th Street		
Existing 4-Lane Roadway	9.6	5.8
Projected 3-Lane Roadway (47th/East Unsignalized)	9.7	6.3
Projected 3-Lane Roadway (47th/East Signalized)	6.3	6.5
Westbound 47th Street		
Existing 4-Lane Roadway	5.4	8.6
Projected 3-Lane Roadway (47th/East Unsignalized)	7.3	10.3
Projected 3-Lane Roadway (47th/East Signalized)	6.8	6.8

[1] Represents average travel time for a vehicle to traverse the entire 47th Street corridor between East Ave. and Gilbert Ave.

The arterial analysis results show that the conversion of the roadway from four lanes to three lanes has a minimal effect on the average travel times through the corridor, as noted earlier in this report. With the 47th Street/East Avenue intersection remaining under all-way stop control, the results indicate that average travel times would increase by less than one minute in the eastbound direction and less than two minutes in the westbound direction for vehicles traveling the full 1.5-mile corridor. The travel time increases would be less for vehicles traveling only a portion of the corridor. The signalization of the 47th Street/East Avenue intersection would generally cause these corridor travel time increases to be less or may even result in travel time reductions over existing conditions as is the case for the eastbound direction in the morning and the westbound direction in the evening.

The net effect of these changes in average travel times is a calmer travel environment along 47th Street with more uniform traffic speeds, which is the primary purpose of the roadway design change.

5.
Conclusion and Next Steps

Many communities nationwide are implementing lane reductions on four-lane roadways serving their communities. In the process, the roadways often become narrower, safer, more efficient, and multi-modal. Three-lane roadways have been demonstrated to operate at similar service levels as four-lane roadways, carry the same volume of traffic, and provide calmer and safer travel conditions for motorists, pedestrians and bicyclists.

The purpose of this study was to determine if conditions were feasible for the conversion of 47th Street to a three lane design and, if so, to develop a preliminary plan showing the necessary changes in pavement markings, signs and traffic signal controls. All pavement modifications would be made within the existing curb-to-curb width of the roadway. The findings from this study do indeed show that 47th Street appears to be an attractive candidate for a three-lane configuration. The geometric conditions of the roadway are sufficient, the traffic volumes utilizing the roadway are within acceptable ranges, and projected traffic operations result in acceptable levels of service during the weekday peak hours. Furthermore, pedestrian safety will be enhanced and dedicated bicycle lanes will be developed, which will better connect key community destinations (i.e., parks, schools, churches) by non-motorized means, a clearly articulated desire of the Village.

The potential for traffic to divert off of 47th Street onto parallel arterial, collector or local roadways once 47th Street is converted to three lanes appears to be low due to several factors, including:

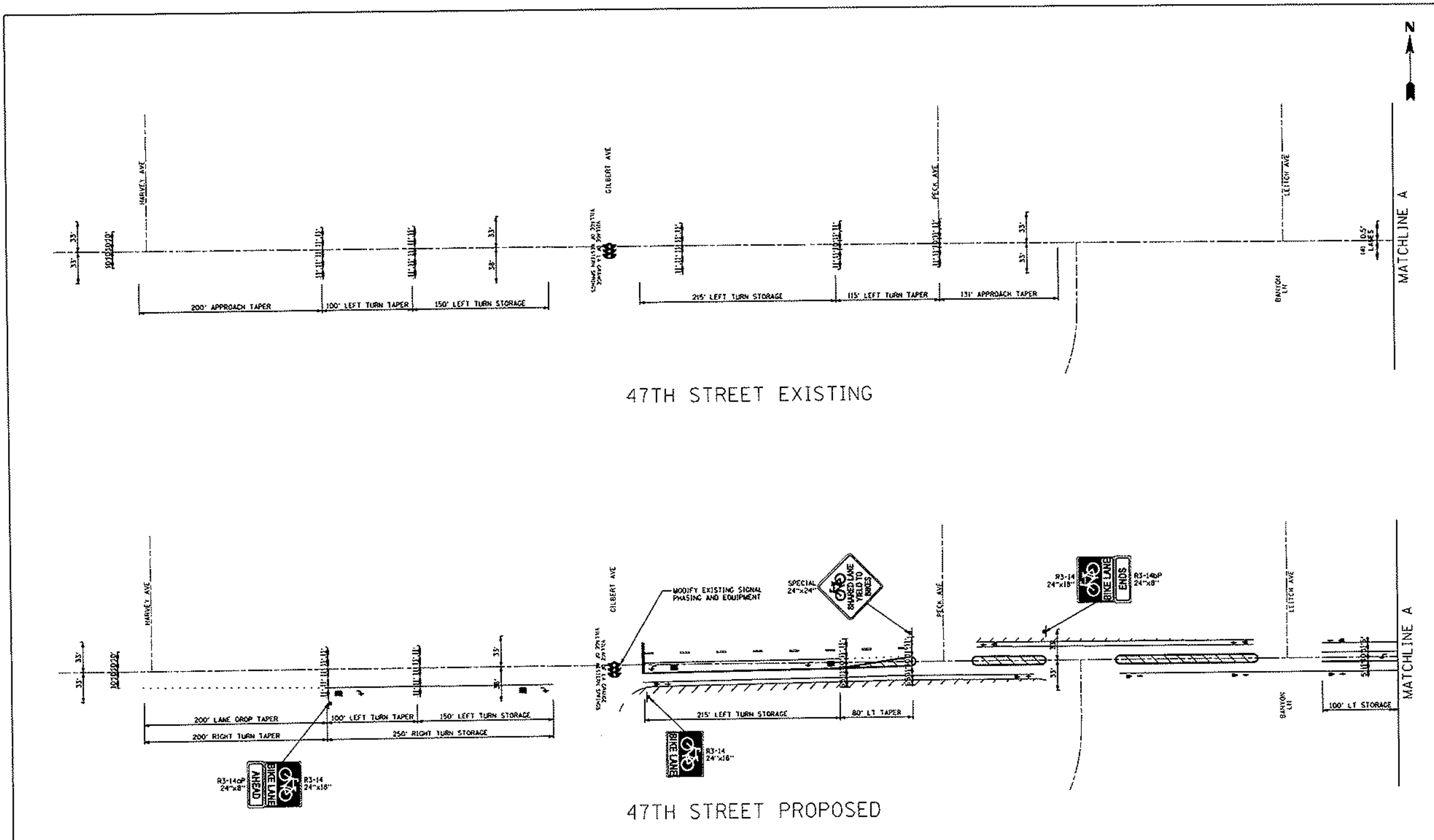
- the distance (one mile) to comparable arterials
- the higher volumes and more congested conditions on these arterials
- the similar speed limits on the arterials
- the two-lane design of the parallel collector roadways
- the lower posted speed limits and frequent stop sign controls on the local roadways
- and the minimal changes in average travel times along 47th Street

Thus, traffic diverting onto other roadway facilities will experience higher travel times than remaining on 47th Street.

With concurrence from the Village of La Grange staff on the findings and recommendations of this feasibility study, the report should be forwarded to the Illinois Department of Transportation for review and comment and to obtain guidance as to the required follow-up engineering design studies necessary for the conversion of 47th Street to three lanes. It is anticipated that IDOT may require additional traffic operational analyses, Intersection Design Studies (IDS) and Traffic Signal Modification Plans for the signal-controlled intersections, and an Phase 2 pavement marking plan showing the pavement marking and sign removals and installations, a list of pay items, design details and technical specifications, and an engineers opinion of probable construction cost. Upon receiving IDOT guidance on the required follow-up studies, the Village could schedule a public meeting to present the preliminary striping and sign plan and to receive comments and feedback from the local residents.

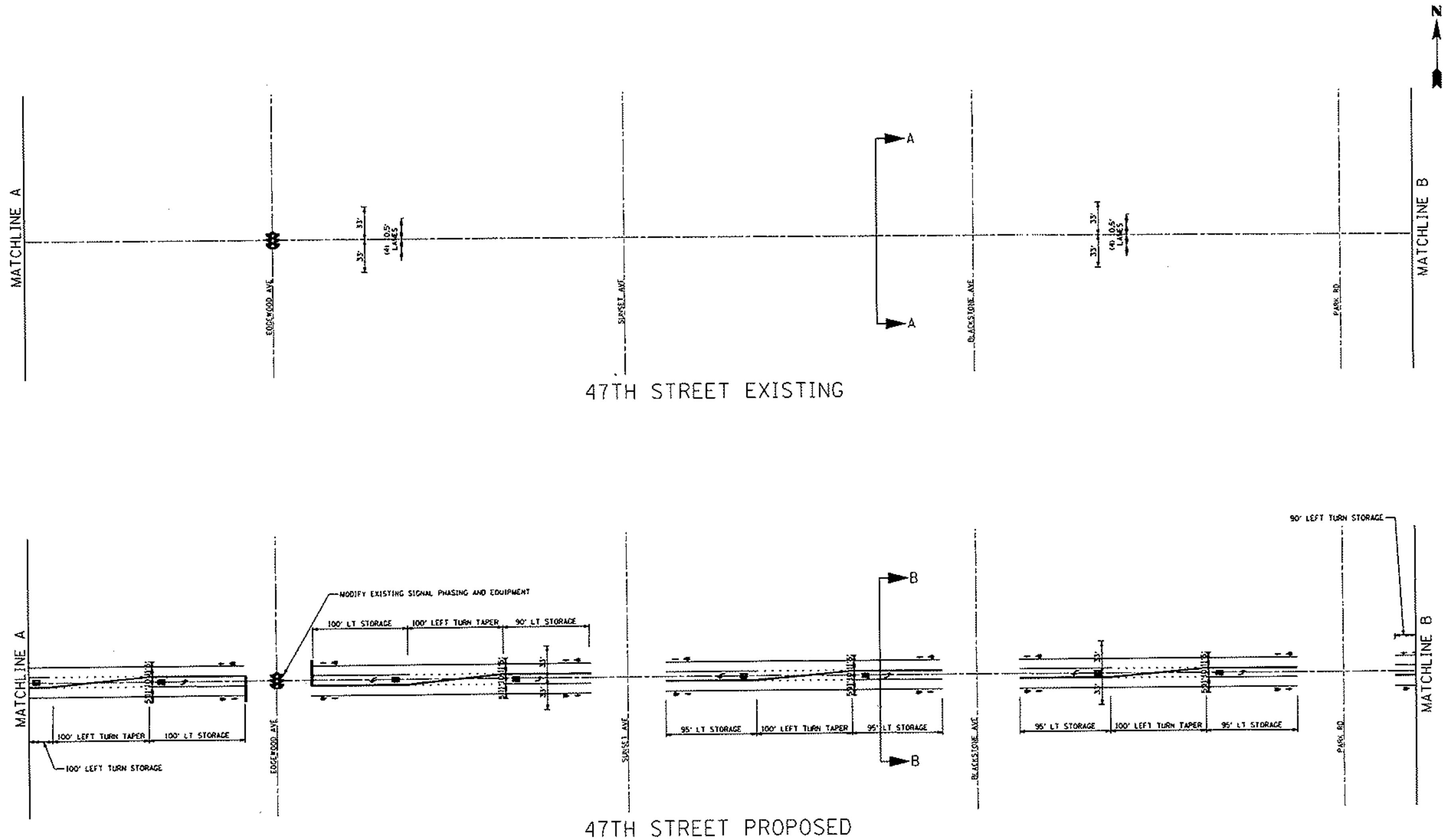
Appendix

Pavement Marking & Sign Plans



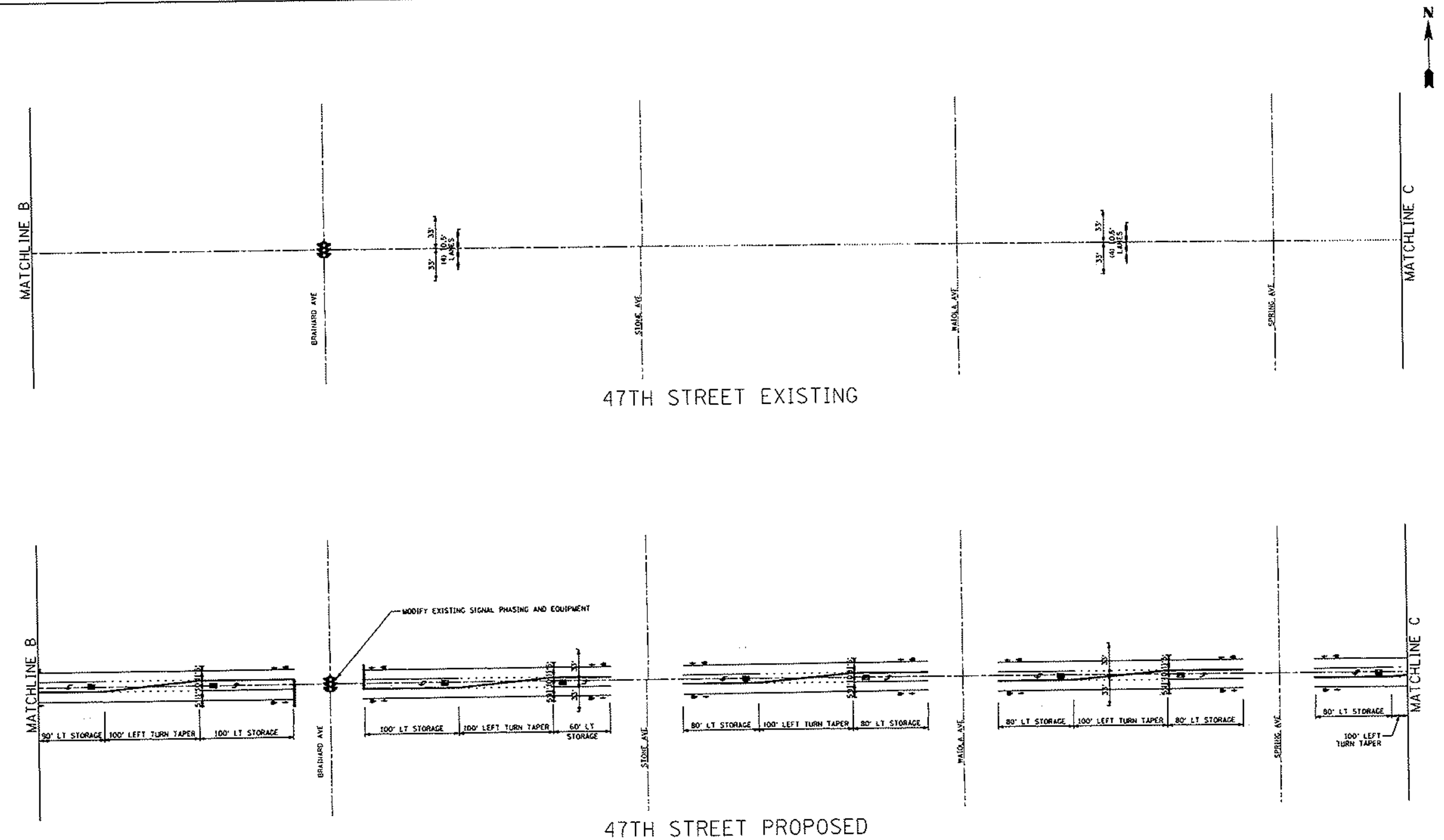
PRELIMINARY

KLOA	VILLAGE OF LA GRANGE	DESIGNED - CJG DRAWN - CJG CHECKED - DMS DATE - 12/22/2010	REV DATE	CHECKED	REVISION	47TH STREET 4-LANE TO 3-LANE CONVERSION PRELIMINARY PAVEMENT MARKING AND SIGN PLAN SCALE: 1" = 50' FILE NAME: ...\plan shs 1.dgn	COUNTY: COOK; TOTAL SHEETS: 7; SHEET NO.: 1



PRELIMINARY

KLOA (Kenig, Lindgren, O'Hara, Aboona, Inc.)	VILLAGE OF LA GRANGE	DESIGNED - CJG DRAWN - CJG CHECKED - DMS DATE - 12/22/2010	REV DATE / CHECKED / REVISION	47TH STREET 4-LANE TO 3-LANE CONVERSION PRELIMINARY PAVEMENT MARKING AND SIGN PLAN SCALE: 1" = 50' FILE NAME: ...\plan sht 2.dgn	COUNTY: COOK / TOTAL SHEETS: 7 / SHEET NO.: 2



PRELIMINARY

KLOA

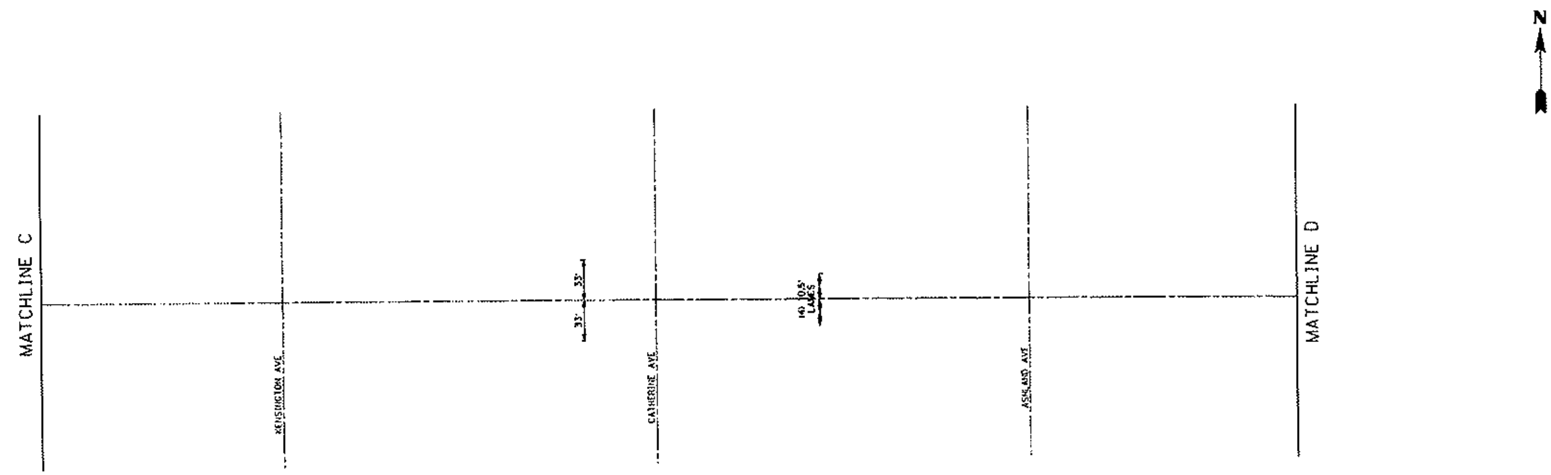
VILLAGE OF LA GRANGE

DESIGNED - GJG	REV DATE	CHECKED	REVISION
DRAWN - GJG			
CHECKED - DMS			
DATE - 12/22/2010			

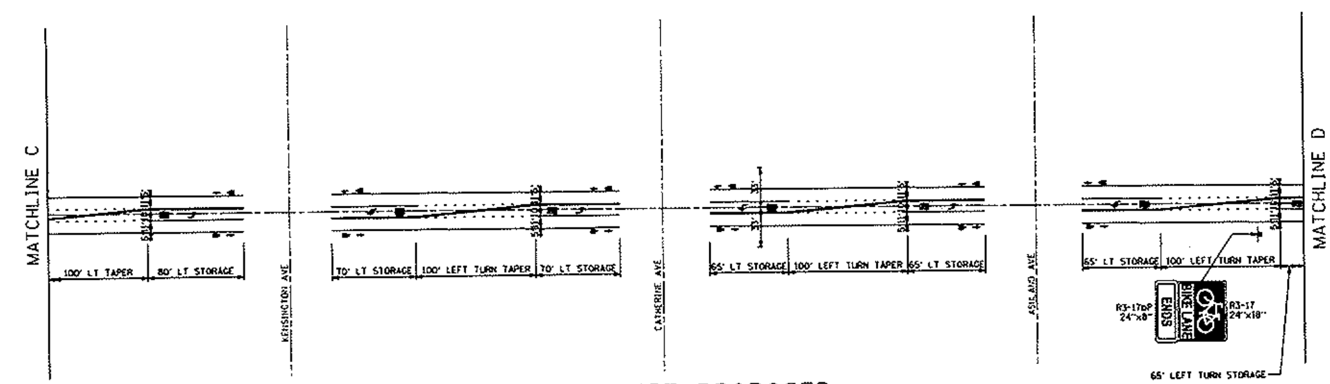
47TH STREET 4-LANE TO 3-LANE CONVERSION
PRELIMINARY PAVEMENT MARKING AND SIGN PLAN

SCALE: 1" = 50' | FILE NAME: ...\plan sht 3.dgn

COUNTY	TOTAL SHEETS	SHEET NO.
COOK	7	3



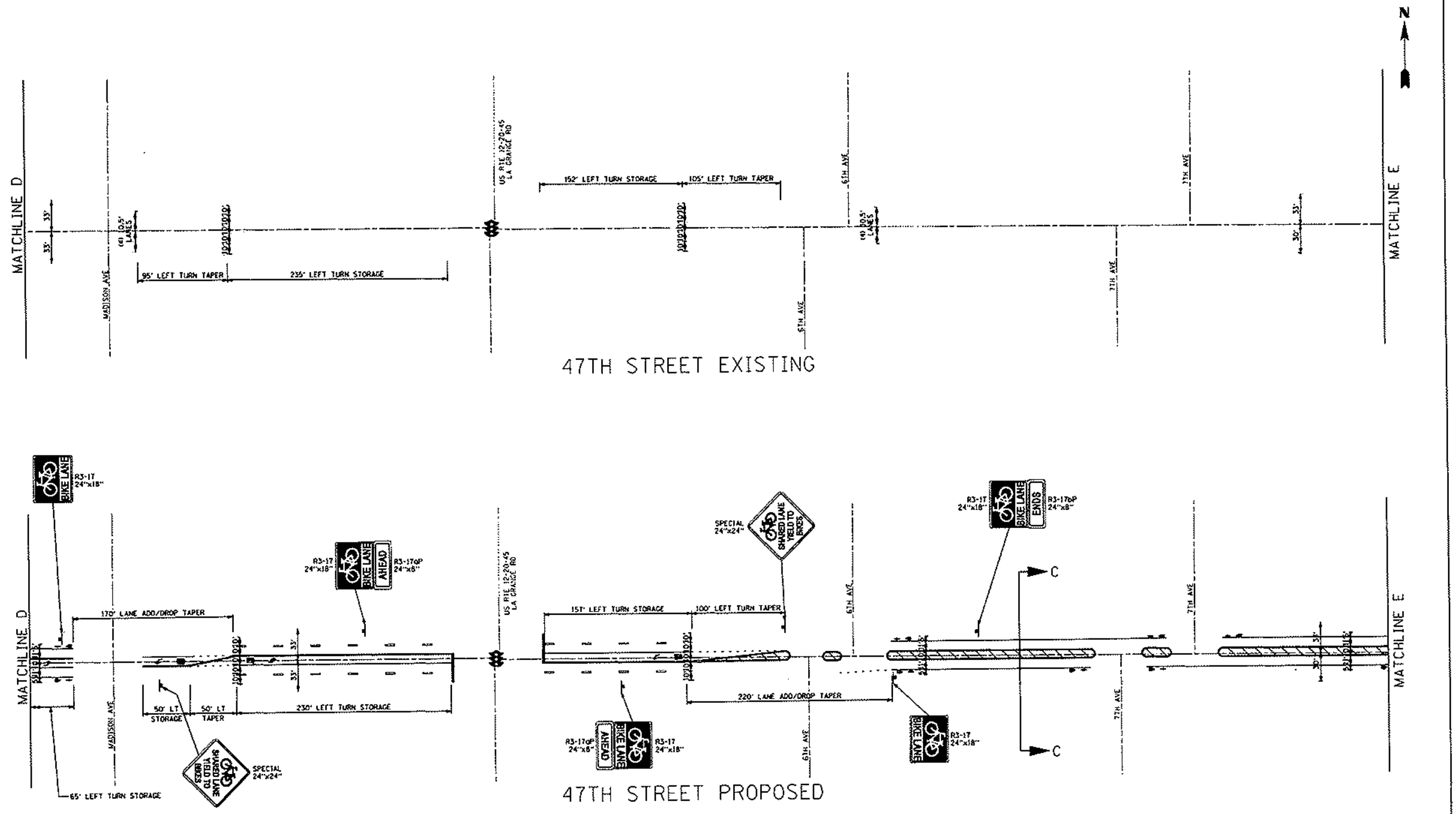
47TH STREET EXISTING



47TH STREET PROPOSED

PRELIMINARY

KLOA	VILLAGE OF LA GRANGE	DESIGNED - GJG DRAWN - GJG CHECKED - DMS DATE - 12/22/2010	REV DATE	CHECKED	REVISION	47TH STREET 4-LANE TO 3-LANE CONVERSION PRELIMINARY PAVEMENT MARKING AND SIGN PLAN SCALE: 1" = 50' FILE NAME:...\plan sht 4.dgn	COUNTY: COOK TOTAL SHEETS: 7 SHEET NO.: 4



PRELIMINARY

KLOA Kenig, Lindgren, O'Hara, Aboona, Inc.
9575 West Higgins Road, Suite 400
Rosemont, Illinois 60018
P: (847) 518-9990 F: (847) 518-9987
PROJECT # 10-676

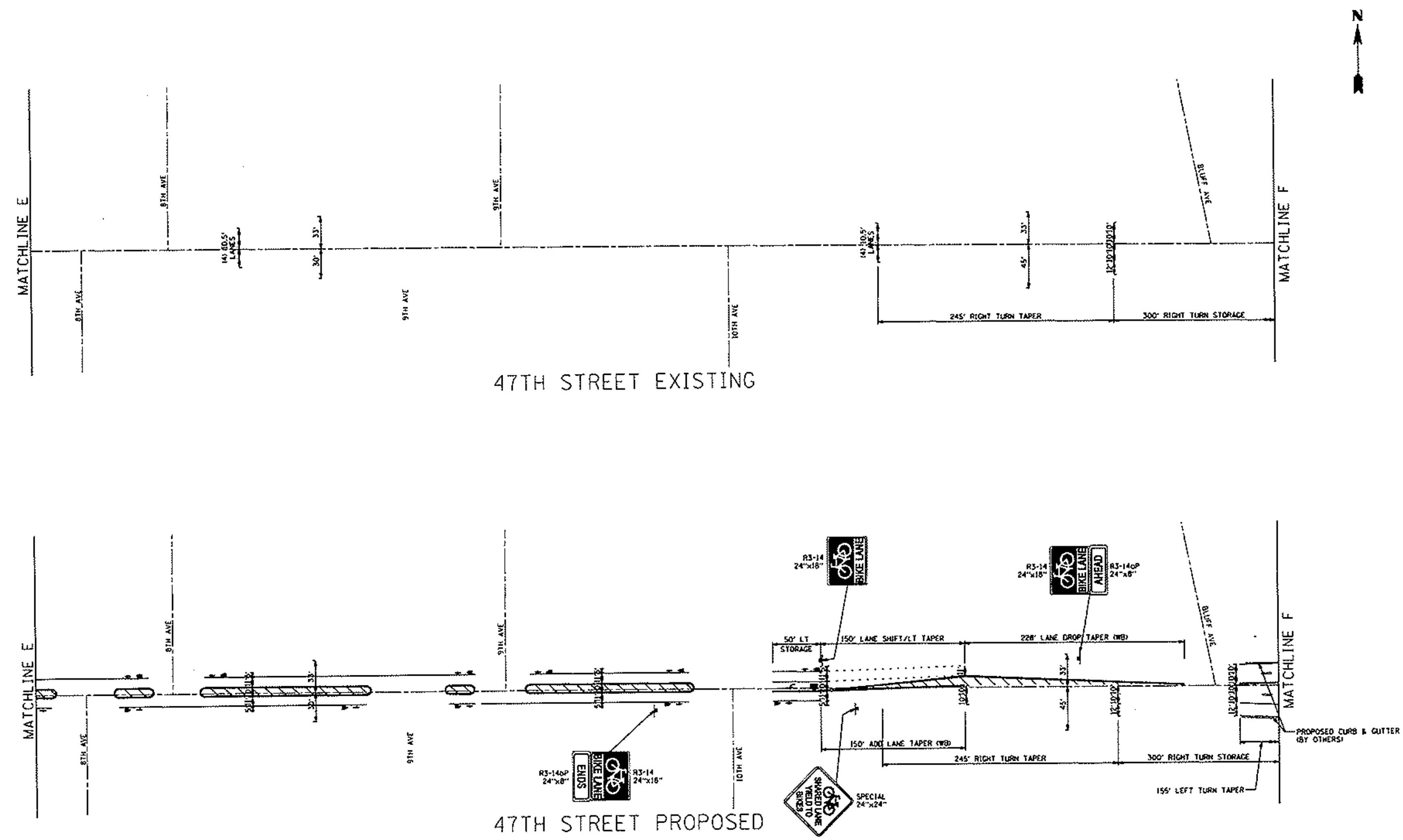
VILLAGE OF LA GRANGE

DESIGNED	- GJG	REV DATE	CHECKED	REVISION	
DRAWN	- GJG				
CHECKED	- DMS				
DATE	- 12/22/2010				

47TH STREET 4-LANE TO 3-LANE CONVERSION
PRELIMINARY PAVEMENT MARKING AND SIGN PLAN

SCALE: 1" = 50' | FILE NAME: ...\plan sht 5.dgn

COUNTY	TOTAL SHEETS	SHEET NO.
COOK	7	5



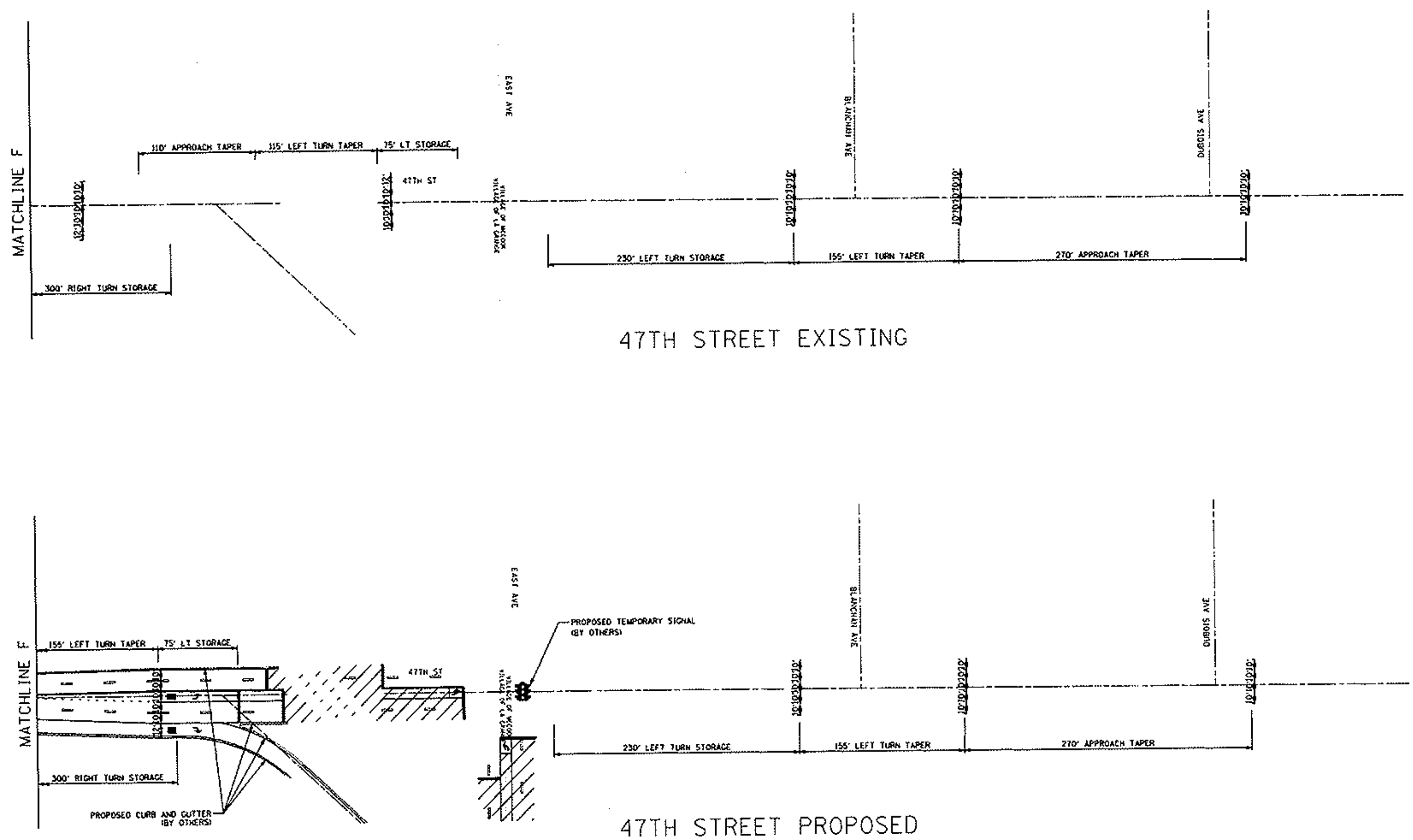
PRELIMINARY

KLOA	VILLAGE OF LA GRANGE	DESIGNED - GJG DRAWN - GJG CHECKED - DMS DATE - 12/22/2010	REV DATE / CHECKED / REVISION

47TH STREET 4-LANE TO 3-LANE CONVERSION
PRELIMINARY PAVEMENT MARKING AND SIGN PLAN

SCALE: 1" = 50' FILE NAME: ...\plan sht 6.dgn

COUNTY	TOTAL SHEETS	SHEET NO.
COOK	7	6



PRELIMINARY

KLOA	VILLAGE OF LA GRANGE	DESIGNED - CJG DRAWN - CJG CHECKED - DMS DATE - 12/22/2010	REV DATE	CHECKED	REVISION	47TH STREET 4-LANE TO 3-LANE CONVERSION PRELIMINARY PAVEMENT MARKING AND SIGN PLAN SCALE: 1" = 50' FILE NAME:...\plan shs 7.dgn	COUNTY COOK	TOTAL SHEETS 7	SHEET NO. 7

Traffic Counts

LaGrange, IL
47th St and Gilbert Ave
Tuesday August 31, 2010

09/02/10
09:32:26

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - by Mvmt

Intersection # 3 47/gilbert

Begin Time	N-Approach RT	TH	LT	E-Approach RT	TH	LT	S-Approach RT	TH	LT	W-Approach RT	TH	LT	Int Total
700	2	60	21	25	78	67	33	127	10	17	82	37	559
715	9	83	14	30	155	80	45	100	18	25	133	60	752
730	3	76	19	21	121	62	38	89	22	11	85	32	579
745	5	46	22	26	100	29	23	82	17	22	68	16	456
800	6	53	12	36	88	42	21	95	20	11	61	11	456
815	10	46	21	5	84	32	16	81	19	12	63	19	408
830	9	68	12	50	88	51	33	88	27	22	77	21	546
845	9	51	11	13	60	43	22	68	10	15	63	1	366
1600	13	83	30	12	79	45	26	67	27	22	78	18	500
1615	13	93	31	13	82	43	27	71	17	23	90	21	524
1630	10	93	29	27	119	65	29	69	23	25	107	28	624
1645	15	90	30	15	130	79	33	49	25	27	111	23	627
1700	10	82	18	27	103	84	52	61	25	27	115	36	640
1715	17	110	31	9	147	91	29	74	40	11	103	37	699
1730	13	106	41	20	72	71	34	65	26	22	108	39	617
1745	4	117	23	19	71	65	43	75	18	12	99	21	567
Total	148	1257	365	348	1577	949	504	1261	344	304	1443	420	8920

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - Totals

Intersection # 3 47/gilbert

Begin Time	Approach Totals N	E	S	W	Exit Totals N	E	S	W	Int Total
700	83	170	170	136	189	136	144	90	559
715	106	265	163	218	190	192	188	182	752
730	98	204	149	128	142	142	149	146	579
745	73	155	122	106	124	113	97	122	456
800	71	166	136	83	142	94	106	114	456
815	77	121	116	94	105	100	90	113	408
830	89	189	148	120	159	122	141	124	546
845	71	116	100	79	82	96	109	79	366
1600	126	136	120	118	97	134	150	119	500
1615	137	138	115	134	105	148	159	112	524
1630	132	211	121	160	124	165	183	152	624
1645	135	224	107	161	87	174	196	170	627
1700	110	214	138	178	124	185	193	138	640
1715	158	247	143	151	120	163	212	204	699
1730	160	163	125	169	124	183	199	111	617
1745	144	155	136	132	115	165	194	93	567
Total	1770	2874	2109	2167	2029	2312	2510	2069	8920

LaGrange, IL
47th St and Edgewood Ave
Tuesday August 31, 2010

09/02/10
09:26:36

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - by Mvmt

Intersection # 2 47/edgewood

Begin	N-Approach			E-Approach			S-Approach			W-Approach			Int
Time	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT	Total
700	15	1	0	8	181	15	11	6	0	2	143	9	391
715	11	0	0	10	192	10	9	5	0	3	150	7	397
730	12	2	1	10	183	12	20	2	0	2	161	3	408
745	2	2	2	4	151	8	5	2	0	1	125	2	304
800	1	1	3	4	175	7	9	2	1	1	89	2	295
815	4	1	2	2	166	8	5	1	2	0	87	3	281
830	6	0	2	1	172	5	6	0	0	1	108	1	302
845	4	1	1	2	134	7	3	0	2	0	103	0	257
1600	5	0	2	1	122	3	10	1	1	1	110	3	259
1615	3	1	2	3	152	5	5	0	1	0	156	3	331
1630	5	0	0	0	184	4	9	1	2	2	127	2	336
1645	9	1	3	1	197	2	11	0	1	3	162	2	392
1700	4	2	1	1	201	11	8	0	0	2	175	3	408
1715	11	1	0	2	223	3	8	3	2	6	163	2	424
1730	8	0	1	4	182	6	14	0	1	1	197	0	414
1745	1	2	0	0	168	3	7	0	0	2	181	1	365
Total	101	15	20	53	2783	109	140	23	13	27	2237	43	5564

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - Totals

Intersection # 2 47/edgewood

Begin	Approach Totals				Exit Totals				Int
Time	N	E	S	W	N	E	S	W	Total
700	16	204	17	154	23	154	18	196	391
715	11	212	14	160	22	159	13	203	397
730	15	205	22	166	15	182	16	195	408
745	6	163	7	128	8	132	11	153	304
800	5	186	12	92	8	101	9	177	295
815	7	176	8	90	6	94	9	172	281
830	8	178	6	110	2	116	6	178	302
845	6	143	5	103	2	107	8	140	257
1600	7	126	12	114	5	122	4	128	259
1615	6	160	6	159	6	163	6	156	331
1630	5	188	12	131	3	136	6	191	336
1645	13	200	12	167	3	176	6	207	392
1700	7	213	8	180	4	184	15	205	408
1715	12	228	13	171	7	171	10	236	424
1730	9	192	15	198	4	212	7	191	414
1745	3	171	7	184	1	188	7	169	365
Total	136	2945	176	2307	119	2397	151	2897	5564

LaGrange, IL
47th St and Brainard Ave
Tuesday August 31, 2010

09/02/10
09:22:01

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - by Mvmt

Intersection # 1 47/brainard

Begin Time	N-Approach RT	N-Approach TH	N-Approach LT	E-Approach RT	E-Approach TH	E-Approach LT	S-Approach RT	S-Approach TH	S-Approach LT	W-Approach RT	W-Approach TH	W-Approach LT	Int Total
700	6	15	7	22	162	17	15	64	30	7	111	6	462
715	17	42	15	23	205	16	28	104	48	24	145	6	673
730	7	29	12	10	181	17	20	80	27	18	154	8	563
745	2	27	10	4	155	27	20	60	20	20	117	3	465
800	4	24	9	14	167	30	25	54	16	19	111	7	480
815	4	27	5	4	145	11	19	40	24	10	82	3	374
830	9	14	10	11	151	12	14	39	20	9	105	4	398
845	8	23	5	6	129	9	14	52	21	10	89	6	372
1600	4	43	10	14	124	23	21	34	18	18	111	5	425
1615	15	53	18	8	127	17	18	58	16	23	114	4	471
1630	10	60	9	11	161	15	6	38	18	17	145	4	494
1645	26	61	28	8	178	18	19	44	20	12	129	12	555
1700	11	50	12	8	176	22	16	47	16	28	174	11	571
1715	23	67	17	16	174	21	20	47	35	17	124	5	566
1730	12	60	18	11	164	11	15	53	25	21	181	9	580
1745	16	64	18	5	115	14	12	47	27	21	141	9	489
Total	174	659	203	175	2514	280	282	861	381	274	2033	102	7938

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - Totals

Intersection # 1 47/brainard

Begin Time	Approach Totals N	Approach Totals E	Approach Totals S	Approach Totals W	Exit Totals N	Exit Totals E	Exit Totals S	Exit Totals W	Int Total
700	28	201	109	124	92	133	39	198	462
715	74	244	180	175	133	188	82	270	673
730	48	208	127	180	98	186	64	215	563
745	39	186	100	140	67	147	74	177	465
800	37	211	95	137	75	145	73	187	480
815	36	160	83	95	47	106	48	173	374
830	33	174	73	118	54	129	35	180	398
845	36	144	87	105	64	108	42	158	372
1600	57	161	73	134	53	142	84	146	425
1615	86	152	92	141	70	150	93	158	471
1630	79	187	62	166	53	160	92	189	494
1645	115	204	83	153	64	176	91	224	555
1700	73	206	79	213	66	202	100	203	571
1715	107	211	102	146	68	161	105	232	566
1730	90	186	93	211	73	214	92	201	580
1745	98	134	86	171	61	171	99	158	489
Total	1036	2969	1524	2409	1138	2518	1213	3069	7938

LaGrange, IL
47th St and LaGrange Rd
Tuesday August 31, 2010

09/02/10
09:37:26

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - by Mvmt

Intersection # 4 47/lagrange

Begin Time	N-Approach RT	N-Approach TH	N-Approach LT	E-Approach RT	E-Approach TH	E-Approach LT	S-Approach RT	S-Approach TH	S-Approach LT	W-Approach RT	W-Approach TH	W-Approach LT	Int Total
700	26	95	17	15	137	14	30	216	59	6	110	16	741
715	14	94	15	15	167	22	27	214	54	12	136	18	788
730	10	104	21	17	139	26	33	195	46	10	138	22	761
745	23	111	17	12	150	27	22	149	43	15	105	23	697
800	16	103	15	17	115	26	16	116	38	16	117	16	611
815	14	94	12	9	105	26	24	137	42	7	86	17	573
830	19	120	20	9	97	27	21	144	54	16	80	14	621
845	14	78	13	12	75	19	20	149	35	12	61	18	506
1600	21	178	23	14	99	28	29	135	37	16	73	21	674
1615	17	163	30	12	78	38	34	119	43	32	82	7	655
1630	19	152	20	11	114	44	24	128	41	19	83	21	676
1645	26	215	31	9	130	61	43	129	41	35	135	26	881
1700	18	136	27	4	87	32	29	110	36	16	68	25	588
1715	17	201	30	11	145	27	9	144	33	30	89	22	758
1730	18	156	23	15	107	50	11	128	38	25	115	26	712
1745	26	198	33	20	50	34	17	103	25	24	110	25	665
Total	298	2198	347	202	1795	501	389	2316	665	291	1588	317	10907

TURNS/TEAPAC[Ver 3.61.12] - 15-Minute Counts: All Vehicles - Totals

Intersection # 4 47/lagrange

Begin Time	Approach Totals N	Approach Totals E	Approach Totals S	Approach Totals W	Exit Totals N	Exit Totals E	Exit Totals S	Exit Totals W	Int Total
700	138	166	305	132	247	157	115	222	741
715	123	204	295	166	247	178	128	235	788
730	135	182	274	170	234	192	140	195	761
745	151	189	214	143	184	144	153	216	697
800	134	158	170	149	149	148	145	169	611
815	120	140	203	110	163	122	127	161	573
830	159	133	219	110	167	121	163	170	621
845	105	106	204	91	179	94	109	124	506
1600	222	141	201	110	170	125	222	157	674
1615	210	128	196	121	138	146	233	138	655
1630	191	169	193	123	160	127	215	174	676
1645	272	200	213	196	164	209	311	197	881
1700	181	123	175	109	139	124	184	141	588
1715	248	183	186	141	177	128	258	195	758
1730	197	172	177	166	169	149	231	163	712
1745	257	104	145	159	148	160	256	101	665
Total	2843	2498	3370	2196	2835	2324	2990	2758	10907

CMAP Traffic Projections

Chicago Metropolitan
Agency for Planning

233 South Wacker Drive
Suite 800
Chicago, Illinois 60606

312 454 0400
www.cmap.illinois.gov

October 28, 2010

Hon. Elizabeth Asperger
President
Village of La Grange
53 South La Grange Road
La Grange, IL 60525

Subject: 47th Street from Gilbert Avenue to East Avenue
Village of La Grange

Dear President Asperger:

In response to a request made on your behalf and dated October 22, 2010, we have developed year 2030 average daily traffic (ADT) projections for the subject location.

ROAD SEGMENT	2030 ADT
47th St from Gilbert Ave to LaGrange Rd	16,000
47th St from LaGrange Rd to East Ave	14,000

Traffic projections are developed using existing ADT data provided in the request letter and the results from the March 2010 CMAP RTP/TIP Travel Demand Analysis. The regional travel model uses CMAP 2030 socioeconomic projections and assumes the implementation of the 2030 Regional Transportation Plan for the Northeastern Illinois area.

If you have any questions, please call Jose Rodriguez at (312) 386-8806.

Sincerely,

Donald P. Kopec

Donald P. Kopec
Deputy Director for Planning and Programming

cc: Russell (KLOA)
M:\proj1\ceb\forecasts\2010 Response\ck-39-10.docx

Capacity Analysis Worksheets
Existing Traffic Conditions

/

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Gilbert
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Gilbert Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	145	368	75	238	454	102	139	398	67	76	265	19
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		14.0	29.0					13.0	36.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	359	1733	0.43	0.45	20.8	C		
TR	906	3435	0.51	0.26	35.0+	D	31.5	C
Westbound								
L	397	1718	0.63	0.45	24.1	C		
TR	886	3362	0.66	0.26	37.9	D	33.8	C
Northbound								
L	469	1744	0.31	0.50	16.5	B		
TR	598	1828	0.82	0.33	42.9	D	36.8	D
Southbound								
L	325	1762	0.25	0.50	18.6	B		
TR	608	1857	0.49	0.33	30.3	C	27.8	C

Intersection Delay = 33.1 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Gilbert
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Gilbert Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	145	368	75	238	454	102	139	398	67	76	265	19
% Heavy Veh	1	1	1	1	1	11	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	38	97	20	63	119	27	37	105	18	20	70	5
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	153	466		251	585		146	490		80	299	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.170			0.183			0.145			0.067	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Arriv. Type	3	3		4	4		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		14.0	29.0					13.0	36.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 110.0 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	145	368	75	238	454	102	139	398	67	76	265	19
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	153	387	79	251	478	107	146	419	71	80	279	20
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	153	466		251	585		146	490		80	299	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.170			0.183			0.145			0.067	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	1	0	1	1	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.972		0.990	0.990		0.990	0.990	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	1.000		1.000	1.000	
fRT		0.975			0.973			0.978			0.990	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.237			0.308			0.375			0.165		
fLpb	0.969	1.000		0.961	1.000		0.976	1.000		0.986	1.000	
fRpb		0.984			0.983			0.993			0.997	
S	1733	3435		1718	3362		1744	1828		1762	1857	
Sec.	433			558			688			306		

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		153	1733	0.09	0.127	221	0.69
Perm		0	433	0.00	0.318	138	0.00
Left	L	153			0.45	359	0.43
Prot							
Perm							
Thru	TR	466	3435	0.14	0.26	906	0.51
Right							
Westbound							
Prot		219	1718	# 0.13	0.127	219	1.00
Perm		32	558	0.06	0.318	178	0.18
Left	L	251			0.45	397	0.63
Prot							
Perm							
Thru	TR	585	3362	# 0.17	0.26	886	0.66
Right							
Northbound							
Prot		146	1744	# 0.08	0.118	206	0.71
Perm		0	688	0.00	0.382	263	0.00
Left	L	146			0.50	469	0.31
Prot							
Perm							
Thru	TR	490	1828	# 0.27	0.33	598	0.82
Right							
Southbound							
Prot		80	1762	0.05	0.118	208	0.38
Perm		0	306	0.00	0.382	117	0.00
Left	L	80			0.50	325	0.25
Prot							
Perm							
Thru	TR	299	1857	0.16	0.33	608	0.49
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.65
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.84

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.43	0.45	20.0	1.000	359	0.11	0.8	0.0	20.8	C		
TR	0.51	0.26	34.5	1.000	906	0.12	0.5	0.0	35.0+	D	31.5	C
Westbound												
L	0.63	0.45	20.8	1.000	397	0.21	3.3	0.0	24.1	C		
TR	0.66	0.26	36.1	1.000	886	0.24	1.8	0.0	37.9	D	33.8	C
Northbound												
L	0.31	0.50	16.2	1.000	469	0.11	0.4	0.0	16.5	B		
TR	0.82	0.33	34.0	1.000	598	0.36	8.8	0.0	42.9	D	36.8	D
Southbound												
L	0.25	0.50	18.2	1.000	325	0.11	0.4	0.0	18.6	B		
TR	0.49	0.33	29.7	1.000	608	0.11	0.6	0.0	30.3	C	27.8	C

Intersection delay = 33.1 (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 110.0 sec				
Total actual green time for LT lane group, G (s)	46.0	46.0	52.0	52.0
Effective permitted green time for LT lane group, g(s)	35.0	35.0	42.0	42.0
Opposing effective green time, go (s)	29.0	29.0	36.0	36.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	1	1
Adjusted LT flow rate, VLT (veh/h)	153	251	146	80
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	585	466	299	490
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	4.68	7.67	4.46	2.44
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.39	7.48	9.14	14.97
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.65	0.74	0.67	0.67
gq, (see Exhibit C16-4,5,6,7,8)	15.76	12.75	14.74	27.68
gu=g-gq if gq>=gf, or = g-gf if gq<gf	19.24	22.25	27.26	14.32
n=Max(gq-gf)/2,0)	7.88	6.37	7.37	13.84
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.32	2.06	1.73	2.06
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.11	0.11	0.10	0.10
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.24	0.31	0.37	0.17
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	0.237	0.308	0.375	0.165

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 110.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	0.952	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	29.0	29.0	36.0	36.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	189	189	152	152
OCCpedg	0.095	0.095	0.076	0.076
Opposing queue clearing green, gq (s)	15.76	12.75	14.74	27.68
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.544	0.440	0.409	0.769
OCCpedu	0.069	0.074	0.060	0.047
Opposing flow rate, Vo (veh/h)	585	466	299	490
OCCr	0.031	0.039	0.040	0.024
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.969	0.961	0.976	0.986
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.969	0.961	0.976	0.986
Permitted Right Turns				
Effective pedestrian green time, gp (s)	29.0	29.0	36.0	36.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	189	189	152	152
OCCpedg	0.095	0.095	0.076	0.076
Effective green, g (s)	29.0	29.0	36.0	36.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.095	0.095	0.076	0.076
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.905	0.905	0.954	0.954
Proportion right-turns, PRT	0.170	0.183	0.145	0.067
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.984	0.983	0.993	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Cycle length, C 110.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v	153	251	146	80
v/c ratio from Capacity Worksheet, X	0.43	0.63	0.31	0.25
Protected phase effective green interval, g (s)	14.0	14.0	13.0	13.0
Opposing queue effective green interval, gq	15.76	12.75	14.74	27.68
Unopposed green interval, gu	19.24	22.25	27.26	14.32
Red time r=(C-g-gq-gu)	61.0	61.0	55.0	55.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.04	0.07	0.04	0.02
Protected ph. departure rate, Sp=s/3600	0.481	0.477	0.484	0.489
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.22	0.24	0.29	0.25
XPerm	0.35	0.45	0.21	0.26
XProt	0.47	0.78	0.44	0.24
Case	1	1	1	1
Queue at beginning of green arrow, Qa	2.59	4.25	2.23	1.22
Queue at beginning of unsaturated green, Qu	0.67	0.89	0.60	0.62
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	20.0	20.8	16.2	18.2

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		20.0	0.00	0.0	0.0	20.8
TR	0.0	0.00	40.5	34.5	0.00	0.0	0.0	35.0+
	0.0						0.0	
Westbound								
L	0.0	0.00		20.8	0.00	0.0	0.0	24.1
TR	0.0	0.00	40.5	36.1	0.00	0.0	0.0	37.9
	0.0						0.0	
Northbound								
L	0.0	0.00		16.2	0.00	0.0	0.0	16.5
TR	0.0	0.00	37.0	34.0	0.00	0.0	0.0	42.9
	0.0						0.0	
Southbound								
L	0.0	0.00		18.2	0.00	0.0	0.0	18.6
TR	0.0	0.00	37.0	29.7	0.00	0.0	0.0	30.3
	0.0						0.0	

Intersection Delay 33.1 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	153	244		251	307		146	490		80	299	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	2	0	1	2	0	1	1	0	1	1	0
SL	804	1804		889	1765		938	1828		650	1857	
LnCapacity	359	475		397	465		469	598		325	608	
Flow Ratio	0.2	0.1		0.3	0.2		0.2	0.3		0.1	0.2	
v/c Ratio	0.43	0.51		0.63	0.66		0.31	0.82		0.25	0.49	
Grn Ratio	0.45	0.26		0.45	0.26		0.50	0.33		0.50	0.33	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		4	4		3	3		3	3	
Pltn Ratio	1.00	1.00		1.33	1.33		1.00	1.00		1.00	1.00	
PF2	1.00	1.00		0.84	0.95		1.00	1.00		1.00	1.00	
Q1	2.7	6.3		3.9	7.9		2.3	13.8		1.3	7.3	
kB	0.4	0.5		0.4	0.5		0.5	0.6		0.4	0.6	
Q2	0.3	0.5		0.7	0.9		0.2	2.2		0.1	0.6	
Q Average	3.0	6.9		4.6	8.8		2.5	16.0		1.4	7.9	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	3.6	8.1		5.5	10.4		3.0	18.7		1.7	9.3	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5		1.6	1.5		1.6	1.5	
BOQ	4.8	10.6		7.2	13.5		4.0	23.6		2.2	12.1	
QSRatio												
90th Percentile Output:												
fB%	1.7	1.7		1.7	1.7		1.8	1.6		1.8	1.7	
BOQ	5.3	11.6		7.9	14.6		4.4	25.3		2.5	13.2	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.9		2.0	1.9		2.0	1.7		2.1	1.9	
BOQ	6.1	13.1		9.1	16.5		5.1	27.9		2.8	14.9	
QSRatio												
98th Percentile Output:												
fB%	2.5	2.3		2.4	2.2		2.5	2.0		2.6	2.2	
BOQ	7.6	15.7		11.1	19.5		6.4	31.9		3.6	17.7	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Gilbert
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Gilbert Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	135	437	87	325	452	71	116	249	148	76	265	19
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A		A		NB	Left	A	A		
	Thru			A			Thru		A		
	Right			A			Right		A		
	Peds			X			Peds		X		
WB	Left	A	A	A		SB	Left	A	A		
	Thru		A	A			Thru		A		
	Right		A	A			Right		A		
	Peds			X			Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	10.0	34.0				7.0	42.0		
Yellow		3.0	3.0	4.0				3.0	4.0		
All Red		0.0	0.0	2.0				0.0	2.0		

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	257	1714	0.55	0.30	38.2	D		
TR	975	3441	0.57	0.28	37.5	D	37.6	D
Westbound								
L	433	1732	0.79	0.49	26.1	C		
TR	1358	3467	0.41	0.39	24.0	C	24.8	C
Northbound								
L	389	1746	0.31	0.46	20.5	C		
TR	612	1748	0.68	0.35	36.4	D	32.9	C
Southbound								
L	297	1756	0.27	0.46	21.5	C		
TR	650	1857	0.46	0.35	30.7	C	28.8	C

Intersection Delay = 30.7 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Gilbert
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Gilbert Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	135	437	87	325	452	71	116	249	148	76	265	19
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	36	115	23	86	119	19	31	66	39	20	70	5
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	142	552		342	551		122	418		80	299	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.167			0.136			0.373			0.067	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0		0.0	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		0.0	0.0	
Arriv. Type	3	3		4	4		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4
EB	Left	A		A	
	Thru			A	
	Right			A	
	Peds			X	
WB	Left	A	A	A	
	Thru		A	A	
	Right		A	A	
	Peds			X	
NB	Right				
SB	Right				
Green		6.0	10.0	34.0	
Yellow		3.0	3.0	4.0	
All Red		0.0	0.0	2.0	

		5	6	7	8
NB	Left	A	A		
	Thru		A		
	Right		A		
	Peds		X		
SB	Left	A	A		
	Thru		A		
	Right		A		
	Peds		X		
EB	Right				
WB	Right				
Green		7.0	42.0		
Yellow		3.0	4.0		
All Red		0.0	2.0		

Cycle Length: 120.0 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	135	437	87	325	452	71	116	249	148	76	265	19
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	142	460	92	342	476	75	122	262	156	80	279	20
No. Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	142	552		342	551		122	418		80	299	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.167			0.136			0.373			0.067	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	1	0	1	1	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.990		0.990	0.990		0.990	0.990	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	1.000		1.000	1.000	
fRT		0.975			0.980			0.944			0.990	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.446			0.262			0.391			0.263		
fLpb	0.959	1.000		0.969	1.000		0.977	1.000		0.983	1.000	
fRpb		0.985			0.988			0.984			0.997	
S	1714	3441		1732	3467		1746	1748		1756	1857	
Sec.	805			477			718			487		

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		29	1714	0.02	0.017	29	1.00
Perm		113	805	0.14	0.283	228	0.50
Left	L	142			0.30	257	0.55
Prot							
Perm							
Thru	TR	552	3441	# 0.16	0.28	975	0.57
Right							
Westbound							
Prot		274	1732	# 0.16	0.158	274	1.00
Perm		68	477	0.14	0.333	159	0.43
Left	L	342			0.49	433	0.79
Prot							
Perm							
Thru	TR	551	3467	0.16	0.39	1358	0.41
Right							
Northbound							
Prot		102	1746	# 0.06	0.058	102	1.00
Perm		20	718	0.03	0.400	287	0.07
Left	L	122			0.46	389	0.31
Prot							
Perm							
Thru	TR	418	1748	# 0.24	0.35	612	0.68
Right							
Southbound							
Prot		80	1756	0.05	0.058	102	0.78
Perm		0	487	0.00	0.400	195	0.00
Left	L	80			0.46	297	0.27
Prot							
Perm							
Thru	TR	299	1857	0.16	0.35	650	0.46
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.62
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.77

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.55	0.30	35.6	1.000	257	0.15	2.6	0.0	38.2	D		
TR	0.57	0.28	36.7	1.000	975	0.16	0.8	0.0	37.5	D	37.6	D
Westbound												
L	0.79	0.49	21.3	0.779	433	0.34	9.5	0.0	26.1	C		
TR	0.41	0.39	26.4	0.903	1358	0.11	0.2	0.0	24.0	C	24.8	C
Northbound												
L	0.31	0.46	20.1	1.000	389	0.11	0.5	0.0	20.5	C		
TR	0.68	0.35	33.3	1.000	612	0.25	3.1	0.0	36.4	D	32.9	C
Southbound												
L	0.27	0.46	21.0	1.000	297	0.11	0.5	0.0	21.5	C		
TR	0.46	0.35	30.2	1.000	650	0.11	0.5	0.0	30.7	C	28.8	C

Intersection delay = 30.7 (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 120.0 sec				
Total actual green time for LT lane group, G (s)	40.0	56.0	52.0	52.0
Effective permitted green time for LT lane group, g(s)	34.0	40.0	48.0	48.0
Opposing effective green time, go (s)	47.0	34.0	42.0	42.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	1	1
Adjusted LT flow rate, VLT (veh/h)	142	342	122	80
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	551	552	299	418
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	4.73	11.40	4.07	2.67
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.65	9.66	9.97	13.93
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.48	0.72	0.65	0.65
gq, (see Exhibit C16-4,5,6,7,8)	0.00	16.51	15.54	23.59
gu=g-gq if gq>=gf, or = g-gf if gq<gf	34.00	23.49	32.46	24.41
n=Max(gq-gf)/2,0)	0.00	8.26	7.77	11.80
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.24	2.24	1.73	1.93
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.12	0.10	0.08	0.08
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.45	0.26	0.39	0.26
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	0.446	0.262	0.391	0.263

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 120.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	0.952	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	34.0	34.0	42.0	42.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	176	176	142	142
OCCpedg	0.088	0.088	0.071	0.071
Opposing queue clearing green, gq (s)	0.00	16.51	15.54	23.59
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.486	0.370	0.562
OCCpedu	0.088	0.067	0.058	0.051
Opposing flow rate, Vo (veh/h)	551	552	299	418
OCCr	0.041	0.031	0.038	0.029
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.959	0.969	0.977	0.983
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.959	0.969	0.977	0.983
Permitted Right Turns				
Effective pedestrian green time, gp (s)	34.0	34.0	42.0	42.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	176	176	142	142
OCCpedg	0.088	0.088	0.071	0.071
Effective green, g (s)	34.0	40.0	42.0	42.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.088	0.088	0.071	0.071
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.912	0.912	0.957	0.957
Proportion right-turns, PRT	0.167	0.136	0.373	0.067
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.985	0.988	0.984	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	120.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		142	342	122	80
v/c ratio from Capacity Worksheet, X		0.55	0.79	0.31	0.27
Protected phase effective green interval, g (s)		2.0	19.0	7.0	7.0
Opposing queue effective green interval, gq		0.00	16.51	15.54	23.59
Unopposed green interval, gu		34.00	23.49	32.46	24.41
Red time r=(C-g-gq-gu)		84.0	61.0	65.0	65.0
Arrival rate, qa=v/(3600(max[X,1.0]))		0.04	0.09	0.03	0.02
Protected ph. departure rate, Sp=s/3600		0.476	0.481	0.485	0.488
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.22	0.23	0.29	0.27
XPerm		0.18	0.72	0.17	0.16
XProt		3.56	0.83	0.72	0.47
Case		2	1	1	1
Queue at beginning of green arrow, Qa		3.31	5.80	2.20	1.44
Queue at beginning of unsaturated green, Qu		2.95	1.57	0.53	0.52
Residual queue, Qr		2.44	0.00	0.00	0.00
Uniform Delay, d1		35.6	21.3	20.1	21.0

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		35.6	0.00	0.0	0.0	38.2
TR	0.0	0.00	43.0	36.7	0.00	0.0	0.0	37.5
	0.0						0.0	
Westbound								
L	0.0	0.00		21.3	0.00	0.0	0.0	26.1
TR	0.0	0.00	36.5	26.4	0.00	0.0	0.0	24.0
	0.0						0.0	
Northbound								
L	0.0	0.00		20.1	0.00	0.0	0.0	20.5
TR	0.0	0.00	39.0	33.3	0.00	0.0	0.0	36.4
	0.0						0.0	
Southbound								
L	0.0	0.00		21.0	0.00	0.0	0.0	21.5
TR	0.0	0.00	39.0	30.2	0.00	0.0	0.0	30.7
	0.0						0.0	

Intersection Delay 30.7 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	142	289		342	289		122	418		80	299	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	2	0	1	2	0	1	1	0	1	1	0
SL	855	1807		881	1820		849	1748		649	1857	
LnCapacity	257	512		433	713		389	612		297	650	
Flow Ratio	0.2	0.2		0.4	0.2		0.1	0.2		0.1	0.2	
v/c Ratio	0.55	0.56		0.79	0.41		0.31	0.68		0.27	0.46	
Grn Ratio	0.30	0.28		0.49	0.39		0.46	0.35		0.46	0.35	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		4	4		3	3		3	3	
Pltn Ratio	1.00	1.00		1.33	1.33		1.00	1.00		1.00	1.00	
PF2	1.00	1.00		0.86	0.84		1.00	1.00		1.00	1.00	
Q1	3.3	8.2		5.7	5.8		2.2	11.9		1.5	7.7	
kB	0.4	0.5		0.5	0.7		0.4	0.6		0.4	0.6	
Q2	0.5	0.7		1.6	0.5		0.2	1.3		0.1	0.5	
Q Average	3.8	8.9		7.3	6.3		2.4	13.2		1.6	8.3	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	4.5	10.5		8.6	7.5		2.9	15.4		1.9	9.8	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.5	1.5		1.6	1.5		1.6	1.5	
BOQ	6.0	13.6		11.2	9.7		3.9	19.6		2.5	12.6	
QSRatio												
90th Percentile Output:												
fB%	1.7	1.7		1.7	1.7		1.8	1.6		1.8	1.7	
BOQ	6.6	14.8		12.2	10.6		4.3	21.1		2.8	13.7	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.9		1.9	1.9		2.0	1.8		2.0	1.9	
BOQ	7.6	16.6		13.8	12.1		5.0	23.5		3.3	15.5	
QSRatio												
98th Percentile Output:												
fB%	2.4	2.2		2.3	2.3		2.5	2.1		2.6	2.2	
BOQ	9.3	19.6		16.5	14.6		6.2	27.1		4.2	18.4	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Edgewood
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Edgewood Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	21	579	8	45	707	32	1	15	45	3	5	40
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left		A			NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds		X				Peds	X			
WB Left	A	A			SB	Left	A			
Thru	A	A				Thru	A			
Right	A	A				Right	A			
Peds		X				Peds	X			
NB Right					EB	Right				
SB Right					WB	Right				
Green	13.0	52.0					30.0			
Yellow	3.0	4.0					4.0			
All Red	0.0	2.0					2.0			

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1528	3233	0.42	0.47	15.6	B	15.6	B
Westbound								
LTR	1754	3538	0.47	0.62	6.2	A	6.2	A
Northbound								
LTR	442	1622	0.14	0.27	30.4	C	30.4	C
Southbound								
LTR	428	1570	0.12	0.27	30.2	C	30.2	C

Intersection Delay = 11.7 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Edgewood
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Edgewood Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	21	579	8	45	707	32	1	15	45	3	5	40
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	6	152	2	12	186	8	1	4	12	1	2	11
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat		1900			1900			1900			1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			0			0			0			0
Adj Flow		639			825			64			50	
%InSharedLn												
Prop LTs		0.034			0.057			0.016			0.060	
Prop RTs		0.013			0.041			0.734			0.840	
Peds Bikes		50	0		50	0		50	0		50	0
Buses		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	
Arriv. Type		4			4			3			3	
Unit Ext.		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	
Ext of g		2.0			2.0			2.0			2.0	
Ped Min g		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left		A			NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds		X				Peds	X			
WB Left	A	A			SB	Left	A			
Thru	A	A				Thru	A			
Right	A	A				Right	A			
Peds		X				Peds	X			
NB Right					EB	Right				
SB Right					WB	Right				
Green	13.0	52.0					30.0			
Yellow	3.0	4.0					4.0			
All Red	0.0	2.0					2.0			

Cycle Length: 110.0 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	21	579	8	45	707	32	1	15	45	3	5	40
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	22	609	8	47	744	34	1	16	47	3	5	42
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
Lane group		LTR			LTR			LTR			LTR	
Adj flow		639			825			64			50	
Prop LTs		0.034			0.057			0.016			0.060	
Prop RTs		0.013			0.041			0.734			0.840	

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

	Eastbound			Westbound			Northbound			Southbound		
LG		LTR			LTR			LTR			LTR	
So		1900			1900			1900			1900	
Lanes	0	2	0	0	2	0	0	1	0	0	1	0
fW		1.000			1.000			1.000			1.000	
fHV		0.990			0.990			0.990			0.990	
fG		1.000			1.000			1.000			1.000	
fP		1.000			1.000			1.000			1.000	
fBB		1.000			1.000			1.000			1.000	
fA		1.000			1.000			1.000			1.000	
fLU		0.952			0.952			1.000			1.000	
fRT		0.998			0.994			0.901			0.887	
fLT		0.906			0.997			0.998			0.990	
Sec.					0.766							
fLpb		0.999			0.999			0.999			0.997	
fRpb		0.999			0.998			0.960			0.954	
S		3233			3538			1622			1570	
Sec.					2716							

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	639	3233	# 0.20	0.47	1528	0.42
Right							
Westbound							
Prot							
Perm							
Left							
Prot		322	3538	# 0.09	0.091	322	1.00
Perm		503	2716	0.19	0.527	1432	0.35
Thru	LTR	825			0.62	1754	0.47
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	64	1622	# 0.04	0.27	442	0.14
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	50	1570	0.03	0.27	428	0.12
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.33
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.39

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.42	0.47	19.1	0.806	1528	0.11	0.2	0.0	15.6	B	15.6	B
Westbound												
LTR	0.47	0.62	11.3	0.529	1754	0.11	0.2	0.0	6.2	A	6.2	A
Northbound												
LTR	0.14	0.27	30.3	1.000	442	0.11	0.2	0.0	30.4	C	30.4	C
Southbound												
LTR	0.12	0.27	30.0	1.000	428	0.11	0.1	0.0	30.2	C	30.2	C

Intersection delay = 11.7 (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	110.0 sec				
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		0.952	0.952	1.000	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	110.0 sec				
Total actual green time for LT lane group, G (s)		52.0	68.0	30.0	30.0
Effective permitted green time for LT lane group, g(s)		52.0	58.0	30.0	30.0
Opposing effective green time, go (s)		68.0	52.0	30.0	30.0
Number of lanes in LT lane group, N		2	2	1	1

Number of lanes in opposing approach, No	2	2	1	1
Adjusted LT flow rate, VLT (veh/h)	22	47	1	3
Proportion of LT in LT lane group, PLT	0.034	0.057	0.016	0.060
Proportion of LT in opposing flow, PLTo	0.06	0.03	0.06	0.02
Adjusted opposing flow rate, Vo (veh/h)	825	639	50	64
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	0.67	1.44	0.03	0.09
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	13.24	10.25	1.53	1.96
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	20.8	0.6	21.3	18.8
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.18	0.37	0.73	0.73
gq, (see Exhibit C16-4,5,6,7,8)	0.00	10.09	0.00	0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf	31.22	47.91	8.74	11.22
n=Max(gq-gf)/2,0)	0.00	4.76	0.00	0.00
PTHo=1-PLTo	0.94	0.97	0.94	0.98
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.09	0.20	0.02	0.06
EL1 (refer to Exhibit C16-3)	3.28	2.72	1.45	1.47
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	4.46	1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.04	0.04	0.07	0.07
gdiff=max(gq-gf,0)	0.00	9.52	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.90	0.62	1.00	0.99
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	0.906	0.766	0.998	0.990

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)	52.0	52.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	105	105	183	183
OCCpedg	0.053	0.053	0.092	0.092
Opposing queue clearing green, gq (s)	0.00	10.09	0.00	0.00
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.194	0.000	0.000
OCCpedu	0.053	0.047	0.092	0.092
Opposing flow rate, Vo (veh/h)	825	639	50	64
OCCr	0.017	0.020	0.085	0.084
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.983	0.980	0.949	0.950
Proportion of left turns, PLT	0.034	0.057	0.016	0.060
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.999	0.999	0.999	0.997
Permitted Right Turns				
Effective pedestrian green time, gp (s)	52.0	52.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	105	105	183	183
OCCpedg	0.053	0.053	0.092	0.092
Effective green, g (s)	52.0	58.0	30.0	30.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.053	0.053	0.092	0.092
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.947	0.947	0.945	0.945
Proportion right-turns, PRT	0.013	0.041	0.734	0.840
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.999	0.998	0.960	0.954

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	110.0 sec				
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 Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	29.0	19.1	0.00	0.0	0.0	15.6
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	21.0	11.3	0.00	0.0	0.0	6.2
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	40.0	30.3	0.00	0.0	0.0	30.4
	0.0						0.0	
Southbound								
	0.0						0.0	
LTR	0.0	0.00	40.0	30.0	0.00	0.0	0.0	30.2
	0.0						0.0	

Intersection Delay 11.7 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound	Westbound	Northbound	Southbound
LaneGroup	LTR	LTR	LTR	LTR
Init Queue	0.0	0.0	0.0	0.0
Flow Rate	335	433	64	50
So	1900	1900	1900	1900
No.Lanes	0 2 0	0 2 0	0 1 0	0 1 0
SL	1698	1489	1622	1570
LnCapacity	802	921	442	428
Flow Ratio	0.2	0.3	0.0	0.0
v/c Ratio	0.42	0.47	0.14	0.12
Grn Ratio	0.47	0.62	0.27	0.27
I Factor	1.000	1.000	1.000	1.000
AT or PVG	4	4	3	3
Pltn Ratio	1.33	1.33	1.00	1.00
PF2	0.76	0.53	1.00	1.00
Q1	5.1	2.8	1.5	1.1
kB	0.7	0.7	0.5	0.5
Q2	0.5	0.7	0.1	0.1
Q Average	5.6	3.5	1.6	1.2
Q Spacing	25.0	25.0	25.0	25.0
Q Storage	0	0	0	0
Q S Ratio				
70th Percentile Output:				
fB%	1.2	1.2	1.2	1.2
BOQ	6.7	4.1	1.9	1.4
QSRatio				
85th Percentile Output:				
fB%	1.5	1.6	1.6	1.6
BOQ	8.7	5.4	2.5	1.9
QSRatio				
90th Percentile Output:				
fB%	1.7	1.7	1.8	1.8
BOQ	9.6	6.0	2.8	2.1
QSRatio				
95th Percentile Output:				
fB%	1.9	2.0	2.1	2.1
BOQ	10.9	6.9	3.2	2.5
QSRatio				
98th Percentile Output:				
fB%	2.3	2.5	2.6	2.6
BOQ	13.2	8.5	4.0	3.2
QSRatio				

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Edgewood
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Edgewood Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Volume	7	697	12	22	803	8	4	3	41	5	4	32
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left		A			NB Left	A			
Thru		A			Thru	A			
Right		A			Right	A			
Peds		X			Peds	X			
WB Left	A	A			SB Left	A			
Thru	A	A			Thru	A			
Right	A	A			Right	A			
Peds		X			Peds	X			
NB Right					EB Right				
SB Right					WB Right				
Green	16.0	59.0				30.0			
Yellow	3.0	4.0				4.0			
All Red	0.0	2.0				2.0			

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1660	3376	0.45	0.49	15.8	B	15.8	B
Westbound								
LTR	2073	3569	0.42	0.65	4.6	A	4.6	A
Northbound								
LTR	387	1548	0.13	0.25	35.0+	D	35.0+	D
Southbound								
LTR	389	1555	0.11	0.25	34.8	C	34.8	C

Intersection Delay = 11.1 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Edgewood
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Edgewood Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	7	697	12	22	803	8	4	3	41	5	4	32
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	2	183	3	6	211	2	1	1	11	2	1	8
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat		1900			1900			1900			1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
LGConfig		LTR			LTR			LTR			LTR	
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vol			0			0			0			0
Adj Flow		754			876			50			43	
%InSharedLn												
Prop LTs		0.009			0.026			0.080			0.116	
Prop RTs		0.017			0.009			0.860			0.791	
Peds Bikes		50	0		50	0		50	0		50	0
Buses		0			0			0			0	
%InProtPhase				0.0		0.0						

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet		0.0			0.0			0.0			0.0	
Arriv. Type		4			4			3			3	
Unit Ext.		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	
Ext of g		2.0			2.0			2.0			2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left		A			NB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds		X				Peds	X			
WB	Left	A	A			SB	Left	A			
	Thru	A	A				Thru	A			
	Right	A	A				Right	A			
	Peds		X				Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		16.0	59.0					30.0			
Yellow		3.0	4.0					4.0			
All Red		0.0	2.0					2.0			

Cycle Length: 120.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume, V	7	697	12	22	803	8	4	3	41	5	4	32
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	7	734	13	23	845	8	4	3	43	5	4	34
No. Lanes	0	2	0	0	2	0	0	1	0	0	1	0
Lane group		LTR			LTR			LTR			LTR	
Adj flow		754			876			50			43	
Prop LTs		0.009			0.026			0.080			0.116	
Prop RTs		0.017			0.009			0.860			0.791	

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

		Eastbound			Westbound			Northbound			Southbound	
LG		LTR			LTR			LTR			LTR	
So		1900			1900			1900			1900	
Lanes	0	2	0	0	2	0	0	1	0	0	1	0
fW		1.000			1.000			1.000			1.000	
fHV		0.990			0.990			0.990			0.990	
fG		1.000			1.000			1.000			1.000	
fP		1.000			1.000			1.000			1.000	
fBB		1.000			1.000			1.000			1.000	
fA		1.000			1.000			1.000			1.000	
fLU		0.952			0.952			1.000			1.000	
fRT		0.997			0.999			0.884			0.893	
fLT		0.946			0.999			0.986			0.978	
Sec.					0.871							
fLpb		1.000			1.000			0.995			0.993	
fRpb		0.999			1.000			0.948			0.953	
S		3376			3569			1548			1555	
Sec.					3113							

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	754	3376	# 0.22	0.49	1660	0.45
Right							
Westbound							
Prot							
Perm							
Left							
Prot		387	3569	# 0.11	0.108	387	1.00
Perm		489	3113	0.16	0.542	1686	0.29
Thru	LTR	876			0.65	2073	0.42
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	50	1548	# 0.03	0.25	387	0.13
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	43	1555	0.03	0.25	389	0.11
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.36
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.43

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
LTR	0.45	0.49	20.0	0.779	1660	0.11	0.2	0.0	15.8	B	15.8	B
Westbound												
LTR	0.42	0.65	10.1	0.438	2073	0.11	0.1	0.0	4.6	A	4.6	A
Northbound												
LTR	0.13	0.25	34.9	1.000	387	0.11	0.2	0.0	35.0+	D	35.0+	D
Southbound												
LTR	0.11	0.25	34.7	1.000	389	0.11	0.1	0.0	34.8	C	34.8	C

```
        Intersection delay = 11.1  (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                                   120.0   sec
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                         0.952 0.952 1.000 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                                   120.0   sec
Total actual green time for LT lane group, G (s)         59.0  78.0  30.0  30.0
Effective permitted green time for LT lane group, g(s)   59.0  65.0  30.0  30.0
Opposing effective green time, go (s)                    78.0  59.0  30.0  30.0
Number of lanes in LT lane group, N                      2     2     1     1
```

Number of lanes in opposing approach, No	2	2	1	1
Adjusted LT flow rate, VLT (veh/h)	7	23	4	5
Proportion of LT in LT lane group, PLT	0.009	0.026	0.080	0.116
Proportion of LT in opposing flow, PLTo	0.03	0.01	0.12	0.08
Adjusted opposing flow rate, Vo (veh/h)	876	754	43	50
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	0.23	0.77	0.13	0.17
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	15.34	13.20	1.43	1.67
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	37.2	9.5	17.5	16.7
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.13	0.34	0.75	0.75
gq, (see Exhibit C16-4,5,6,7,8)	0.00	12.87	0.00	0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf	21.76	52.13	12.45	13.30
n=Max(gq-gf)/2,0)	0.00	1.70	0.00	0.00
PTHo=1-PLTo	0.97	0.99	0.88	0.92
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.02	0.08	0.08	0.12
EL1 (refer to Exhibit C16-3)	3.46	3.06	1.44	1.45
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	1.70	1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.03	0.03	0.07	0.07
gdiff=max(gq-gf,0)	0.00	3.41	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.98	0.83	0.99	0.98
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	0.946	0.871	0.986	0.978

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)	59.0	59.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	101	101	200	200
OCCpedg	0.051	0.051	0.100	0.100
Opposing queue clearing green, gq (s)	0.00	12.87	0.00	0.00
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.218	0.000	0.000
OCCpedu	0.051	0.045	0.100	0.100
Opposing flow rate, Vo (veh/h)	876	754	43	50
OCCr	0.015	0.016	0.094	0.093
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.985	0.984	0.943	0.944
Proportion of left turns, PLT	0.009	0.026	0.080	0.116
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	1.000	1.000	0.995	0.993
Permitted Right Turns				
Effective pedestrian green time, gp (s)	59.0	59.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	101	101	200	200
OCCpedg	0.051	0.051	0.100	0.100
Effective green, g (s)	59.0	65.0	30.0	30.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.051	0.051	0.100	0.100
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.950	0.950	0.940	0.940
Proportion right-turns, PRT	0.017	0.009	0.860	0.791
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.999	1.000	0.948	0.953

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	120.0 sec				
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 Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound	0.0						0.0	
LTR	0.0	0.00	30.5	20.0	0.00	0.0	0.0	15.8
	0.0						0.0	
Westbound	0.0						0.0	
LTR	0.0	0.00	21.0	10.1	0.00	0.0	0.0	4.6
	0.0						0.0	
Northbound	0.0						0.0	
LTR	0.0	0.00	45.0	34.9	0.00	0.0	0.0	35.0+
	0.0						0.0	
Southbound	0.0						0.0	
LTR	0.0	0.00	45.0	34.7	0.00	0.0	0.0	34.8
	0.0						0.0	

Intersection Delay 11.1 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound	Westbound	Northbound	Southbound
LaneGroup	LTR	LTR	LTR	LTR
Init Queue	0.0	0.0	0.0	0.0
Flow Rate	396	460	50	43
So	1900	1900	1900	1900
No.Lanes	0 2 0	0 2 0	0 1 0	0 1 0
SL	1773	1674	1548	1555
LnCapacity	871	1088	387	389
Flow Ratio	0.2	0.3	0.0	0.0
v/c Ratio	0.45	0.42	0.13	0.11
Grn Ratio	0.49	0.65	0.25	0.25
I Factor	1.000	1.000	1.000	1.000
AT or PVG	4	4	3	3
Pltn Ratio	1.33	1.33	1.00	1.00
PF2	0.75	0.44	1.00	1.00
Q1	6.5	2.5	1.3	1.1
kB	0.8	0.9	0.5	0.5
Q2	0.6	0.6	0.1	0.1
Q Average	7.1	3.1	1.4	1.2
Q Spacing	25.0	25.0	25.0	25.0
Q Storage	0	0	0	0
Q S Ratio				
70th Percentile Output:				
fB%	1.2	1.2	1.2	1.2
BOQ	8.4	3.7	1.6	1.4
QSRatio				
85th Percentile Output:				
fB%	1.5	1.6	1.6	1.6
BOQ	10.9	4.8	2.2	1.8
QSRatio				
90th Percentile Output:				
fB%	1.7	1.7	1.8	1.8
BOQ	11.9	5.4	2.4	2.1
QSRatio				
95th Percentile Output:				
fB%	1.9	2.0	2.1	2.1
BOQ	13.5	6.2	2.8	2.4
QSRatio				
98th Percentile Output:				
fB%	2.3	2.5	2.6	2.6
BOQ	16.2	7.7	3.5	3.0
QSRatio				

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Brainard
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Brainard Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
LGConfig		LTR			LTR		L	TR		L	TR	
Volume	23	527	69	77	703	59	125	308	83	44	113	32
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4
EB	Left		A		
	Thru		A		
	Right		A		
	Peds		X		
WB	Left	A	A		
	Thru	A	A		
	Right	A	A		
	Peds		X		
NB	Right				
SB	Right				
Green		12.0	36.0		
Yellow		3.0	4.0		
All Red		0.0	2.0		

		5	6	7	8
NB	Left	A		A	
	Thru			A	
	Right			A	
	Peds			X	
SB	Left	A	A	A	
	Thru		A	A	
	Right		A	A	
	Peds			X	
EB	Right				
WB	Right				
Green		12.0	4.0	25.0	
Yellow		3.0	3.0	4.0	
All Red		0.0	0.0	2.0	

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1017	3109	0.64	0.33	31.7	C	31.7	C
Westbound								
LTR	1150	3501	0.77	0.46	27.8	C	27.8	C
Northbound								
L	390	1692	0.34	0.30	29.7	C		
TR	408	1796	1.01	0.23	88.9	F	74.5	E
Southbound								
L	377	1787	0.12	0.45	19.9	B		
TR	521	1792	0.29	0.29	30.6	C	28.1	C

Intersection Delay = 40.1 (sec/veh) Intersection LOS = D

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Brainard
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Brainard Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	23	527	69	77	703	59	125	308	83	44	113	32
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	6	139	18	20	185	16	33	81	22	12	30	8
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat		1900			1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
LGConfig		LTR			LTR		L	TR		L	TR	
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow		652			883		132	411		46	153	
%InSharedLn												
Prop LTs		0.037			0.092		1.000	0.000		1.000	0.000	
Prop RTs		0.112			0.070			0.212			0.222	
Peds Bikes	50	0		50	0			50	0		50	0
Buses		0			0		0	0		0	0	
%InProtPhase				0.0		0.0	0.0			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		4			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		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left		A			NB	Left	A		A	
	Thru		A				Thru			A	
	Right		A				Right			A	
	Peds		X				Peds			X	
WB	Left	A	A			SB	Left	A	A	A	
	Thru	A	A				Thru		A	A	
	Right	A	A				Right		A	A	
	Peds		X				Peds			X	
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		12.0	36.0					12.0	4.0	25.0	
Yellow		3.0	4.0					3.0	3.0	4.0	
All Red		0.0	2.0					0.0	0.0	2.0	

Cycle Length: 110.0 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	23	527	69	77	703	59	125	308	83	44	113	32
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	24	555	73	81	740	62	132	324	87	46	119	34
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
Lane group		LTR			LTR		L	TR		L	TR	
Adj flow		652			883		132	411		46	153	
Prop LTs		0.037			0.092		1.000	0.000		1.000	0.000	
Prop RTs		0.112			0.070			0.212			0.222	

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

	Eastbound	Westbound	Northbound		Southbound	
LG	LTR	LTR	L	TR	L	TR
So	1900	1900	1900	1900	1900	1900
Lanes	0 2 0	0 2 0	1	1 0	1	1 0
fW	1.000	1.000	1.000	1.000	1.000	1.000
fHV	0.990	0.990	0.990	0.990	0.990	0.990
fG	1.000	1.000	1.000	1.000	1.000	1.000
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	0.952	0.952	1.000	1.000	1.000	1.000
fRT	0.983	0.989		0.968		0.967
fLT	0.891	0.995	0.950	1.000	0.950	1.000
Sec.		0.644	0.660		0.129	
fLpb	0.999	0.998	0.947	1.000	1.000	1.000
fRpb	0.991	0.995		0.986		0.985
S	3109	3501	1692	1796	1787	1792
Sec.		2264	1175		243	

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	652	3109	0.21	0.33	1017	0.64
Right							
Westbound							
Prot							
Perm							
Left							
Prot		286	3501	# 0.08	0.082	286	1.00
Perm		597	2264	# 0.26	0.382	864	0.69
Thru	LTR	883			0.46	1150	0.77
Right							
Northbound							
Prot		123	1692	0.07	0.073	123	1.00
Perm		9	1175	0.01	0.227	267	0.03
Left	L	132			0.30	390	0.34
Prot							
Perm							
Thru	TR	411	1796	# 0.23	0.23	408	1.01
Right							
Southbound							
Prot		46	1787	# 0.03	0.173	309	0.15
Perm		0	243	0.00	0.282	68	0.00
Left	L	46			0.45	377	0.12
Prot							
Perm							
Thru	TR	153	1792	0.09	0.29	521	0.29
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.60
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.72

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
LTR	0.64	0.33	31.5	0.964	1017	0.22	1.4	0.0	31.7	C	31.7	C
Westbound												
LTR	0.77	0.46	24.6	1.000	1150	0.32	3.2	0.0	27.8	C	27.8	C
Northbound												
L	0.34	0.30	29.2	1.000	390	0.11	0.5	0.0	29.7	C		
TR	1.01	0.23	42.5	1.000	408	0.50	46.4	0.0	88.9	F	74.5	E
Southbound												
L	0.12	0.45	19.8	1.000	377	0.11	0.1	0.0	19.9	B		
TR	0.29	0.29	30.2	1.000	521	0.11	0.3	0.0	30.6	C	28.1	C

Intersection delay = 40.1 (sec/veh) Intersection LOS = D

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 110.0 sec				
Total actual green time for LT lane group, G (s)			37.0	47.0
Effective permitted green time for LT lane group, g(s)			25.0	31.0
Opposing effective green time, go (s)			32.0	25.0
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)			132	46
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)			153	411
Lost time for LT lane group, tL			6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600			4.03	1.41
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			4.68	12.56
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]			0.71	0.77
gq, (see Exhibit C16-4,5,6,7,8)			0.00	25.15
gu=g-gq if gq>=gf, or = g-gf if gq<gf			25.00	5.85
n=Max(gq-gf)/2,0)			0.00	12.58
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)			1.52	1.92
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.16	0.13
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.66	0.13
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			0.660	0.129

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 110.0 sec				
Total actual green time for LT lane group, G (s)	36.0	51.0		
Effective permitted green time for LT lane group, g(s)	36.0	42.0		
Opposing effective green time, go (s)	51.0	36.0		
Number of lanes in LT lane group, N	2	2		

Number of lanes in opposing approach, No	2	2		
Adjusted LT flow rate, VLT (veh/h)	24	81		
Proportion of LT in LT lane group, PLT	0.037	0.092	0.000	0.000
Proportion of LT in opposing flow, PLTo	0.09	0.04		
Adjusted opposing flow rate, Vo (veh/h)	883	652		
Lost time for LT lane group, tL	6.00	6.00		
Computation				
LT volume per cycle, LTC=VLTC/3600	0.73	2.48		
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	14.17	10.46		
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	11.8	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33		
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.54	0.56		
gq, (see Exhibit C16-4,5,6,7,8)	0.00	15.80		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	24.23	26.20		
n=Max(gq-gf)/2,0)	0.00	7.90		
PTHo=1-PLTo	0.91	0.96		
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.09	0.37		
EL1 (refer to Exhibit C16-3)	3.48	2.76		
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	6.97		
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.06	0.07		
gdiff=max(gq-gf,0)	0.00	15.80		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.87	0.38		
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	0.891	0.644		

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)	36.0	36.0	25.0	25.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	152	152	220	220
OCCpedg	0.076	0.076	0.110	0.110
Opposing queue clearing green, gq (s)	0.00	15.80	0.00	25.15
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.439	0.000	1.006
OCCpedu	0.076	0.059	0.110	0.055
Opposing flow rate, Vo (veh/h)	883	652	153	411
OCCr	0.022	0.024	0.089	0.031
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.978	0.976	0.947	0.981
Proportion of left turns, PLT	0.037	0.092	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.999	0.998	0.947	1.000
Permitted Right Turns				
Effective pedestrian green time, gp (s)	36.0	36.0	25.0	25.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	152	152	220	220
OCCpedg	0.076	0.076	0.110	0.110
Effective green, g (s)	36.0	42.0	25.0	31.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.076	0.076	0.110	0.110
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.924	0.924	0.934	0.934
Proportion right-turns, PRT	0.112	0.070	0.212	0.222
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.991	0.995	0.986	0.985

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	110.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v				132	46
v/c ratio from Capacity Worksheet, X				0.34	0.12
Protected phase effective green interval, g (s)				8.0	19.0
Opposing queue effective green interval, gq				0.00	25.15
Unopposed green interval, gu				25.00	5.85
Red time r=(C-g-gq-gu)				77.0	60.0
Arrival rate, qa=v/(3600(max[X,1.0]))				0.04	0.01
Protected ph. departure rate, Sp=s/3600				0.470	0.496
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)				0.33	0.36
XPerm				0.11	0.19
XProt				0.83	0.11
Case				1	1
Queue at beginning of green arrow, Qa				2.82	0.77
Queue at beginning of unsaturated green, Qu				0.00	0.32
Residual queue, Qr				0.00	0.00
Uniform Delay, d1				29.2	19.8

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
	0.0						0.0	
LTR	0.0	0.00	37.0	31.5	0.00	0.0	0.0	31.7
	0.0						0.0	
Westbound								
	0.0						0.0	
LTR	0.0	0.00	29.5	24.6	0.00	0.0	0.0	27.8
	0.0						0.0	
Northbound								
L	0.0	0.00		29.2	0.00	0.0	0.0	29.7
TR	0.0	0.00	42.5	42.5	0.00	0.8	0.0	88.9
	0.0						0.0	
Southbound								
L	0.0	0.00		19.8	0.00	0.0	0.0	19.9
TR	0.0	0.00	39.0	30.2	0.00	0.0	0.0	30.6
	0.0						0.0	

Intersection Delay 40.1 sec/veh   Intersection LOS D

BACK OF QUEUE WORKSHEET

	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	342	463	132	411	46	153
So	1900	1900	1900	1900	1900	1900
No.Lanes	0 2 0	0 2 0	1	1 0	1	1 0
SL	1632	1303	1300	1796	830	1792
LnCapacity	534	603	390	408	377	521
Flow Ratio	0.2	0.4	0.1	0.2	0.1	0.1
v/c Ratio	0.64	0.77	0.34	1.01	0.12	0.29
Grn Ratio	0.33	0.46	0.30	0.23	0.45	0.29
I Factor	1.000	1.000		1.000		1.000
AT or PVG	4	3	3	3	3	3
Pltn Ratio	1.33	1.00	1.00	1.00	1.00	1.00
PF2	0.92	1.00	1.00	1.00	1.00	1.00
Q1	8.2	8.1	2.9	12.6	0.8	3.6
kB	0.5	0.6	0.5	0.5	0.4	0.5
Q2	0.9	1.7	0.2	5.0	0.1	0.2
Q Average	9.1	9.8	3.1	17.6	0.8	3.8
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%	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	10.7	11.6	3.7	20.5	1.0	4.6
QSRatio						
85th Percentile Output:						
fB%	1.5	1.5	1.6	1.5	1.6	1.6
BOQ	13.8	14.9	4.9	25.8	1.3	6.0
QSRatio						
90th Percentile Output:						
fB%	1.7	1.6	1.7	1.6	1.8	1.7
BOQ	15.0	16.2	5.5	27.5	1.5	6.6
QSRatio						
95th Percentile Output:						
fB%	1.9	1.8	2.0	1.7	2.1	2.0
BOQ	16.9	18.2	6.3	30.3	1.7	7.6
QSRatio						
98th Percentile Output:						
fB%	2.2	2.2	2.5	2.0	2.6	2.4
BOQ	20.0	21.3	7.8	34.4	2.2	9.4
QSRatio						

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Brainard
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: Brainard Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
LGConfig		LTR			LTR		L	TR		L	TR	
Volume	37	608	78	72	692	43	96	191	70	75	238	72
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left		A			NB	Left	A	A		
Thru		A				Thru		A		
Right		A				Right		A		
Peds		X				Peds		X		
WB Left	A	A			SB	Left	A	A		
Thru	A	A				Thru		A		
Right	A	A				Right		A		
Peds		X				Peds		X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	12.0	51.0					12.0	27.0		
Yellow	3.0	4.0					3.0	4.0		
All Red	0.0	2.0					0.0	2.0		

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
LTR	1272	2994	0.60	0.43	23.8	C	23.8	C
Westbound								
LTR	1362	3521	0.62	0.55	19.4	B	19.4	B
Northbound								
L	280	1740	0.36	0.38	27.6	C		
TR	399	1773	0.69	0.22	47.6	D	42.3	D
Southbound								
L	318	1731	0.25	0.38	26.2	C		
TR	402	1788	0.81	0.22	56.2	E	50.4	D

Intersection Delay = 29.7 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Brainard
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: Brainard Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	37	608	78	72	692	43	96	191	70	75	238	72
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	10	160	21	19	182	11	25	50	18	20	63	19
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat		1900			1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
LGConfig		LTR			LTR		L	TR		L	TR	
Lane Width		12.0			12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow		761			849		101	275		79	327	
%InSharedLn												
Prop LTs		0.051			0.090		1.000	0.000		1.000	0.000	
Prop RTs		0.108			0.053			0.269			0.232	
Peds Bikes		50	0		50	0		50	0		50	0
Buses		0			0		0	0		0	0	
%InProtPhase					0.0	0.0	0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet		0.0			0.0		0.0	0.0		0.0	0.0	
Arriv. Type		4			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		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left		A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru	A	A				Thru		A		
	Right	A	A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		12.0	51.0					12.0	27.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 120.0 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	37	608	78	72	692	43	96	191	70	75	238	72
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	39	640	82	76	728	45	101	201	74	79	251	76
No. Lanes	0	2	0	0	2	0	1	1	0	1	1	0
Lane group		LTR			LTR		L	TR		L	TR	
Adj flow		761			849		101	275		79	327	
Prop LTs		0.051			0.090		1.000	0.000		1.000	0.000	
Prop RTs		0.108			0.053			0.269			0.232	

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

	Eastbound			Westbound		Northbound			Southbound		
LG	LTR			LTR		L	TR		L	TR	
So	1900			1900		1900	1900		1900	1900	
Lanes 0	2	0	0	2	0	1	1	0	1	1	0
fW	1.000			1.000		1.000	1.000		1.000	1.000	
fHV	0.990			0.990		0.990	0.990		0.990	0.990	
fG	1.000			1.000		1.000	1.000		1.000	1.000	
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	0.952			0.952		1.000	1.000		1.000	1.000	
fRT	0.984			0.992			0.960			0.965	
fLT	0.856			0.996		0.950	1.000		0.950	1.000	
Sec.				0.653		0.211			0.290		
fLpb	0.999			0.998		0.974	1.000		0.969	1.000	
fRpb	0.994			0.997			0.982			0.985	
S	2994			3521		1740	1773		1731	1788	
Sec.				2311		386			529		

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	761	2994	# 0.25	0.43	1272	0.60
Right							
Westbound							
Prot							
Perm							
Left							
Prot		264	3521	# 0.07	0.075	264	1.00
Perm		585	2311	0.25	0.475	1098	0.53
Thru	LTR	849			0.55	1362	0.62
Right							
Northbound							
Prot		101	1740	# 0.06	0.100	174	0.58
Perm		0	386	0.00	0.275	106	0.00
Left	L	101			0.38	280	0.36
Prot							
Perm							
Thru	TR	275	1773	0.16	0.22	399	0.69
Right							
Southbound							
Prot		79	1731	0.05	0.100	173	0.46
Perm		0	529	0.00	0.275	145	0.00
Left	L	79			0.38	318	0.25
Prot							
Perm							
Thru	TR	327	1788	# 0.18	0.22	402	0.81
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.57
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.71

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
LTR	0.60	0.43	26.6	0.867	1272	0.19	0.8	0.0	23.8	C	23.8	C
Westbound												
LTR	0.62	0.55	18.5	1.000	1362	0.21	0.9	0.0	19.4	B	19.4	B
Northbound												
L	0.36	0.38	26.9	1.000	280	0.11	0.8	0.0	27.6	C		
TR	0.69	0.22	42.7	1.000	399	0.26	5.0	0.0	47.6	D	42.3	D
Southbound												
L	0.25	0.38	25.8	1.000	318	0.11	0.4	0.0	26.2	C		
TR	0.81	0.22	44.1	1.000	402	0.35	12.1	0.0	56.2	E	50.4	D

Intersection delay = 29.7 (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 120.0 sec				
Total actual green time for LT lane group, G (s)			42.0	42.0
Effective permitted green time for LT lane group, g(s)			33.0	33.0
Opposing effective green time, go (s)			27.0	27.0
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)			101	79
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)			327	275
Lost time for LT lane group, tL			6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600			3.37	2.63
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			10.90	9.17
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]			0.77	0.77
gq, (see Exhibit C16-4,5,6,7,8)			20.65	16.77
gu=g-gq if gq>=gf, or = g-gf if gq<gf			12.35	16.23
n=Max(gq-gf)/2,0)			10.32	8.39
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)			1.78	1.69
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.12	0.12
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.21	0.29
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			0.211	0.290

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 120.0 sec				
Total actual green time for LT lane group, G (s)	51.0	66.0		
Effective permitted green time for LT lane group, g(s)	51.0	57.0		
Opposing effective green time, go (s)	66.0	51.0		
Number of lanes in LT lane group, N	2	2		

Number of lanes in opposing approach, No	2	2		
Adjusted LT flow rate, VLT (veh/h)	39	76		
Proportion of LT in LT lane group, PLT	0.051	0.090	0.000	0.000
Proportion of LT in opposing flow, PLTo	0.09	0.05		
Adjusted opposing flow rate, Vo (veh/h)	849	761		
Lost time for LT lane group, tL	6.00	6.00		
Computation				
LT volume per cycle, LTC=VLTC/3600	1.30	2.53		
Opposing lane util. factor, fLUo	0.952	0.952	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	14.86	13.32		
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	11.6	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33		
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.45	0.43		
gq, (see Exhibit C16-4,5,6,7,8)	0.00	16.40		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	39.41	40.60		
n=Max(gq-gf)/2,0)	0.00	8.20		
PTHo=1-PLTo	0.91	0.95		
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	0.15	0.38		
EL1 (refer to Exhibit C16-3)	3.37	3.08		
EL2=Max((1-Ptho**n)/Plto, 1.0)	1.00	6.84		
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.04	0.05		
gdiff=max(gq-gf,0)	0.00	16.40		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.80	0.40		
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	0.856	0.653		

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)	51.0	51.0	27.0	27.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	117	117	222	222
OCCpedg	0.059	0.059	0.111	0.111
Opposing queue clearing green, gq (s)	0.00	16.40	20.65	16.77
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.322	0.765	0.621
OCCpedu	0.059	0.049	0.069	0.077
Opposing flow rate, Vo (veh/h)	849	761	327	275
OCCr	0.018	0.017	0.044	0.052
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.982	0.983	0.974	0.969
Proportion of left turns, PLT	0.051	0.090	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.999	0.998	0.974	0.969
Permitted Right Turns				
Effective pedestrian green time, gp (s)	51.0	51.0	27.0	27.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	117	117	222	222
OCCpedg	0.059	0.059	0.111	0.111
Effective green, g (s)	51.0	57.0	27.0	27.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.059	0.059	0.111	0.111
Number of cross-street receiving lanes, Nrec	1	1	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.942	0.942	0.933	0.933
Proportion right-turns, PRT	0.108	0.053	0.269	0.232
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.994	0.997	0.982	0.985

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Cycle length, C 120.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v			101	79
v/c ratio from Capacity Worksheet, X			0.36	0.25
Protected phase effective green interval, g (s)			12.0	12.0
Opposing queue effective green interval, gq			20.65	16.77
Unopposed green interval, gu			12.35	16.23
Red time r=(C-g-gq-gu)			75.0	75.0
Arrival rate, qa=v/(3600(max[X,1.0]))			0.03	0.02
Protected ph. departure rate, Sp=s/3600			0.483	0.481
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)			0.29	0.30
XPerm			0.26	0.15
XProt			0.42	0.33
Case			1	1
Queue at beginning of green arrow, Qa			2.10	1.65
Queue at beginning of unsaturated green, Qu			0.58	0.37
Residual queue, Qr			0.00	0.00
Uniform Delay, d1			26.9	25.8

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound	0.0						0.0	
LTR	0.0	0.00	34.5	26.6	0.00	0.0	0.0	23.8
	0.0						0.0	
Westbound	0.0						0.0	
LTR	0.0	0.00	27.0	18.5	0.00	0.0	0.0	19.4
	0.0						0.0	
Northbound								
L	0.0	0.00		26.9	0.00	0.0	0.0	27.6
TR	0.0	0.00	46.5	42.7	0.00	0.0	0.0	47.6
	0.0						0.0	
Southbound								
L	0.0	0.00		25.8	0.00	0.0	0.0	26.2
TR	0.0	0.00	46.5	44.1	0.00	0.0	0.0	56.2
	0.0						0.0	

Intersection Delay 29.7 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	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	399	445	101	275	79	327
So	1900	1900	1900	1900	1900	1900
No.Lanes	0 2 0	0 2 0	1	1 0	1	1 0
SL	1572	1300	747	1773	850	1788
LnCapacity	668	715	280	399	318	402
Flow Ratio	0.3	0.3	0.1	0.2	0.1	0.2
v/c Ratio	0.60	0.62	0.36	0.69	0.25	0.81
Grn Ratio	0.43	0.55	0.38	0.22	0.38	0.22
I Factor	1.000	1.000		1.000		1.000
AT or PVG	4	3	3	3	3	3
Pltn Ratio	1.33	1.00	1.00	1.00	1.00	1.00
PF2	0.85	1.00	1.00	1.00	1.00	1.00
Q1	8.7	7.0	2.2	8.4	1.7	10.3
kB	0.6	0.7	0.4	0.5	0.4	0.5
Q2	0.9	1.1	0.2	1.0	0.1	1.7
Q Average	9.6	8.1	2.4	9.4	1.8	12.1
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%	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	11.4	9.5	2.9	11.1	2.2	14.2
QSRatio						
85th Percentile Output:						
fB%	1.5	1.5	1.6	1.5	1.6	1.5
BOQ	14.6	12.3	3.8	14.3	2.9	18.1
QSRatio						
90th Percentile Output:						
fB%	1.6	1.7	1.8	1.7	1.8	1.6
BOQ	15.9	13.5	4.2	15.5	3.2	19.6
QSRatio						
95th Percentile Output:						
fB%	1.9	1.9	2.0	1.9	2.0	1.8
BOQ	17.8	15.2	4.8	17.4	3.7	21.8
QSRatio						
98th Percentile Output:						
fB%	2.2	2.2	2.5	2.2	2.6	2.1
BOQ	21.0	18.1	6.0	20.5	4.7	25.3
QSRatio						

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/La Grange
Area Type: All other areas
Jurisd: IDOT
Year : Existing 4-lane

N/S St: La Grange Rd

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	79	489	43	89	593	59	202	774	112	70	404	73
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A	A			NB	Left	A	A	A	
Thru		A				Thru		A	A	
Right		A				Right		A	A	
Peds		X				Peds			X	
WB Left	A	A			SB	Left	A		A	
Thru		A				Thru			A	
Right		A				Right			A	
Peds		X				Peds			X	
NB Right					EB	Right				
SB Right					WB	Right				
Green	12.0	32.0					11.0	8.0	46.0	
Yellow	3.0	4.0					3.0	3.0	4.0	
All Red	0.0	2.0					0.0	0.0	2.0	

Cycle Length: 130.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/c	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	238	1761	0.35	0.38	29.3	C		
TR	867	3521	0.65	0.25	45.6	D	43.5	D
Westbound								
L	280	1752	0.34	0.38	28.3	C		
TR	865	3514	0.79	0.25	51.0	D	48.3	D
Northbound								
L	560	1755	0.38	0.57	9.8	A		
TR	1445	3296	0.65	0.44	25.3	C	22.4	C
Southbound								
L	271	1768	0.27	0.41	24.5	C		
TR	1162	3284	0.43	0.35	30.4	C	29.6	C

Intersection Delay = 34.5 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/La Grange
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: La Grange Rd

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	79	489	43	89	593	59	202	774	112	70	404	73
% Heavy Veh	1	1	1	1	1	1	1	8	1	1	8	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	21	129	11	23	156	16	53	204	29	18	106	19
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	83	560		94	686		213	933		74	502	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.080			0.090			0.126			0.153	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0		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		0.0	0.0	
Arriv. Type	3	3		3	3		4	4		4	4	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A	A	
	Thru		A				Thru		A	A	
	Right		A				Right		A	A	
	Peds		X				Peds			X	
WB	Left	A	A			SB	Left	A		A	
	Thru		A				Thru			A	
	Right		A				Right			A	
	Peds		X				Peds			X	
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		12.0	32.0					11.0	8.0	46.0	
Yellow		3.0	4.0					3.0	3.0	4.0	
All Red		0.0	2.0					0.0	0.0	2.0	

Cycle Length: 130.0 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	79	489	43	89	593	59	202	774	112	70	404	73
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	83	515	45	94	624	62	213	815	118	74	425	77
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	83	560		94	686		213	933		74	502	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.080			0.090			0.126			0.153	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	2	0	1	2	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.990		0.990	0.934		0.990	0.935	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	0.952		1.000	0.952	
fRT		0.988			0.986			0.981			0.977	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.139			0.220			0.356			0.266		
fLpb	0.986	1.000		0.980	1.000		0.982	1.000		0.989	1.000	
fRpb		0.995			0.994			0.995			0.994	
S	1761	3521		1752	3514		1755	3296		1768	3284	
Sec.	257			405			657			496		

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		83	1761	0.05	0.092	163	0.51
Perm		0	257	0.00	0.292	75	0.00
Left	L	83			0.38	238	0.35
Prot							
Perm							
Thru	TR	560	3521	0.16	0.25	867	0.65
Right							
Westbound							
Prot		94	1752	# 0.05	0.092	162	0.58
Perm		0	405	0.00	0.292	118	0.00
Left	L	94			0.38	280	0.34
Prot							
Perm							
Thru	TR	686	3514	# 0.20	0.25	865	0.79
Right							
Northbound							
Prot		213	1755	0.12	0.169	297	0.72
Perm		0	657	0.00	0.400	263	0.00
Left	L	213			0.57	560	0.38
Prot							
Perm							
Thru	TR	933	3296	# 0.28	0.44	1445	0.65
Right							
Southbound							
Prot		74	1768	# 0.04	0.054	95	0.78
Perm		0	496	0.00	0.354	176	0.00
Left	L	74			0.41	271	0.27
Prot							
Perm							
Thru	TR	502	3284	0.15	0.35	1162	0.43
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.57
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.70

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.35	0.38	28.4	1.000	238	0.11	0.9	0.0	29.3	C		
TR	0.65	0.25	43.9	1.000	867	0.22	1.7	0.0	45.6	D	43.5	D
Westbound												
L	0.34	0.38	27.6	1.000	280	0.11	0.7	0.0	28.3	C		
TR	0.79	0.25	45.9	1.000	865	0.34	5.1	0.0	51.0	D	48.3	D
Northbound												
L	0.38	0.57	14.5	0.643	560	0.11	0.4	0.0	9.8	A		
TR	0.65	0.44	28.6	0.851	1445	0.22	1.0	0.0	25.3	C	22.4	C
Southbound												
L	0.27	0.41	24.0	1.000	271	0.11	0.5	0.0	24.5	C		
TR	0.43	0.35	32.0	0.940	1162	0.11	0.3	0.0	30.4	C	29.6	C

Intersection delay = 34.5 (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 130.0 sec				
Total actual green time for LT lane group, G (s)	47.0	47.0	71.0	57.0
Effective permitted green time for LT lane group, g(s)	38.0	38.0	52.0	46.0
Opposing effective green time, go (s)	32.0	32.0	46.0	57.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	2	2
Adjusted LT flow rate, VLT (veh/h)	83	94	213	74
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	686	560	502	933
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	3.00	3.39	7.69	2.67
Opposing lane util. factor, fLUo	0.952	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	13.01	10.62	9.52	17.70
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.33	1.33
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.75	0.75	0.53	0.42
gq, (see Exhibit C16-4,5,6,7,8)	24.53	19.14	12.50	6.08
gu=g-gq if gq>=gf, or = g-gf if gq<gf	13.47	18.86	39.50	39.92
n=Max(gq-gf)/2,0)	12.26	9.57	6.25	3.04
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.56	2.26	2.14	3.26
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.11	0.11	0.08	0.09
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.14	0.22	0.36	0.27
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	0.139	0.220	0.356	0.266

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 130.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	0.952	0.952	0.952
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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns

	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	32.0	32.0	46.0	46.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	203	203	141	141
OCCpedg	0.102	0.102	0.071	0.071
Opposing queue clearing green, gq (s)	24.53	19.14	12.50	6.08
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.766	0.598	0.272	0.132
OCCpedu	0.063	0.071	0.061	0.066
Opposing flow rate, Vo (veh/h)	686	560	502	933
OCCr	0.024	0.033	0.030	0.018
Number of cross-street receiving lanes, Nrec	2	2	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.986	0.980	0.982	0.989
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.986	0.980	0.982	0.989
Permitted Right Turns				
Effective pedestrian green time, gp (s)	32.0	32.0	46.0	46.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	203	203	141	141
OCCpedg	0.102	0.102	0.071	0.071
Effective green, g (s)	32.0	32.0	52.0	46.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.102	0.102	0.071	0.071
Number of cross-street receiving lanes, Nrec	2	2	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.939	0.939	0.958	0.958
Proportion right-turns, PRT	0.080	0.090	0.126	0.153
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.995	0.994	0.995	0.994

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 130.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v	83	94	213	74
v/c ratio from Capacity Worksheet, X	0.35	0.34	0.38	0.27
Protected phase effective green interval, g (s)	12.0	12.0	22.0	7.0
Opposing queue effective green interval, gq	24.53	19.14	12.50	6.08
Unopposed green interval, gu	13.47	18.86	39.50	39.92
Red time r=(C-g-gq-gu)	80.0	80.0	56.0	77.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.02	0.03	0.06	0.02
Protected ph. departure rate, Sp=s/3600	0.489	0.487	0.488	0.491
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.20	0.23	0.24	0.16
XPerm	0.32	0.23	0.32	0.15
XProt	0.36	0.41	0.43	0.50
Case	1	1	1	1
Queue at beginning of green arrow, Qa	1.84	2.09	3.31	1.58
Queue at beginning of unsaturated green, Qu	0.57	0.50	0.74	0.12
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	28.4	27.6	14.5	24.0

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		28.4	0.00	0.0	0.0	29.3
TR	0.0	0.00	49.0	43.9	0.00	0.0	0.0	45.6
	0.0						0.0	
Westbound								
L	0.0	0.00		27.6	0.00	0.0	0.0	28.3
TR	0.0	0.00	49.0	45.9	0.00	0.0	0.0	51.0
	0.0						0.0	
Northbound								
L	0.0	0.00		14.5	0.00	0.0	0.0	9.8
TR	0.0	0.00	36.5	28.6	0.00	0.0	0.0	25.3
	0.0						0.0	
Southbound								
L	0.0	0.00		24.0	0.00	0.0	0.0	24.5
TR	0.0	0.00	42.0	32.0	0.00	0.0	0.0	30.4
	0.0						0.0	

Intersection Delay 34.5 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	83	294		94	360		213	490		74	263	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	2	0	1	2	0	1	2	0	1	2	0
SL	618	1849		728	1845		983	1731		664	1724	
LnCapacity	238	455		280	454		560	758		271	610	
Flow Ratio	0.1	0.2		0.1	0.2		0.2	0.3		0.1	0.2	
v/c Ratio	0.35	0.65		0.34	0.79		0.38	0.65		0.27	0.43	
Grn Ratio	0.38	0.25		0.38	0.25		0.57	0.44		0.41	0.35	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3		4	4		4	4	
Pltn Ratio	1.00	1.00		1.00	1.00		1.33	1.33		1.33	1.33	
PF2	1.00	1.00		1.00	1.00		0.62	0.85		0.80	0.87	
Q1	1.9	9.5		2.2	12.2		2.2	11.8		1.3	6.3	
kB	0.4	0.5		0.4	0.5		0.6	0.7		0.4	0.6	
Q2	0.2	0.9		0.2	1.8		0.4	1.3		0.2	0.5	
Q Average	2.1	10.5		2.3	14.0		2.5	13.1		1.4	6.8	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	2.5	12.3		2.8	16.3		3.0	15.3		1.7	8.0	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5		1.6	1.5		1.6	1.5	
BOQ	3.3	15.8		3.7	20.8		4.0	19.6		2.3	10.4	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.8	1.6		1.8	1.6		1.8	1.7	
BOQ	3.7	17.1		4.1	22.3		4.5	21.1		2.6	11.4	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.8		2.0	1.8		2.0	1.8		2.1	1.9	
BOQ	4.3	19.2		4.8	24.8		5.1	23.4		3.0	13.0	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.1		2.5	2.0		2.5	2.1		2.6	2.3	
BOQ	5.3	22.4		6.0	28.5		6.4	27.0		3.7	15.5	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC	Inter.: 47th/La Grange
Agency: KLOA	Area Type: All other areas
Date: 11/9/2010	Jurisd: IDOT
Period: PM Peak	Year : Existing 4-lane
Project ID: 10-076	
E/W St: 47th St	N/S St: La Grange Rd

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	99	407	106	170	469	39	148	511	92	111	708	79
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		17.0	29.0					14.0	47.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	353	1749	0.29	0.42	24.6	C		
TR	794	3424	0.68	0.23	46.1	D	42.7	D
Westbound								
L	351	1750	0.51	0.42	26.6	C		
TR	817	3523	0.65	0.23	45.4	D	40.7	D
Northbound								
L	354	1770	0.44	0.54	18.3	B		
TR	1236	3286	0.51	0.38	28.1	C	26.2	C
Southbound								
L	427	1763	0.27	0.54	15.9	B		
TR	1244	3308	0.67	0.38	31.2	C	29.3	C

Intersection Delay = 33.9 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/La Grange
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 4-lane
Project ID: 10-076
E/W St: 47th St N/S St: La Grange Rd

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	99	407	106	170	469	39	148	511	92	111	708	79
% Heavy Veh	1	1	1	1	1	1	1	8	1	1	8	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	26	107	28	45	123	10	39	134	24	29	186	21
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	104	540		179	535		156	635		117	828	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.207			0.077			0.153			0.100	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Arriv. Type	3	3		3	3		4	4		4	4	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		17.0	29.0					14.0	47.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 125.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume, V	99	407	106	170	469	39	148	511	92	111	708	79
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	104	428	112	179	494	41	156	538	97	117	745	83
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	104	540		179	535		156	635		117	828	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.207			0.077			0.153			0.100	

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

LG	Eastbound L	Eastbound TR		Westbound L	Westbound TR		Northbound L	Northbound TR		Southbound L	Southbound TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	2	0	1	2	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.990		0.990	0.935		0.990	0.932	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	0.952		1.000	0.952	
fRT		0.969			0.989			0.977			0.985	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.223			0.220			0.198			0.292		
fLpb	0.979	1.000		0.979	1.000		0.990	1.000		0.986	1.000	
fRpb		0.987			0.995			0.994			0.996	
S	1749	3424		1750	3523		1770	3286		1763	3308	
Sec.	411			405			368			542		

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		104	1749	0.06	0.136	238	0.44
Perm		0	411	0.00	0.280	115	0.00
Left	L	104			0.42	353	0.29
Prot							
Perm							
Thru	TR	540	3424	# 0.16	0.23	794	0.68
Right							
Westbound							
Prot		179	1750	# 0.10	0.136	238	0.75
Perm		0	405	0.00	0.280	113	0.00
Left	L	179			0.42	351	0.51
Prot							
Perm							
Thru	TR	535	3523	0.15	0.23	817	0.65
Right							
Northbound							
Prot		156	1770	# 0.09	0.112	198	0.79
Perm		0	368	0.00	0.424	156	0.00
Left	L	156			0.54	354	0.44
Prot							
Perm							
Thru	TR	635	3286	0.19	0.38	1236	0.51
Right							
Southbound							
Prot		117	1763	0.07	0.112	197	0.59
Perm		0	542	0.00	0.424	230	0.00
Left	L	117			0.54	427	0.27
Prot							
Perm							
Thru	TR	828	3308	# 0.25	0.38	1244	0.67
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.60
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.74

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.29	0.42	24.1	1.000	353	0.11	0.5	0.0	24.6	C		
TR	0.68	0.23	43.8	1.000	794	0.25	2.4	0.0	46.1	D	42.7	D
Westbound												
L	0.51	0.42	25.4	1.000	351	0.12	1.3	0.0	26.6	C		
TR	0.65	0.23	43.5	1.000	817	0.23	1.9	0.0	45.4	D	40.7	D
Northbound												
L	0.44	0.54	17.4	1.000	354	0.11	0.9	0.0	18.3	B		
TR	0.51	0.38	30.2	0.919	1236	0.12	0.4	0.0	28.1	C	26.2	C
Southbound												
L	0.27	0.54	15.5	1.000	427	0.11	0.3	0.0	15.9	B		
TR	0.67	0.38	32.5	0.919	1244	0.24	1.4	0.0	31.2	C	29.3	C

Intersection delay = 33.9 (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 125.0 sec				
Total actual green time for LT lane group, G (s)	49.0	49.0	64.0	64.0
Effective permitted green time for LT lane group, g(s)	35.0	35.0	53.0	53.0
Opposing effective green time, go (s)	29.0	29.0	47.0	47.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	2	2
Adjusted LT flow rate, VLT (veh/h)	104	179	156	117
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	535	540	828	635
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	3.61	6.22	5.42	4.06
Opposing lane util. factor, fLUo	0.952	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.76	9.85	15.10	11.58
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.00	1.33	1.33
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.77	0.77	0.50	0.50
gq, (see Exhibit C16-4,5,6,7,8)	17.76	17.96	22.22	15.34
gu=g-gq if gq>=gf, or = g-gf if gq<gf	17.24	17.04	30.78	37.66
n=Max(gq-gf)/2,0)	8.88	8.98	11.11	7.67
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.21	2.22	2.94	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	0.08	0.08
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.22	0.22	0.20	0.29
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	0.223	0.220	0.198	0.292

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 125.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	0.952	0.952	0.952
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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	29.0	29.0	47.0	47.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	215	215	132	132
OCCpedg	0.108	0.108	0.066	0.066
Opposing queue clearing green, gq (s)	17.76	17.96	22.22	15.34
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.612	0.619	0.473	0.326
OCCpedu	0.075	0.074	0.050	0.055
Opposing flow rate, Vo (veh/h)	535	540	828	635
OCCr	0.035	0.035	0.016	0.023
Number of cross-street receiving lanes, Nrec	2	2	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.979	0.979	0.990	0.986
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.979	0.979	0.990	0.986
Permitted Right Turns				
Effective pedestrian green time, gp (s)	29.0	29.0	47.0	47.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	215	215	132	132
OCCpedg	0.108	0.108	0.066	0.066
Effective green, g (s)	29.0	29.0	47.0	47.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.108	0.108	0.066	0.066
Number of cross-street receiving lanes, Nrec	2	2	2	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.936	0.936	0.960	0.960
Proportion right-turns, PRT	0.207	0.077	0.153	0.100
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.987	0.995	0.994	0.996

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 125.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v	104	179	156	117
v/c ratio from Capacity Worksheet, X	0.29	0.51	0.44	0.27
Protected phase effective green interval, g (s)	17.0	17.0	14.0	14.0
Opposing queue effective green interval, gq	17.76	17.96	22.22	15.34
Unopposed green interval, gu	17.24	17.04	30.78	37.66
Red time r=(C-g-gq-gu)	73.0	73.0	58.0	58.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.03	0.05	0.04	0.03
Protected ph. departure rate, Sp=s/3600	0.486	0.486	0.492	0.490
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.23	0.23	0.18	0.21
XPerm	0.25	0.44	0.42	0.22
XProt	0.31	0.54	0.45	0.34
Case	1	1	1	1
Queue at beginning of green arrow, Qa	2.11	3.63	2.51	1.89
Queue at beginning of unsaturated green, Qu	0.51	0.89	0.96	0.50
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	24.1	25.4	17.4	15.5

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		24.1	0.00	0.0	0.0	24.6
TR	0.0	0.00	48.0	43.8	0.00	0.0	0.0	46.1
	0.0						0.0	
Westbound								
L	0.0	0.00		25.4	0.00	0.0	0.0	26.6
TR	0.0	0.00	48.0	43.5	0.00	0.0	0.0	45.4
	0.0						0.0	
Northbound								
L	0.0	0.00		17.4	0.00	0.0	0.0	18.3
TR	0.0	0.00	39.0	30.2	0.00	0.0	0.0	28.1
	0.0						0.0	
Southbound								
L	0.0	0.00		15.5	0.00	0.0	0.0	15.9
TR	0.0	0.00	39.0	32.5	0.00	0.0	0.0	31.2
	0.0						0.0	

Intersection Delay 33.9 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	104	283		179	280		156	333		117	434	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	2	0	1	2	0	1	2	0	1	2	0
SL	848	1798		845	1850		661	1725		797	1737	
LnCapacity	353	417		351	429		354	649		427	653	
Flow Ratio	0.1	0.2		0.2	0.2		0.2	0.2		0.1	0.2	
v/c Ratio	0.29	0.68		0.51	0.65		0.44	0.51		0.27	0.66	
Grn Ratio	0.42	0.23		0.42	0.23		0.54	0.38		0.54	0.38	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3		3	3		4	4		4	4	
Pltn Ratio	1.00	1.00		1.00	1.00		1.33	1.33		1.33	1.33	
PF2	1.00	1.00		1.00	1.00		0.69	0.87		0.65	0.90	
Q1	2.2	9.0		3.9	8.8		1.8	7.8		1.3	11.3	
kB	0.4	0.5		0.4	0.5		0.4	0.6		0.5	0.7	
Q2	0.2	1.0		0.4	0.9		0.3	0.7		0.2	1.2	
Q Average	2.4	9.9		4.3	9.7		2.2	8.4		1.5	12.5	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	2.8	11.7		5.2	11.4		2.6	10.0		1.7	14.7	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5		1.6	1.5		1.6	1.5	
BOQ	3.7	15.1		6.8	14.7		3.4	12.9		2.3	18.7	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.7	1.6		1.8	1.7		1.8	1.6	
BOQ	4.2	16.3		7.5	16.0		3.8	14.0		2.6	20.2	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.8		2.0	1.8		2.0	1.9		2.1	1.8	
BOQ	4.8	18.4		8.6	18.0		4.4	15.8		3.0	22.5	
QSRatio												
98th Percentile Output:												
fB%	2.5	2.2		2.4	2.2		2.5	2.2		2.6	2.1	
BOQ	6.0	21.5		10.5	21.1		5.5	18.7		3.8	26.0	
QSRatio												

ERROR MESSAGES

No errors to report.

Capacity Analysis Worksheets
Projected 2030 Traffic Conditions

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Gilbert
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane

N/S St: Gilbert Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
LGConfig	L	T	R	L	TR		L	TR		L	TR	
Volume	145	368	75	238	454	102	139	398	67	76	265	19
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		13.0	33.0					12.0	34.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	380	1736	0.40	0.47	18.7	B		
T	594	1980	0.65	0.30	36.0	D	30.8	C
R	440	1466	0.18	0.30	28.7	C		
Westbound								
L	362	1728	0.69	0.47	26.3	C		
TR	1011	3370	0.58	0.30	33.0	C	31.0	C
Northbound								
L	430	1743	0.34	0.47	18.4	B		
TR	562	1819	0.87	0.31	50.0	D	42.7	D
Southbound								
L	283	1745	0.28	0.47	20.6	C		
TR	574	1856	0.52	0.31	32.2	C	29.7	C

Intersection Delay = 33.8 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Gilbert
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Gilbert Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	145	368	75	238	454	102	139	398	67	76	265	19
% Heavy Veh	1	1	1	1	1	11	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	38	97	20	63	119	27	37	105	18	20	70	5
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	2000	1900	1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
LGConfig	L	T	R	L	TR		L	TR		L	TR	
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	153	387	79	251	585		146	490		80	299	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000	1.000		0.183			0.145			0.067	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0	0	0	0		0	0		0	0	
%InProtPhase	0.0			0.0			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	0.0		0.0	0.0	
Arriv. Type	3	3	3	4	4		3	3		3	3	
Unit Ext.	3.0	3.0	3.0	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	2.0		2.0	2.0	
Ext of g	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A	A			NB	Left	A	A		
Thru		A				Thru		A		
Right		A				Right		A		
Peds		X				Peds		X		
WB Left	A	A			SB	Left	A	A		
Thru		A				Thru		A		
Right		A				Right		A		
Peds		X				Peds		X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	13.0	33.0					12.0	34.0		
Yellow	3.0	4.0					3.0	4.0		
All Red	0.0	2.0					0.0	2.0		

Cycle Length: 110.0 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	145	368	75	238	454	102	139	398	67	76	265	19
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	153	387	79	251	478	107	146	419	71	80	279	20
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
Lane group	L	T	R	L	TR		L	TR		L	TR	
Adj flow	153	387	79	251	585		146	490		80	299	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000	1.000		0.183			0.145			0.067	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	T	R	L	TR		L	TR		L	TR	
So	1900	2000	1900	1900	1900		1900	1900		1900	1900	
Lanes	1	1	1	1	2	0	1	1	0	1	1	0
fW	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990	0.990	0.990	0.972		0.990	0.990		0.990	0.990	
fG	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000	1.000	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	1.000		1.000	1.000	
fA	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000	1.000	1.000	0.952		1.000	1.000		1.000	1.000	
fRT		1.000	0.850		0.973			0.978			0.990	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.270			0.245			0.359			0.140		
fLpb	0.971	1.000		0.967	1.000		0.975	1.000		0.976	1.000	
fRpb		1.000	0.917		0.985			0.988			0.997	
S	1736	1980	1466	1728	3370		1743	1819		1745	1856	
Sec.	494			445			659			257		

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		153	1736	0.09	0.118	205	0.75
Perm		0	494	0.00	0.355	175	0.00
Left	L	153			0.47	380	0.40
Prot							
Perm							
Thru	T	387	1980	# 0.20	0.30	594	0.65
Right	R	79	1466	0.05	0.30	440	0.18
Westbound							
Prot		204	1728	# 0.12	0.118	204	1.00
Perm		47	445	0.11	0.355	158	0.30
Left	L	251			0.47	362	0.69
Prot							
Perm							
Thru	TR	585	3370	0.17	0.30	1011	0.58
Right							
Northbound							
Prot		146	1743	# 0.08	0.109	190	0.77
Perm		0	659	0.00	0.364	240	0.00
Left	L	146			0.47	430	0.34
Prot							
Perm							
Thru	TR	490	1819	# 0.27	0.31	562	0.87
Right							
Southbound							
Prot		80	1745	0.05	0.109	190	0.42
Perm		0	257	0.00	0.364	93	0.00
Left	L	80			0.47	283	0.28
Prot							
Perm							
Thru	TR	299	1856	0.16	0.31	574	0.52
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.67
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.85

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.40	0.47	18.0	1.000	380	0.11	0.7	0.0	18.7	B		
T	0.65	0.30	33.5	1.000	594	0.23	2.5	0.0	36.0	D	30.8	C
R	0.18	0.30	28.5	1.000	440	0.11	0.2	0.0	28.7	C		
Westbound												
L	0.69	0.47	20.6	1.000	362	0.26	5.6	0.0	26.3	C		
TR	0.58	0.30	32.6	0.986	1011	0.17	0.8	0.0	33.0	C	31.0	C
Northbound												
L	0.34	0.47	17.9	1.000	430	0.11	0.5	0.0	18.4	B		
TR	0.87	0.31	35.9	1.000	562	0.40	14.0	0.0	50.0	D	42.7	D
Southbound												
L	0.28	0.47	20.1	1.000	283	0.11	0.6	0.0	20.6	C		
TR	0.52	0.31	31.3	1.000	574	0.13	0.9	0.0	32.2	C	29.7	C

Intersection delay = 33.8 (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 110.0 sec				
Total actual green time for LT lane group, G (s)	49.0	49.0	49.0	49.0
Effective permitted green time for LT lane group, g(s)	39.0	39.0	40.0	40.0
Opposing effective green time, go (s)	33.0	33.0	34.0	34.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	1	1	1
Adjusted LT flow rate, VLT (veh/h)	153	251	146	80
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	585	387	299	490
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	4.68	7.67	4.46	2.44
Opposing lane util. factor, fLUo	0.952	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.39	11.82	9.14	14.97
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.60	0.70	0.69	0.69
gq, (see Exhibit C16-4,5,6,7,8)	14.59	21.09	15.14	28.43
gu=g-gq if gq>=gf, or = g-gf if gq<gf	24.41	17.91	24.86	11.57
n=Max(gq-gf)/2,0)	7.29	10.54	7.57	14.21
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.32	1.88	1.73	2.06
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.10	0.10	0.10	0.10
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.27	0.24	0.36	0.14
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	0.270	0.245	0.359	0.140

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 110.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	1.000	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	33.0	33.0	34.0	34.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	166	166	161	161
OCCpedg	0.083	0.083	0.081	0.081
Opposing queue clearing green, gq (s)	14.59	21.09	15.14	28.43
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.442	0.639	0.445	0.836
OCCpedu	0.065	0.056	0.063	0.047
Opposing flow rate, Vo (veh/h)	585	387	299	490
OCCr	0.029	0.033	0.041	0.024
Number of cross-street receiving lanes, Nrec	1	1	2	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.971	0.967	0.975	0.976
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.971	0.967	0.975	0.976
Permitted Right Turns				
Effective pedestrian green time, gp (s)	33.0	33.0	34.0	34.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	166	166	161	161
OCCpedg	0.083	0.083	0.081	0.081
Effective green, g (s)	33.0	33.0	34.0	34.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.083	0.083	0.081	0.081
Number of cross-street receiving lanes, Nrec	1	1	1	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.917	0.917	0.919	0.952
Proportion right-turns, PRT	1.000	0.183	0.145	0.067
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	1.000	0.985	0.988	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 110.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v	153	251	146	80
v/c ratio from Capacity Worksheet, X	0.40	0.69	0.34	0.28
Protected phase effective green interval, g (s)	13.0	13.0	12.0	12.0
Opposing queue effective green interval, gq	14.59	21.09	15.14	28.43
Unopposed green interval, gu	24.41	17.91	24.86	11.57
Red time r=(C-g-gq-gu)	58.0	58.0	58.0	58.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.04	0.07	0.04	0.02
Protected ph. departure rate, Sp=s/3600	0.482	0.480	0.484	0.485
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.22	0.27	0.29	0.25
XPerm	0.31	0.56	0.22	0.31
XProt	0.48	0.79	0.49	0.27
Case	1	1	1	1
Queue at beginning of green arrow, Qa	2.46	4.04	2.35	1.29
Queue at beginning of unsaturated green, Qu	0.62	1.47	0.61	0.63
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	18.0	20.6	17.9	20.1

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		18.0	0.00	0.0	0.0	18.7
T	0.0	0.00	38.5	33.5	0.00	0.0	0.0	36.0
R	0.0	0.00	38.5	28.5	0.00	0.0	0.0	28.7
Westbound								
L	0.0	0.00		20.6	0.00	0.0	0.0	26.3
TR	0.0	0.00	38.5	32.6	0.00	0.0	0.0	33.0
	0.0						0.0	
Northbound								
L	0.0	0.00		17.9	0.00	0.0	0.0	18.4
TR	0.0	0.00	38.0	35.9	0.00	0.0	0.0	50.0
	0.0						0.0	
Southbound								
L	0.0	0.00		20.1	0.00	0.0	0.0	20.6
TR	0.0	0.00	38.0	31.3	0.00	0.0	0.0	32.2
	0.0						0.0	

Intersection Delay 33.8 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	T	R	L	TR		L	TR		L	TR	
Init Queue	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	153	387	79	251	307		146	490		80	299	
So	1900	2000	1900	1900	1900		1900	1900		1900	1900	
No.Lanes	1	1	1	1	2	0	1	1	0	1	1	0
SL	804	1980	1466	766	1769		909	1819		600	1856	
LnCapacity	380	594	440	362	530		430	562		283	574	
Flow Ratio	0.2	0.2	0.1	0.3	0.2		0.2	0.3		0.1	0.2	
v/c Ratio	0.40	0.65	0.18	0.69	0.58		0.34	0.87		0.28	0.52	
Grn Ratio	0.47	0.30	0.30	0.47	0.30		0.47	0.31		0.47	0.31	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3	3	4	4		3	3		3	3	
Pltn Ratio	1.00	1.00	1.00	1.33	1.33		1.00	1.00		1.00	1.00	
PF2	1.00	1.00	1.00	0.84	0.92		1.00	1.00		1.00	1.00	
Q1	2.6	10.3	1.8	3.7	7.3		2.4	14.2		1.3	7.5	
kB	0.4	0.6	0.5	0.4	0.5		0.5	0.6		0.4	0.6	
Q2	0.3	1.0	0.1	0.9	0.7		0.2	2.8		0.1	0.6	
Q Average	2.9	11.3	1.9	4.6	8.0		2.7	17.0		1.5	8.1	
Q Spacing	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0	0	0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2	1.2	1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	3.4	13.3	2.3	5.4	9.5		3.2	19.8		1.8	9.6	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5	1.6	1.6	1.5		1.6	1.5		1.6	1.5	
BOQ	4.5	17.0	3.0	7.1	12.3		4.2	25.0		2.3	12.4	
QSRatio												
90th Percentile Output:												
fB%	1.7	1.6	1.8	1.7	1.7		1.7	1.6		1.8	1.7	
BOQ	5.0	18.4	3.3	7.8	13.4		4.7	26.7		2.6	13.5	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.8	2.0	2.0	1.9		2.0	1.7		2.1	1.9	
BOQ	5.8	20.6	3.9	9.0	15.1		5.4	29.5		3.0	15.3	
QSRatio												
98th Percentile Output:												
fB%	2.5	2.1	2.6	2.4	2.2		2.5	2.0		2.6	2.2	
BOQ	7.2	24.0	4.8	11.0	18.0		6.7	33.5		3.8	18.2	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC	Inter.: 47th/Gilbert
Agency: KLOA	Area Type: All other areas
Date: 11/9/2010	Jurisd: IDOT
Period: PM Peak	Year : Existing 3-lane
Project ID: 10-076	
E/W St: 47th St	N/S St: Gilbert Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
LGConfig	L	T	R	L	TR		L	TR		L	TR	
Volume	135	437	87	325	452	71	116	249	148	76	265	19
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A		A		NB	Left	A	A		
	Thru			A			Thru		A		
	Right			A			Right		A		
	Peds			X			Peds		X		
WB	Left	A	A	A		SB	Left	A	A		
	Thru		A	A			Thru		A		
	Right		A	A			Right		A		
	Peds			X			Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	10.0	37.0				6.0	40.0		
Yellow		3.0	3.0	4.0				3.0	4.0		
All Red		0.0	0.0	2.0				0.0	2.0		

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	278	1720	0.51	0.33	34.6	C		
T	611	1980	0.75	0.31	42.6	D	39.4	D
R	453	1469	0.20	0.31	30.8	C		
Westbound								
L	385	1740	0.89	0.52	40.3	D		
TR	1446	3470	0.38	0.42	21.4	C	28.7	C
Northbound								
L	353	1745	0.35	0.43	22.5	C		
TR	575	1726	0.73	0.33	39.8	D	35.9	D
Southbound								
L	259	1735	0.31	0.43	23.5	C		
TR	619	1857	0.48	0.33	32.4	C	30.5	C

Intersection Delay = 33.5 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Gilbert
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Gilbert Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	135	437	87	325	452	71	116	249	148	76	265	19
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	36	115	23	86	119	19	31	66	39	20	70	5
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	2000	1900	1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
LGConfig	L	T	R	L	TR		L	TR		L	TR	
Lane Width	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	142	460	92	342	551		122	418		80	299	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000	1.000		0.136			0.373			0.067	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0	0	0	0		0	0		0	0	
%InProtPhase	0.0			0.0		0.0	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	0.0		0.0	0.0	
Arriv. Type	3	3	3	4	4		3	3		3	3	
Unit Ext.	3.0	3.0	3.0	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	2.0		2.0	2.0	
Ext of g	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A		A		NB	Left	A	A		
	Thru			A			Thru		A		
	Right			A			Right		A		
	Peds			X			Peds		X		
WB	Left	A	A	A		SB	Left	A	A		
	Thru		A	A			Thru		A		
	Right		A	A			Right		A		
	Peds			X			Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	10.0	37.0				6.0	40.0		
Yellow		3.0	3.0	4.0				3.0	4.0		
All Red		0.0	0.0	2.0				0.0	2.0		

Cycle Length: 120.0 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	135	437	87	325	452	71	116	249	148	76	265	19
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	142	460	92	342	476	75	122	262	156	80	279	20
No. Lanes	1	1	1	1	2	0	1	1	0	1	1	0
Lane group	L	T	R	L	TR		L	TR		L	TR	
Adj flow	142	460	92	342	551		122	418		80	299	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000	1.000		0.136			0.373			0.067	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	T	R	L	TR		L	TR		L	TR	
So	1900	2000	1900	1900	1900		1900	1900		1900	1900	
Lanes	1	1	1	1	2	0	1	1	0	1	1	0
fW	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990	0.990	0.990	0.990		0.990	0.990		0.990	0.990	
fG	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000	1.000	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	1.000		1.000	1.000	
fA	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000	1.000	1.000	0.952		1.000	1.000		1.000	1.000	
fRT		1.000	0.850		0.980			0.944			0.990	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.446			0.168			0.377			0.245		
fLpb	0.962	1.000		0.974	1.000		0.976	1.000		0.971	1.000	
fRpb		1.000	0.919		0.989			0.972			0.997	
S	1720	1980	1469	1740	3470		1745	1726		1735	1857	
Sec.	808			308			693			448		

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		29	1720	0.02	0.017	29	1.00
Perm		113	808	0.14	0.308	249	0.45
Left	L	142			0.33	278	0.51
Prot							
Perm							
Thru	T	460	1980	# 0.23	0.31	611	0.75
Right	R	92	1469	0.06	0.31	453	0.20
Westbound							
Prot		275	1740	# 0.16	0.158	275	1.00
Perm		67	308	0.22	0.358	110	0.61
Left	L	342			0.52	385	0.89
Prot							
Perm							
Thru	TR	551	3470	0.16	0.42	1446	0.38
Right							
Northbound							
Prot		87	1745	# 0.05	0.050	87	1.00
Perm		35	693	0.05	0.383	266	0.13
Left	L	122			0.43	353	0.35
Prot							
Perm							
Thru	TR	418	1726	# 0.24	0.33	575	0.73
Right							
Southbound							
Prot		80	1735	0.05	0.050	87	0.92
Perm		0	448	0.00	0.383	172	0.00
Left	L	80			0.43	259	0.31
Prot							
Perm							
Thru	TR	299	1857	0.16	0.33	619	0.48
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.68
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.85

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.51	0.33	33.1	1.000	278	0.12	1.6	0.0	34.6	C		
T	0.75	0.31	37.4	1.000	611	0.31	5.3	0.0	42.6	D	39.4	D
R	0.20	0.31	30.6	1.000	453	0.11	0.2	0.0	30.8	C		
Westbound												
L	0.89	0.52	25.4	0.740	385	0.41	21.5	0.0	40.3	D		
TR	0.38	0.42	24.3	0.876	1446	0.11	0.2	0.0	21.4	C	28.7	C
Northbound												
L	0.35	0.43	21.9	1.000	353	0.11	0.6	0.0	22.5	C		
TR	0.73	0.33	35.2	1.000	575	0.29	4.6	0.0	39.8	D	35.9	D
Southbound												
L	0.31	0.43	22.9	1.000	259	0.11	0.7	0.0	23.5	C		
TR	0.48	0.33	31.8	1.000	619	0.11	0.6	0.0	32.4	C	30.5	C

Intersection delay = 33.5 (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 120.0 sec				
Total actual green time for LT lane group, G (s)	43.0	59.0	49.0	49.0
Effective permitted green time for LT lane group, g(s)	37.0	43.0	46.0	46.0
Opposing effective green time, go (s)	50.0	37.0	40.0	40.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	1	1	1
Adjusted LT flow rate, VLT (veh/h)	142	342	122	80
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	551	460	299	418
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	4.73	11.40	4.07	2.67
Opposing lane util. factor, fLUo	0.952	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.65	15.33	9.97	13.93
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.00	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.44	0.69	0.67	0.67
gq, (see Exhibit C16-4,5,6,7,8)	0.00	28.49	15.94	24.20
gu=g-gq if gq>=gf, or = g-gf if gq<gf	37.00	14.51	30.06	21.80
n=Max(gq-gf)/2,0)	0.00	14.25	7.97	12.10
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.24	2.01	1.73	1.93
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.11	0.09	0.09	0.09
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.45	0.17	0.38	0.25
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	0.446	0.168	0.377	0.245

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 120.0 sec				
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	0.000	0.000	0.000	0.000
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	0.952	1.000	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	37.0	37.0	40.0	40.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	162	162	150	150
OCCpedg	0.081	0.081	0.075	0.075
Opposing queue clearing green, gq (s)	0.00	28.49	15.94	24.20
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.000	0.770	0.398	0.605
OCCpedu	0.081	0.050	0.060	0.052
Opposing flow rate, Vo (veh/h)	551	460	299	418
OCCr	0.038	0.026	0.040	0.029
Number of cross-street receiving lanes, Nrec	1	1	2	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.962	0.974	0.976	0.971
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.962	0.974	0.976	0.971
Permitted Right Turns				
Effective pedestrian green time, gp (s)	37.0	37.0	40.0	40.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	162	162	150	150
OCCpedg	0.081	0.081	0.075	0.075
Effective green, g (s)	37.0	43.0	40.0	40.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.081	0.081	0.075	0.075
Number of cross-street receiving lanes, Nrec	1	1	1	2
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.919	0.919	0.925	0.955
Proportion right-turns, PRT	1.000	0.136	0.373	0.067
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	1.000	0.989	0.972	0.997

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 120.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v	142	342	122	80
v/c ratio from Capacity Worksheet, X	0.51	0.89	0.35	0.31
Protected phase effective green interval, g (s)	2.0	19.0	6.0	6.0
Opposing queue effective green interval, gq	0.00	28.49	15.94	24.20
Unopposed green interval, gu	37.00	14.51	30.06	21.80
Red time r=(C-g-gq-gu)	81.0	58.0	68.0	68.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.04	0.09	0.03	0.02
Protected ph. departure rate, Sp=s/3600	0.478	0.483	0.485	0.482
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.22	0.25	0.29	0.26
XPerm	0.18	1.11	0.18	0.18
XProt	3.43	0.80	0.86	0.57
Case	2	3	1	1
Queue at beginning of green arrow, Qa	3.20	5.92	2.30	1.51
Queue at beginning of unsaturated green, Qu	2.83	2.71	0.54	0.54
Residual queue, Qr	2.32	0.41	0.00	0.00
Uniform Delay, d1	33.1	25.4	21.9	22.9

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		33.1	0.00	0.0	0.0	34.6
T	0.0	0.00	41.5	37.4	0.00	0.0	0.0	42.6
R	0.0	0.00	41.5	30.6	0.00	0.0	0.0	30.8
Westbound								
L	0.0	0.00		25.4	0.00	0.0	0.0	40.3
TR	0.0	0.00	35.0	24.3	0.00	0.0	0.0	21.4
	0.0						0.0	
Northbound								
L	0.0	0.00		21.9	0.00	0.0	0.0	22.5
TR	0.0	0.00	40.0	35.2	0.00	0.0	0.0	39.8
	0.0						0.0	
Southbound								
L	0.0	0.00		22.9	0.00	0.0	0.0	23.5
TR	0.0	0.00	40.0	31.8	0.00	0.0	0.0	32.4
	0.0						0.0	

Intersection Delay 33.5 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	T	R	L	TR		L	TR		L	TR	
Init Queue	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	142	460	92	342	289		122	418		80	299	
So	1900	2000	1900	1900	1900		1900	1900		1900	1900	
No.Lanes	1	1	1	1	2	0	1	1	0	1	1	0
SL	855	1980	1469	747	1822		814	1726		596	1857	
LnCapacity	278	611	453	385	759		353	575		259	619	
Flow Ratio	0.2	0.2	0.1	0.5	0.2		0.1	0.2		0.1	0.2	
v/c Ratio	0.51	0.75	0.20	0.89	0.38		0.35	0.73		0.31	0.48	
Grn Ratio	0.33	0.31	0.31	0.52	0.42		0.43	0.33		0.43	0.33	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	3	3	3	4	4		3	3		3	3	
Pltn Ratio	1.00	1.00	1.00	1.33	1.33		1.00	1.00		1.00	1.00	
PF2	1.00	1.00	1.00	0.90	0.81		1.00	1.00		1.00	1.00	
Q1	3.2	13.8	2.3	5.7	5.4		2.3	12.3		1.5	7.9	
kB	0.4	0.6	0.5	0.4	0.7		0.4	0.6		0.4	0.6	
Q2	0.4	1.7	0.1	2.5	0.4		0.2	1.5		0.2	0.6	
Q Average	3.6	15.5	2.4	8.2	5.9		2.6	13.7		1.7	8.5	
Q Spacing	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0	0	0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2	1.2	1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	4.3	18.1	2.9	9.7	6.9		3.1	16.1		2.0	10.0	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5	1.6	1.5	1.5		1.6	1.5		1.6	1.5	
BOQ	5.7	22.9	3.8	12.5	9.1		4.0	20.4		2.7	13.0	
QSRatio												
90th Percentile Output:												
fB%	1.7	1.6	1.8	1.7	1.7		1.8	1.6		1.8	1.7	
BOQ	6.3	24.6	4.2	13.7	9.9		4.5	22.0		3.0	14.1	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.8	2.0	1.9	1.9		2.0	1.8		2.0	1.9	
BOQ	7.2	27.2	4.8	15.4	11.3		5.2	24.4		3.5	15.9	
QSRatio												
98th Percentile Output:												
fB%	2.5	2.0	2.5	2.2	2.3		2.5	2.0		2.6	2.2	
BOQ	8.9	31.1	6.1	18.3	13.7		6.5	28.1		4.4	18.8	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Edgewood
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane

N/S St: Edgewood Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LGConfig	L	TR		L	TR			LTR			LTR	
Volume	21	579	8	45	707	32	1	15	45	3	5	40
Lane Width	12.0	12.0		12.0	12.0			12.0			12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4		5	6	7	8
EB Left	A	A			NB Left	A			
Thru		A			Thru	A			
Right		A			Right	A			
Peds		X			Peds	X			
WB Left	A	A			SB Left	A			
Thru		A			Thru	A			
Right		A			Right	A			
Peds		X			Peds	X			
NB Right					EB Right				
SB Right					WB Right				
Green	6.0	59.0				30.0			
Yellow	3.0	4.0				4.0			
All Red	0.0	2.0				2.0			

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	303	1767	0.07	0.65	11.9	B		
TR	1006	1876	0.61	0.54	13.6	B	13.5	B
Westbound								
L	424	1758	0.11	0.65	9.1	A		
TR	1000	1865	0.78	0.54	18.3	B	17.8	B
Northbound								
LTR	430	1575	0.15	0.27	30.5	C	30.5	C
Southbound								
LTR	413	1516	0.12	0.27	30.2	C	30.2	C

Intersection Delay = 17.0 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Edgewood
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Edgewood Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	21	579	8	45	707	32	1	15	45	3	5	40
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	6	152	2	12	186	8	1	4	12	1	2	11
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900			1900			1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LGConfig	L	TR		L	TR			LTR			LTR	
Lane Width	12.0	12.0		12.0	12.0			12.0			12.0	
RTOR Vol			0			0			0			0
Adj Flow	22	617		47	778			64			50	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000			0.016			0.060	
Prop RTs		0.013			0.044		0.734			0.840		
Peds Bikes		50	0		50	0	50		0	50		0
Buses	0	0		0	0			0			0	
%InProtPhase	0.0			0.0								

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0			0.0			0.0	
Arriv. Type	4	4		4	4			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		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination		1	2	3	4
EB	Left	A	A		
	Thru		A		
	Right		A		
	Peds		X		
WB	Left	A	A		
	Thru		A		
	Right		A		
	Peds		X		
NB	Right				
SB	Right				
Green		6.0	59.0		
Yellow		3.0	4.0		
All Red		0.0	2.0		

		5	6	7	8
NB	Left	A			
	Thru	A			
	Right	A			
	Peds	X			
SB	Left	A			
	Thru	A			
	Right	A			
	Peds	X			
EB	Right				
WB	Right				
Green		30.0			
Yellow		4.0			
All Red		2.0			

Cycle Length: 110.0 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	21	579	8	45	707	32	1	15	45	3	5	40
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	22	609	8	47	744	34	1	16	47	3	5	42
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
Lane group	L	TR		L	TR			LTR			LTR	
Adj flow	22	617		47	778			64			50	
Prop LTs	1.000	0.000		1.000	0.000			0.016			0.060	
Prop RTs		0.013			0.044			0.734			0.840	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR			LTR			LTR	
So	1900	1900		1900	1900			1900			1900	
Lanes	1	1	0	1	1	0	0	1	0	0	1	0
fW	1.000	1.000		1.000	1.000			1.000			1.000	
fHV	0.990	0.990		0.990	0.990			0.990			0.990	
fG	1.000	1.000		1.000	1.000			1.000			1.000	
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			1.000	
fRT		0.998			0.993			0.901			0.887	
fLT	0.950	1.000		0.950	1.000			0.998			0.990	
Sec.	0.189			0.300								
fLpb	0.988	1.000		0.984	1.000			0.999			0.995	
fRpb		0.999			0.998			0.933			0.923	
S	1767	1876		1758	1865			1575			1516	
Sec.	351			555								

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		22	1767	0.01	0.055	96	0.23
Perm		0	351	0.00	0.591	207	0.00
Left	L	22			0.65	303	0.07
Prot							
Perm							
Thru	TR	617	1876	0.33	0.54	1006	0.61
Right							
Westbound							
Prot		47	1758	# 0.03	0.055	96	0.49
Perm		0	555	0.00	0.591	328	0.00
Left	L	47			0.65	424	0.11
Prot							
Perm							
Thru	TR	778	1865	# 0.42	0.54	1000	0.78
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	64	1575	# 0.04	0.27	430	0.15
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	50	1516	0.03	0.27	413	0.12
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.48
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.58

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.07	0.65	11.8	1.000	303	0.11	0.1	0.0	11.9	B		
TR	0.61	0.54	17.6	0.707	1006	0.20	1.1	0.0	13.6	B	13.5	B
Westbound												
L	0.11	0.65	9.0	1.000	424	0.11	0.1	0.0	9.1	A		
TR	0.78	0.54	20.3	0.707	1000	0.33	4.0	0.0	18.3	B	17.8	B
Northbound												
LTR	0.15	0.27	30.3	1.000	430	0.11	0.2	0.0	30.5	C	30.5	C
Southbound												
LTR	0.12	0.27	30.1	1.000	413	0.11	0.1	0.0	30.2	C	30.2	C

Intersection delay = 17.0 (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 110.0 sec				
Total actual green time for LT lane group, G (s)	68.0	68.0		
Effective permitted green time for LT lane group, g(s)	65.0	65.0		
Opposing effective green time, go (s)	59.0	59.0		
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)	22	47		
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)	778	617		
Lost time for LT lane group, tL	6.00	6.00		
Computation				
LT volume per cycle, LTC=VLTC/3600	0.67	1.44		
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	23.77	18.85		
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.33		
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.28	0.28		
gq, (see Exhibit C16-4,5,6,7,8)	31.96	19.78		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	33.04	45.22		
n=Max(gq-gf)/2,0)	15.98	9.89		
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)	2.70	2.32		
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.06	0.06		
gdiff=max(gq-gf,0)	0.00	0.00		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.19	0.30		
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	0.189	0.300		

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 110.0 sec				
Total actual green time for LT lane group, G (s)			30.0	30.0
Effective permitted green time for LT lane group, g(s)			30.0	30.0
Opposing effective green time, go (s)			30.0	30.0
Number of lanes in LT lane group, N			1	1

	EB	WB	NB	SB
Number of lanes in opposing approach, No			1	1
Adjusted LT flow rate, VLT (veh/h)			1	3
Proportion of LT in LT lane group, PLT	0.000	0.000	0.016	0.060
Proportion of LT in opposing flow, PLTo			0.06	0.02
Adjusted opposing flow rate, Vo (veh/h)			50	64
Lost time for LT lane group, tL			6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600			0.03	0.09
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			1.53	1.96
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			21.3	18.8
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.73	0.73
gq, (see Exhibit C16-4,5,6,7,8)			0.00	0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf			8.74	11.22
n=Max(gq-gf)/2,0)			0.00	0.00
PTHo=1-PLTo			0.94	0.98
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.02	0.06
EL1 (refer to Exhibit C16-3)			1.45	1.47
EL2=Max((1-Ptho**n)/Plto, 1.0)			1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.07	0.07
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			1.00	0.99
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			0.998	0.990

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)	59.0	59.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	93	93	183	183
OCCpedg	0.047	0.047	0.092	0.092
Opposing queue clearing green, gq (s)	31.96	19.78	0.00	0.00
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.542	0.335	0.000	0.000
OCCpedu	0.034	0.039	0.092	0.092
Opposing flow rate, Vo (veh/h)	778	617	50	64
OCCr	0.012	0.016	0.085	0.084
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.988	0.984	0.915	0.916
Proportion of left turns, PLT	1.000	1.000	0.016	0.060
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.988	0.984	0.999	0.995
Permitted Right Turns				
Effective pedestrian green time, gp (s)	59.0	59.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	93	93	183	183
OCCpedg	0.047	0.047	0.092	0.092
Effective green, g (s)	59.0	59.0	30.0	30.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.047	0.047	0.092	0.092
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.953	0.953	0.909	0.909
Proportion right-turns, PRT	0.013	0.044	0.734	0.840
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.999	0.998	0.933	0.923

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	110.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		22	47		
v/c ratio from Capacity Worksheet, X		0.07	0.11		
Protected phase effective green interval, g (s)		6.0	6.0		
Opposing queue effective green interval, gq		31.96	19.78		
Unopposed green interval, gu		33.04	45.22		
Red time r=(C-g-gq-gu)		39.0	39.0		
Arrival rate, qa=v/(3600(max[X,1.0]))		0.01	0.01		
Protected ph. departure rate, Sp=s/3600		0.491	0.488		
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.19	0.22		
XPerm		0.06	0.08		
XProt		0.09	0.20		
Case		1	1		
Queue at beginning of green arrow, Qa		0.24	0.51		
Queue at beginning of unsaturated green, Qu		0.20	0.26		
Residual queue, Qr		0.00	0.00		
Uniform Delay, d1		11.8	9.0		

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		11.8	0.00	0.0	0.0	11.9
TR	0.0	0.00	25.5	17.6	0.00	0.0	0.0	13.6
	0.0						0.0	
Westbound								
L	0.0	0.00		9.0	0.00	0.0	0.0	9.1
TR	0.0	0.00	25.5	20.3	0.00	0.0	0.0	18.3
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	40.0	30.3	0.00	0.0	0.0	30.5
	0.0						0.0	
Southbound								
	0.0						0.0	
LTR	0.0	0.00	40.0	30.1	0.00	0.0	0.0	30.2
	0.0						0.0	

Intersection Delay 17.0 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR			LTR			LTR	
Init Queue	0.0	0.0		0.0	0.0			0.0			0.0	
Flow Rate	22	617		47	778			64			50	
So	1900	1900		1900	1900			1900			1900	
No.Lanes	1	1	0	1	1	0	0	1	0	0	1	0
SL	471	1876		657	1865			1575			1516	
LnCapacity	303	1006		424	1000			430			413	
Flow Ratio	0.0	0.3		0.1	0.4			0.0			0.0	
v/c Ratio	0.07	0.61		0.11	0.78			0.15			0.12	
Grn Ratio	0.65	0.54		0.65	0.54			0.27			0.27	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	4	4		4	4			3			3	
Pltn Ratio	1.33	1.33		1.33	1.33			1.00			1.00	
PF2	0.40	0.73		0.40	0.81			1.00			1.00	
Q1	0.1	9.6		0.2	15.3			1.5			1.1	
kB	0.4	0.8		0.5	0.8			0.5			0.5	
Q2	0.0	1.2		0.1	2.5			0.1			0.1	
Q Average	0.1	10.8		0.3	17.8			1.6			1.2	
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%	1.2	1.2		1.2	1.2			1.2			1.2	
BOQ	0.1	12.7		0.3	20.7			1.9			1.5	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5			1.6			1.6	
BOQ	0.2	16.3		0.4	26.0			2.5			1.9	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.8	1.6			1.8			1.8	
BOQ	0.2	17.6		0.5	27.8			2.8			2.2	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.8		2.1	1.7			2.1			2.1	
BOQ	0.3	19.7		0.6	30.6			3.2			2.5	
QSRatio												
98th Percentile Output:												
fB%	2.7	2.1		2.7	2.0			2.6			2.6	
BOQ	0.3	23.0		0.7	34.7			4.0			3.2	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Edgewood
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane

N/S St: Edgewood Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LGConfig	L	TR		L	TR			LTR			LTR	
Volume	7	697	12	22	803	8	4	3	41	5	4	32
Lane Width	12.0	12.0		12.0	12.0			12.0			12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A	A			NB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds		X				Peds	X			
WB Left	A	A			SB	Left	A			
Thru		A				Thru	A			
Right		A				Right	A			
Peds		X				Peds	X			
NB Right					EB	Right				
SB Right					WB	Right				
Green	7.0	68.0					30.0			
Yellow	3.0	4.0					4.0			
All Red	0.0	2.0					2.0			

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	298	1770	0.02	0.68	12.4	B		
TR	1062	1875	0.70	0.57	14.3	B	14.3	B
Westbound								
L	379	1765	0.06	0.68	9.7	A		
TR	1064	1878	0.80	0.57	17.9	B	17.7	B
Northbound								
LTR	372	1487	0.13	0.25	35.1	D	35.1	D
Southbound								
LTR	374	1497	0.11	0.25	34.9	C	34.9	C

Intersection Delay = 17.1 (sec/veh) Intersection LOS = B

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Edgewood
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Edgewood Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	7	697	12	22	803	8	4	3	41	5	4	32
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	2	183	3	6	211	2	1	1	11	2	1	8
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900			1900			1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
LGConfig	L	TR		L	TR			LTR			LTR	
Lane Width	12.0	12.0		12.0	12.0			12.0			12.0	
RTOR Vol			0			0			0			0
Adj Flow	7	747		23	853			50			43	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000			0.080			0.116	
Prop RTs		0.017			0.009			0.860			0.791	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0			0			0	
%InProtPhase	0.0			0.0								

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0			0.0			0.0	
Arriv. Type	4	4		4	4			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		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds		X				Peds	X			
WB	Left	A	A			SB	Left	A			
	Thru		A				Thru	A			
	Right		A				Right	A			
	Peds		X				Peds	X			
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		7.0	68.0					30.0			
Yellow		3.0	4.0					4.0			
All Red		0.0	2.0					2.0			

Cycle Length: 120.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume, V	7	697	12	22	803	8	4	3	41	5	4	32
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	7	734	13	23	845	8	4	3	43	5	4	34
No. Lanes	1	1	0	1	1	0	0	1	0	0	1	0
Lane group	L	TR		L	TR			LTR			LTR	
Adj flow	7	747		23	853			50			43	
Prop LTs	1.000	0.000		1.000	0.000			0.080			0.116	
Prop RTs		0.017			0.009			0.860			0.791	

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

	Eastbound L	Eastbound TR		Westbound L	Westbound TR			Northbound LTR			Southbound LTR	
So	1900	1900		1900	1900			1900			1900	
Lanes	1	1	0	1	1	0	0	1	0	0	1	0
fW	1.000	1.000		1.000	1.000			1.000			1.000	
fHV	0.990	0.990		0.990	0.990			0.990			0.990	
fG	1.000	1.000		1.000	1.000			1.000			1.000	
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			1.000	
fRT		0.997			0.999			0.884			0.893	
fLT	0.950	1.000		0.950	1.000			0.986			0.978	
Sec.	0.169			0.241								
fLpb	0.990	1.000		0.988	1.000			0.992			0.989	
fRpb		0.999			1.000			0.914			0.921	
S	1770	1875		1765	1878			1487			1497	
Sec.	316			448								

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		7	1770	0.00	0.058	103	0.07
Perm		0	316	0.00	0.617	195	0.00
Left	L	7			0.68	298	0.02
Prot							
Perm							
Thru	TR	747	1875	0.40	0.57	1062	0.70
Right							
Westbound							
Prot		23	1765	# 0.01	0.058	103	0.22
Perm		0	448	0.00	0.617	276	0.00
Left	L	23			0.68	379	0.06
Prot							
Perm							
Thru	TR	853	1878	# 0.45	0.57	1064	0.80
Right							
Northbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	50	1487	# 0.03	0.25	372	0.13
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	LTR	43	1497	0.03	0.25	374	0.11
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.50
Total lost time per cycle, L = 18.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.59

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.02	0.68	12.4	1.000	298	0.11	0.0	0.0	12.4	B		
TR	0.70	0.57	18.7	0.649	1062	0.27	2.1	0.0	14.3	B	14.3	B
Westbound												
L	0.06	0.68	9.6	1.000	379	0.11	0.1	0.0	9.7	A		
TR	0.80	0.57	20.6	0.649	1064	0.35	4.5	0.0	17.9	B	17.7	B
Northbound												
LTR	0.13	0.25	34.9	1.000	372	0.11	0.2	0.0	35.1	D	35.1	D
Southbound												
LTR	0.11	0.25	34.7	1.000	374	0.11	0.1	0.0	34.9	C	34.9	C

Intersection delay = 17.1 (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 120.0 sec				
Total actual green time for LT lane group, G (s)	78.0	78.0		
Effective permitted green time for LT lane group, g(s)	74.0	74.0		
Opposing effective green time, go (s)	68.0	68.0		
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)	7	23		
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)	853	747		
Lost time for LT lane group, tL	6.00	6.00		
Computation				
LT volume per cycle, LTC=VLTC/3600	0.23	0.77		
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	28.43	24.90		
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0		
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.33	1.33		
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.24	0.24		
gq, (see Exhibit C16-4,5,6,7,8)	37.76	27.25		
gu=g-gq if gq>=gf, or = g-gf if gq<gf	36.24	46.75		
n=Max(gq-gf)/2,0)	18.88	13.63		
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)	2.89	2.62		
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.05	0.05		
gdiff=max(gq-gf,0)	0.00	0.00		
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.17	0.24		
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	0.169	0.241		

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 120.0 sec				
Total actual green time for LT lane group, G (s)			30.0	30.0
Effective permitted green time for LT lane group, g(s)			30.0	30.0
Opposing effective green time, go (s)			30.0	30.0
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)			4	5
Proportion of LT in LT lane group, PLT	0.000	0.000	0.080	0.116
Proportion of LT in opposing flow, PLTo			0.12	0.08
Adjusted opposing flow rate, Vo (veh/h)			43	50
Lost time for LT lane group, tL			6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600			0.13	0.17
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)			1.43	1.67
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g			17.5	16.7
Opposing platoon ratio, Rpo (refer Exhibit 16-11)			1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]			0.75	0.75
gq, (see Exhibit C16-4,5,6,7,8)			0.00	0.00
gu=g-gq if gq>=gf, or = g-gf if gq<gf			12.45	13.30
n=Max(gq-gf)/2,0)			0.00	0.00
PTHo=1-PLTo			0.88	0.92
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]			0.08	0.12
EL1 (refer to Exhibit C16-3)			1.44	1.45
EL2=Max((1-Ptho**n)/Plto, 1.0)			1.00	1.00
fmin=2(1+PL)/g or fmin=2(1+Pl)/g			0.07	0.07
gdiff=max(gq-gf,0)			0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)			0.99	0.98
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			0.986	0.978

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)	68.0	68.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	88	88	200	200
OCCpedg	0.044	0.044	0.100	0.100
Opposing queue clearing green, gq (s)	37.76	27.25	0.00	0.00
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.555	0.401	0.000	0.000
OCCpedu	0.032	0.035	0.100	0.100
Opposing flow rate, Vo (veh/h)	853	747	43	50
OCCr	0.010	0.012	0.094	0.093
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.990	0.988	0.906	0.907
Proportion of left turns, PLT	1.000	1.000	0.080	0.116
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.990	0.988	0.992	0.989
Permitted Right Turns				
Effective pedestrian green time, gp (s)	68.0	68.0	30.0	30.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	88	88	200	200
OCCpedg	0.044	0.044	0.100	0.100
Effective green, g (s)	68.0	68.0	30.0	30.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.044	0.044	0.100	0.100
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.956	0.956	0.900	0.900
Proportion right-turns, PRT	0.017	0.009	0.860	0.791
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.999	1.000	0.914	0.921

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

		EBLT	WBLT	NBLT	SBLT
Cycle length, C	120.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		7	23		
v/c ratio from Capacity Worksheet, X		0.02	0.06		
Protected phase effective green interval, g (s)		7.0	7.0		
Opposing queue effective green interval, gq		37.76	27.25		
Unopposed green interval, gu		36.24	46.75		
Red time r=(C-g-gq-gu)		39.0	39.0		
Arrival rate, qa=v/(3600(max[X,1.0]))		0.00	0.01		
Protected ph. departure rate, Sp=s/3600		0.492	0.490		
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.18	0.20		
XPerm		0.02	0.05		
XProt		0.03	0.09		
Case		1	1		
Queue at beginning of green arrow, Qa		0.08	0.25		
Queue at beginning of unsaturated green, Qu		0.07	0.17		
Residual queue, Qr		0.00	0.00		
Uniform Delay, d1		12.4	9.6		

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		12.4	0.00	0.0	0.0	12.4
TR	0.0	0.00	26.0	18.7	0.00	0.0	0.0	14.3
	0.0						0.0	
Westbound								
L	0.0	0.00		9.6	0.00	0.0	0.0	9.7
TR	0.0	0.00	26.0	20.6	0.00	0.0	0.0	17.9
	0.0						0.0	
Northbound								
	0.0						0.0	
LTR	0.0	0.00	45.0	34.9	0.00	0.0	0.0	35.1
	0.0						0.0	
Southbound								
	0.0						0.0	
LTR	0.0	0.00	45.0	34.7	0.00	0.0	0.0	34.9
	0.0						0.0	

Intersection Delay 17.1 sec/veh Intersection LOS B

BACK OF QUEUE WORKSHEET

	Eastbound		Westbound		Northbound	Southbound
LaneGroup	L	TR	L	TR	LTR	LTR
Init Queue	0.0	0.0	0.0	0.0	0.0	0.0
Flow Rate	7	747	23	853	50	43
So	1900	1900	1900	1900	1900	1900
No.Lanes	1	1 0	1	1 0	0 1 0	0 1 0
SL	442	1875	562	1878	1487	1497
LnCapacity	298	1062	379	1064	372	374
Flow Ratio	0.0	0.4	0.0	0.5	0.0	0.0
v/c Ratio	0.02	0.70	0.06	0.80	0.13	0.11
Grn Ratio	0.68	0.57	0.68	0.57	0.25	0.25
I Factor		1.000		1.000	1.000	1.000
AT or PVG	4	4	4	4	3	3
Pltn Ratio	1.33	1.33	1.33	1.33	1.00	1.00
PF2	0.31	0.72	0.31	0.78	1.00	1.00
Q1	0.0	13.0	0.1	17.6	1.3	1.1
kB	0.4	0.9	0.4	0.9	0.5	0.5
Q2	0.0	1.9	0.0	3.1	0.1	0.1
Q Average	0.0	14.9	0.1	20.7	1.4	1.2
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%	1.2	1.2	1.2	1.2	1.2	1.2
BOQ	0.0	17.4	0.1	24.0	1.6	1.4
QSRatio						
85th Percentile Output:						
fB%	1.6	1.5	1.6	1.5	1.6	1.6
BOQ	0.1	22.1	0.2	30.0	2.2	1.9
QSRatio						
90th Percentile Output:						
fB%	1.8	1.6	1.8	1.5	1.8	1.8
BOQ	0.1	23.7	0.2	31.9	2.4	2.1
QSRatio						
95th Percentile Output:						
fB%	2.1	1.8	2.1	1.7	2.1	2.1
BOQ	0.1	26.3	0.2	35.0	2.8	2.4
QSRatio						
98th Percentile Output:						
fB%	2.7	2.0	2.7	1.9	2.6	2.6
BOQ	0.1	30.1	0.3	39.4	3.5	3.0
QSRatio						

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Brainard
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane

N/S St: Brainard Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	23	527	69	77	703	59	125	308	83	44	113	32
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	49.0					6.0	31.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 110.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	166	1787	0.14	0.55	22.6	C		
TR	818	1836	0.77	0.45	26.1	C	26.0	C
Westbound								
L	282	1758	0.29	0.55	16.3	B		
TR	825	1851	0.97	0.45	54.4	D	50.9	D
Northbound								
L	404	1674	0.33	0.39	22.9	C		
TR	504	1787	0.82	0.28	46.9	D	41.0	D
Southbound								
L	212	1731	0.22	0.39	24.1	C		
TR	502	1783	0.30	0.28	31.4	C	29.7	C

Intersection Delay = 39.6 (sec/veh) Intersection LOS = D

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/Brainard
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Brainard Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	23	527	69	77	703	59	125	308	83	44	113	32
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	6	139	18	20	185	16	33	81	22	12	30	8
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	24	628		81	802		132	411		46	153	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.116			0.077			0.212			0.222	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			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		0.0	0.0	
Arriv. Type	4	4		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.6			3.6			3.6			3.6	

PHASE DATA

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	49.0					6.0	31.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 110.0 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	23	527	69	77	703	59	125	308	83	44	113	32
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	24	555	73	81	740	62	132	324	87	46	119	34
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	24	628		81	802		132	411		46	153	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.116			0.077			0.212			0.222	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	1	0	1	1	0	1	1	0	1	1	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.990		0.990	0.990		0.990	0.990	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRT		0.983			0.988			0.968			0.967	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.073			0.201			0.529			0.192		
fLpb	1.000	1.000		0.984	1.000		0.937	1.000		0.969	1.000	
fRpb		0.993			0.996			0.981			0.980	
S	1787	1836		1758	1851		1674	1787		1731	1783	
Sec.	137			371			932			350		

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		24	1787	0.01	0.055	97	0.25
Perm		0	137	0.00	0.500	69	0.00
Left	L	24			0.55	166	0.14
Prot							
Perm							
Thru	TR	628	1836	0.34	0.45	818	0.77
Right							
Westbound							
Prot		81	1758	# 0.05	0.055	96	0.84
Perm		0	371	0.00	0.500	186	0.00
Left	L	81			0.55	282	0.29
Prot							
Perm							
Thru	TR	802	1851	# 0.43	0.45	825	0.97
Right							
Northbound							
Prot		91	1674	# 0.05	0.055	91	1.00
Perm		41	932	0.04	0.336	313	0.13
Left	L	132			0.39	404	0.33
Prot							
Perm							
Thru	TR	411	1787	# 0.23	0.28	504	0.82
Right							
Southbound							
Prot		46	1731	0.03	0.055	94	0.49
Perm		0	350	0.00	0.336	118	0.00
Left	L	46			0.39	212	0.22
Prot							
Perm							
Thru	TR	153	1783	0.09	0.28	502	0.30
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.76
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.98

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	LOS	Approach Delay	LOS
Eastbound												
L	0.14	0.55	22.2	1.000	166	0.11	0.4	0.0	22.6	C		
TR	0.77	0.45	25.7	0.842	818	0.32	4.4	0.0	26.1	C	26.0	C
Westbound												
L	0.29	0.55	15.7	1.000	282	0.11	0.6	0.0	16.3	B		
TR	0.97	0.45	29.8	1.000	825	0.48	24.6	0.0	54.4	D	50.9	D
Northbound												
L	0.33	0.39	22.4	1.000	404	0.11	0.5	0.0	22.9	C		
TR	0.82	0.28	36.8	1.000	504	0.36	10.0	0.0	46.9	D	41.0	D
Southbound												
L	0.22	0.39	23.6	1.000	212	0.11	0.5	0.0	24.1	C		
TR	0.30	0.28	31.0	1.000	502	0.11	0.3	0.0	31.4	C	29.7	C

Intersection delay = 39.6 (sec/veh) Intersection LOS = D

SUPPLEMENTAL PERMITTED LT WORKSHEET
for exclusive lefts

Input	EB	WB	NB	SB
Opposed by Single(S) or Multiple(M) lane approach				
Cycle length, C 110.0 sec				
Total actual green time for LT lane group, G (s)	58.0	58.0	40.0	40.0
Effective permitted green time for LT lane group, g(s)	55.0	55.0	37.0	37.0
Opposing effective green time, go (s)	49.0	49.0	31.0	31.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	1	1	1	1
Adjusted LT flow rate, VLT (veh/h)	24	81	132	46
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	802	628	153	411
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	0.73	2.48	4.03	1.41
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	24.51	19.19	4.68	12.56
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.55	0.41	0.72	0.72
gq, (see Exhibit C16-4,5,6,7,8)	49.02	29.14	7.34	23.38
gu=g-gq if gq>=gf, or = g-gf if gq<gf	5.98	25.86	29.66	13.62
n=Max(gq-gf)/2,0)	24.51	14.57	3.67	11.69
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.76	2.34	1.52	1.92
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.07	0.07	0.11	0.11
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.07	0.20	0.53	0.19
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	0.073	0.201	0.529	0.192

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 110.0 sec				
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				

	EB	WB	NB	SB
Number of lanes in opposing approach, No				
Adjusted LT flow rate, VLT (veh/h)				
Proportion of LT in LT lane group, PLT	0.000	0.000	0.000	0.000
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	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	49.0	49.0	31.0	31.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	112	112	177	177
OCCpedg	0.056	0.056	0.089	0.089
Opposing queue clearing green, gq (s)	49.02	29.14	7.34	23.38
Eff. ped. green consumed by opp. veh. queue, gq/gp	1.000	0.595	0.237	0.754
OCCpedu	0.028	0.039	0.078	0.055
Opposing flow rate, Vo (veh/h)	802	628	153	411
OCCr	0.009	0.016	0.063	0.031
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.991	0.984	0.937	0.969
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	1.000	0.984	0.937	0.969
Permitted Right Turns				
Effective pedestrian green time, gp (s)	49.0	49.0	31.0	31.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	112	112	177	177
OCCpedg	0.056	0.056	0.089	0.089
Effective green, g (s)	49.0	49.0	31.0	31.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.056	0.056	0.089	0.089
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.944	0.944	0.911	0.911
Proportion right-turns, PRT	0.116	0.077	0.212	0.222
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.993	0.996	0.981	0.980

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

Cycle length, C 110.0 sec

	EBLT	WBLT	NBLT	SBLT
Adj. LT vol from Vol Adjustment Worksheet, v	24	81	132	46
v/c ratio from Capacity Worksheet, X	0.14	0.29	0.33	0.22
Protected phase effective green interval, g (s)	6.0	6.0	6.0	6.0
Opposing queue effective green interval, gq	49.02	29.14	7.34	23.38
Unopposed green interval, gu	5.98	25.86	29.66	13.62
Red time r=(C-g-gq-gu)	49.0	49.0	67.0	67.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.01	0.02	0.04	0.01
Protected ph. departure rate, Sp=s/3600	0.496	0.488	0.465	0.481
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.35	0.22	0.32	0.26
XPerm	0.18	0.22	0.14	0.13
XProt	0.12	0.42	0.96	0.32
Case	1	1	1	1
Queue at beginning of green arrow, Qa	0.33	1.10	2.46	0.86
Queue at beginning of unsaturated green, Qu	0.33	0.66	0.27	0.30
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	22.2	15.7	22.4	23.6

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		22.2	0.00	0.0	0.0	22.6
TR	0.0	0.00	30.5	25.7	0.00	0.0	0.0	26.1
	0.0						0.0	
Westbound								
L	0.0	0.00		15.7	0.00	0.0	0.0	16.3
TR	0.0	0.00	30.5	29.8	0.00	0.0	0.0	54.4
	0.0						0.0	
Northbound								
L	0.0	0.00		22.4	0.00	0.0	0.0	22.9
TR	0.0	0.00	39.5	36.8	0.00	0.0	0.0	46.9
	0.0						0.0	
Southbound								
L	0.0	0.00		23.6	0.00	0.0	0.0	24.1
TR	0.0	0.00	39.5	31.0	0.00	0.0	0.0	31.4
	0.0						0.0	

Intersection Delay 39.6 sec/veh Intersection LOS D

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	24	628		81	802		132	411		46	153	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	1	0	1	1	0	1	1	0	1	1	0
SL	299	1836		507	1851		1036	1787		543	1783	
LnCapacity	166	818		282	825		404	504		212	502	
Flow Ratio	0.1	0.3		0.2	0.4		0.1	0.2		0.1	0.1	
v/c Ratio	0.14	0.77		0.29	0.97		0.33	0.82		0.22	0.30	
Grn Ratio	0.55	0.45		0.55	0.45		0.39	0.28		0.39	0.28	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	4	4		3	3		3	3		3	3	
Pltn Ratio	1.33	1.33		1.00	1.00		1.00	1.00		1.00	1.00	
PF2	0.60	0.89		1.00	1.00		1.00	1.00		1.00	1.00	
Q1	0.2	14.3		1.1	24.0		2.5	11.7		0.9	3.7	
kB	0.3	0.7		0.4	0.7		0.4	0.5		0.3	0.5	
Q2	0.0	2.1		0.1	7.0		0.2	2.0		0.1	0.2	
Q Average	0.2	16.4		1.3	31.0		2.7	13.7		0.9	3.9	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.1		1.2	1.2		1.2	1.2	
BOQ	0.3	19.1		1.5	35.5		3.2	16.0		1.1	4.6	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.4		1.6	1.5		1.6	1.6	
BOQ	0.4	24.2		2.0	43.6		4.3	20.4		1.5	6.1	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.8	1.5		1.7	1.6		1.8	1.7	
BOQ	0.4	25.9		2.2	46.0		4.7	21.9		1.7	6.7	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.7		2.1	1.6		2.0	1.8		2.1	2.0	
BOQ	0.5	28.6		2.6	49.8		5.5	24.3		2.0	7.7	
QSRatio												
98th Percentile Output:												
fB%	2.7	2.0		2.6	1.8		2.5	2.0		2.6	2.4	
BOQ	0.6	32.6		3.3	55.5		6.8	28.0		2.5	9.5	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/Brainard
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane

N/S St: Brainard Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Volume	37	608	78	72	692	43	96	191	70	75	238	72
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A	A			NB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
WB	Left	A	A			SB	Left	A	A		
	Thru		A				Thru		A		
	Right		A				Right		A		
	Peds		X				Peds		X		
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	62.0					6.0	28.0		
Yellow		3.0	4.0					3.0	4.0		
All Red		0.0	2.0					0.0	2.0		

Cycle Length: 120.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	229	1768	0.17	0.62	17.8	B		
TR	950	1839	0.76	0.52	20.7	C	20.6	C
Westbound								
L	304	1764	0.25	0.62	14.5	B		
TR	961	1860	0.80	0.52	29.0	C	27.7	C
Northbound								
L	201	1710	0.50	0.33	32.3	C		
TR	409	1753	0.67	0.23	46.1	D	42.4	D
Southbound								
L	238	1695	0.33	0.33	30.0	C		
TR	413	1770	0.79	0.23	53.4	D	48.8	D

Intersection Delay = 31.3 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/Brainard
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane
Project ID: 10-076
E/W St: 47th St N/S St: Brainard Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	37	608	78	72	692	43	96	191	70	75	238	72
% Heavy Veh	1	1	1	1	1	1	1	1	1	1	1	1
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	10	160	21	19	182	11	25	50	18	20	63	19
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
LGConfig	L	TR		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol			0			0			0			0
Adj Flow	39	722		76	773		101	275		79	327	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.114			0.058			0.269			0.232	
Peds Bikes		50	0		50	0		50	0		50	0
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			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		0.0	0.0	
Arriv. Type	4	4		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Ped Min g		3.7			3.7			3.7			3.7	

PHASE DATA

Phase Combination	1	2	3	4			5	6	7	8
EB Left	A	A			NB	Left	A	A		
Thru		A				Thru		A		
Right		A				Right		A		
Peds		X				Peds		X		
WB Left	A	A			SB	Left	A	A		
Thru		A				Thru		A		
Right		A				Right		A		
Peds		X				Peds		X		
NB Right					EB	Right				
SB Right					WB	Right				
Green	6.0	62.0					6.0	28.0		
Yellow	3.0	4.0					3.0	4.0		
All Red	0.0	2.0					0.0	2.0		

Cycle Length: 120.0 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	37	608	78	72	692	43	96	191	70	75	238	72
PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	39	640	82	76	728	45	101	201	74	79	251	76
No. Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Lane group	L	TR		L	TR		L	TR		L	TR	
Adj flow	39	722		76	773		101	275		79	327	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.114			0.058			0.269			0.232	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	TR		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	1	0	1	1	0	1	1	0	1	1	0
fW	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fHV	0.990	0.990		0.990	0.990		0.990	0.990		0.990	0.990	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRT		0.983			0.991			0.960			0.965	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.133			0.206			0.225			0.302		
fLpb	0.989	1.000		0.987	1.000		0.957	1.000		0.949	1.000	
fRpb		0.995			0.997			0.971			0.975	
S	1768	1839		1764	1860		1710	1753		1695	1770	
Sec.	248			382			405			539		

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		39	1768	0.02	0.050	88	0.44
Perm		0	248	0.00	0.567	141	0.00
Left	L	39			0.62	229	0.17
Prot							
Perm							
Thru	TR	722	1839	0.39	0.52	950	0.76
Right							
Westbound							
Prot		76	1764	# 0.04	0.050	88	0.86
Perm		0	382	0.00	0.567	216	0.00
Left	L	76			0.62	304	0.25
Prot							
Perm							
Thru	TR	773	1860	# 0.42	0.52	961	0.80
Right							
Northbound							
Prot		86	1710	# 0.05	0.050	86	1.00
Perm		15	405	0.04	0.283	115	0.13
Left	L	101			0.33	201	0.50
Prot							
Perm							
Thru	TR	275	1753	0.16	0.23	409	0.67
Right							
Southbound							
Prot		79	1695	0.05	0.050	85	0.93
Perm		0	539	0.00	0.283	153	0.00
Left	L	79			0.33	238	0.33
Prot							
Perm							
Thru	TR	327	1770	# 0.18	0.23	413	0.79
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.69
Total lost time per cycle, L = 24.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.87

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.17	0.62	17.4	1.000	229	0.11	0.4	0.0	17.8	B		
TR	0.76	0.52	23.1	0.740	950	0.31	3.6	0.0	20.7	C	20.6	C
Westbound												
L	0.25	0.62	14.0	1.000	304	0.11	0.4	0.0	14.5	B		
TR	0.80	0.52	24.0	1.000	961	0.35	5.1	0.0	29.0	C	27.7	C
Northbound												
L	0.50	0.33	30.3	1.000	201	0.11	2.0	0.0	32.3	C		
TR	0.67	0.23	41.8	1.000	409	0.24	4.3	0.0	46.1	D	42.4	D
Southbound												
L	0.33	0.33	29.2	1.000	238	0.11	0.8	0.0	30.0	C		
TR	0.79	0.23	43.3	1.000	413	0.34	10.1	0.0	53.4	D	48.8	D

Intersection delay = 31.3 (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 120.0 sec				
Total actual green time for LT lane group, G (s)	71.0	71.0	37.0	37.0
Effective permitted green time for LT lane group, g(s)	68.0	68.0	34.0	34.0
Opposing effective green time, go (s)	62.0	62.0	28.0	28.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	1	1	1	1
Adjusted LT flow rate, VLT (veh/h)	39	76	101	79
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	773	722	327	275
Lost time for LT lane group, tL	6.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	1.30	2.53	3.37	2.63
Opposing lane util. factor, fLUo	1.000	1.000	1.000	1.000
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	25.77	24.07	10.90	9.17
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.48	0.31	0.77	0.77
gq, (see Exhibit C16-4,5,6,7,8)	43.66	32.19	20.42	16.59
gu=g-gq if gq>=gf, or = g-gf if gq<gf	24.34	35.81	13.58	17.41
n=Max(gq-gf)/2,0)	21.83	16.10	10.21	8.30
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.68	2.56	1.78	1.69
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.06	0.06	0.12	0.12
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.13	0.21	0.22	0.30
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	0.133	0.206	0.225	0.302

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 120.0 sec				
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	0.000	0.000	0.000	0.000
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	1.000	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 PEDESTRIAN-BICYCLE EFFECTS WORKSHEET

Permitted Left Turns	EB	WB	NB	SB
Effective pedestrian green time, gp (s)	62.0	62.0	28.0	28.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Pedestrian flow rate, Vpedg (p/h)	96	96	214	214
OCCpedg	0.048	0.048	0.107	0.107
Opposing queue clearing green, gq (s)	43.66	32.19	20.42	16.59
Eff. ped. green consumed by opp. veh. queue, gq/gp	0.704	0.519	0.729	0.593
OCCpedu	0.031	0.036	0.068	0.075
Opposing flow rate, Vo (veh/h)	773	722	327	275
OCCr	0.011	0.013	0.043	0.051
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.989	0.987	0.957	0.949
Proportion of left turns, PLT	1.000	1.000	1.000	1.000
Proportion of left turns using protected phase, PLTA	0.000	0.000	0.000	0.000
Left-turn adjustment, fLpb	0.989	0.987	0.957	0.949
Permitted Right Turns				
Effective pedestrian green time, gp (s)	62.0	62.0	28.0	28.0
Conflicting pedestrian volume, Vped (p/h)	50	50	50	50
Conflicting bicycle volume, Vbic (bicycles/h)	0	0	0	0
Vpedg	96	96	214	214
OCCpedg	0.048	0.048	0.107	0.107
Effective green, g (s)	62.0	62.0	28.0	28.0
Vbicg	0	0	0	0

OCCbicg	0.020	0.020	0.020	0.020
OCCr	0.048	0.048	0.107	0.107
Number of cross-street receiving lanes, Nrec	1	1	1	1
Number of turning lanes, Nturn	1	1	1	1
ApbT	0.952	0.952	0.893	0.893
Proportion right-turns, PRT	0.114	0.058	0.269	0.232
Proportion right-turns using protected phase, PRTA	0.000	0.000	0.000	0.000
Right turn adjustment, fRpb	0.995	0.997	0.971	0.975

SUPPLEMENTAL UNIFORM DELAY WORKSHEET

	EBLT	WBLT	NBLT	SBLT
Cycle length, C 120.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v	39	76	101	79
v/c ratio from Capacity Worksheet, X	0.17	0.25	0.50	0.33
Protected phase effective green interval, g (s)	6.0	6.0	6.0	6.0
Opposing queue effective green interval, gq	43.66	32.19	20.42	16.59
Unopposed green interval, gu	24.34	35.81	13.58	17.41
Red time r=(C-g-gq-gu)	46.0	46.0	80.0	80.0
Arrival rate, qa=v/(3600(max[X,1.0]))	0.01	0.02	0.03	0.02
Protected ph. departure rate, Sp=s/3600	0.491	0.490	0.475	0.471
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)	0.19	0.20	0.28	0.29
XPerm	0.16	0.20	0.25	0.15
XProt	0.19	0.37	0.85	0.67
Case	1	1	1	1
Queue at beginning of green arrow, Qa	0.50	0.97	2.24	1.76
Queue at beginning of unsaturated green, Qu	0.47	0.68	0.57	0.36
Residual queue, Qr	0.00	0.00	0.00	0.00
Uniform Delay, d1	17.4	14.0	30.3	29.2

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		17.4	0.00	0.0	0.0	17.8
TR	0.0	0.00	29.0	23.1	0.00	0.0	0.0	20.7
	0.0						0.0	
Westbound								
L	0.0	0.00		14.0	0.00	0.0	0.0	14.5
TR	0.0	0.00	29.0	24.0	0.00	0.0	0.0	29.0
	0.0						0.0	
Northbound								
L	0.0	0.00		30.3	0.00	0.0	0.0	32.3
TR	0.0	0.00	46.0	41.8	0.00	0.0	0.0	46.1
	0.0						0.0	
Southbound								
L	0.0	0.00		29.2	0.00	0.0	0.0	30.0
TR	0.0	0.00	46.0	43.3	0.00	0.0	0.0	53.4
	0.0						0.0	

Intersection Delay 31.3 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	TR		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	39	722		76	773		101	275		79	327	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	1	0	1	1	0	1	1	0	1	1	0
SL	371	1839		494	1860		601	1753		712	1770	
LnCapacity	229	950		304	961		201	409		238	413	
Flow Ratio	0.1	0.4		0.2	0.4		0.2	0.2		0.1	0.2	
v/c Ratio	0.17	0.76		0.25	0.80		0.50	0.67		0.33	0.79	
Grn Ratio	0.62	0.52		0.62	0.52		0.33	0.23		0.33	0.23	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	4	4		3	3		3	3		3	3	
Pltn Ratio	1.33	1.33		1.00	1.00		1.00	1.00		1.00	1.00	
PF2	0.48	0.82		1.00	1.00		1.00	1.00		1.00	1.00	
Q1	0.2	15.7		1.0	21.3		2.3	8.3		1.8	10.3	
kB	0.3	0.8		0.4	0.8		0.3	0.5		0.3	0.5	
Q2	0.1	2.3		0.1	2.9		0.3	0.9		0.2	1.6	
Q Average	0.3	18.0		1.1	24.2		2.6	9.3		1.9	11.8	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	0.4	21.0		1.3	28.0		3.1	10.9		2.3	13.9	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.4		1.6	1.5		1.6	1.5	
BOQ	0.5	26.4		1.8	34.7		4.1	14.1		3.1	17.8	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.6		1.8	1.5		1.8	1.7		1.8	1.6	
BOQ	0.6	28.2		2.0	36.8		4.5	15.3		3.4	19.2	
QSRatio												
95th Percentile Output:												
fB%	2.1	1.7		2.1	1.7		2.0	1.9		2.0	1.8	
BOQ	0.6	31.0		2.3	40.1		5.2	17.2		4.0	21.5	
QSRatio												
98th Percentile Output:												
fB%	2.7	1.9		2.6	1.9		2.5	2.2		2.6	2.1	
BOQ	0.8	35.2		2.9	45.0		6.5	20.3		5.0	24.9	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: AM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/East
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane (signal)

N/S St: East Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	T		L	TR		L	TR		L	TR	
Volume	69	532		194	441	130	33	254	269	109	204	39
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol						0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A		A	A	NB	Left	A	A		
	Thru			A	A		Thru		A		
	Right						Right		A		
	Peds						Peds				
WB	Left	A	A	A		SB	Left	A	A		
	Thru		A	A			Thru		A		
	Right		A	A			Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	11.0	26.0	5.0			7.0	51.0		
Yellow		3.0	3.0	4.0	3.0			3.0	4.0		
All Red		0.0	0.0	2.0	0.0			0.0	2.0		

Cycle Length: 130.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	355	1770	0.21	0.33	29.5	C		
T	1010	3547	0.55	0.28	40.1	D	38.9	D
Westbound								
L	368	1770	0.55	0.40	29.7	C		
TR	1054	3425	0.57	0.31	38.5	D	36.3	D
Northbound								
L	526	1770	0.07	0.49	17.3	B		
TR	1284	3273	0.43	0.39	29.1	C	28.4	C
Southbound								
L	363	1770	0.32	0.49	19.4	B		
TR	1358	3461	0.19	0.39	26.0	C	24.0	C

Intersection Delay = 33.1 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone: Fax:
E-Mail:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: AM Peak
Intersection: 47th/East
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane (signal)
Project ID: 10-076
E/W St: 47th St N/S St: East Ave

VOLUME DATA

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume	69	532		194	441	130	33	254	269	109	204	39
% Heavy Veh	2	2		2	2	2	2	2	2	2	2	2
PHF	0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	18	140		51	116	34	9	67	71	29	54	10
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	T		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol						0			0			0
Adj Flow	73	560		204	601		35	550		115	256	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000			0.228			0.515			0.160	
Peds Bikes	0			0			0			0		
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			0.0			0.0		

Duration 0.25 Area Type: All other areas

OPERATING PARAMETERS

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Init Unmet	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Arriv. Type	4	4		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		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	A		A	A	NB	Left	A	A		
	Thru			A	A		Thru		A		
	Right						Right		A		
	Peds						Peds				
WB	Left	A	A	A		SB	Left	A	A		
	Thru		A	A			Thru		A		
	Right		A	A			Right		A		
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	11.0	26.0	5.0			7.0	51.0		
Yellow		3.0	3.0	4.0	3.0			3.0	4.0		
All Red		0.0	0.0	2.0	0.0			0.0	2.0		

Cycle Length: 130.0 secs

VOLUME ADJUSTMENT AND SATURATION FLOW WORKSHEET

Volume Adjustment

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
Volume, V	69	532		194	441	130	33	254	269	109	204	39
PHF	0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	73	560		204	464	137	35	267	283	115	215	41
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
Lane group	L	T		L	TR		L	TR		L	TR	
Adj flow	73	560		204	601		35	550		115	256	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000			0.228			0.515			0.160	

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

LG	Eastbound L	Eastbound T		Westbound L	Westbound TR		Northbound L	Northbound TR		Southbound L	Southbound TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	2	0	1	2	0
fW	1.000	1.000		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		0.980	0.980	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	0.952		1.000	0.952	
fRT		1.000			0.966			0.923			0.976	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.394			0.209			0.527			0.328		
fLpb	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1770	3547		1770	3425		1770	3273		1770	3461	
Sec.	734			390			982			612		

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		73	1770	0.04	0.108	191	0.38
Perm		0	734	0.00	0.223	164	0.00
Left	L	73			0.33	355	0.21
Prot							
Perm							
Thru	T	560	3547	# 0.16	0.28	1010	0.55
Right							
Westbound							
Prot		204	1770	# 0.12	0.154	272	0.75
Perm		0	390	0.00	0.246	96	0.00
Left	L	204			0.40	368	0.55
Prot							
Perm							
Thru	TR	601	3425	0.18	0.31	1054	0.57
Right							
Northbound							
Prot		35	1770	0.02	0.054	95	0.37
Perm		0	982	0.00	0.438	431	0.00
Left	L	35			0.49	526	0.07
Prot							
Perm							
Thru	TR	550	3273	# 0.17	0.39	1284	0.43
Right							
Southbound							
Prot		95	1770	# 0.05	0.054	95	1.00
Perm		20	612	0.03	0.438	268	0.07
Left	L	115			0.49	363	0.32
Prot							
Perm							
Thru	TR	256	3461	0.07	0.39	1358	0.19
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.49
Total lost time per cycle, L = 21.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.59

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.21	0.33	30.4	0.961	355	0.11	0.3	0.0	29.5	C		
T	0.55	0.28	39.5	0.997	1010	0.15	0.7	0.0	40.1	D	38.9	D
Westbound												
L	0.55	0.40	27.9	1.000	368	0.15	1.8	0.0	29.7	C		
TR	0.57	0.31	37.8	1.000	1054	0.16	0.7	0.0	38.5	D	36.3	D
Northbound												
L	0.07	0.49	17.3	1.000	526	0.11	0.1	0.0	17.3	B		
TR	0.43	0.39	28.9	1.000	1284	0.11	0.2	0.0	29.1	C	28.4	C
Southbound												
L	0.32	0.49	18.9	1.000	363	0.11	0.5	0.0	19.4	B		
TR	0.19	0.39	25.9	1.000	1358	0.11	0.1	0.0	26.0	C	24.0	C

Intersection delay = 33.1 (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 130.0 sec				
Total actual green time for LT lane group, G (s)	43.0	49.0	61.0	61.0
Effective permitted green time for LT lane group, g(s)	29.0	32.0	57.0	57.0
Opposing effective green time, go (s)	40.0	37.0	51.0	51.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	2	2
Adjusted LT flow rate, VLT (veh/h)	73	204	35	115
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	601	560	256	550
Lost time for LT lane group, tL	3.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	2.64	7.37	1.26	4.15
Opposing lane util. factor, fLUo	0.952	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	11.40	10.62	4.86	10.43
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.69	0.62	0.61	0.61
gq, (see Exhibit C16-4,5,6,7,8)	2.14	16.85	6.38	15.10
gu=g-gq if gq>=gf, or = g-gf if gq<gf	26.86	15.15	50.62	41.90
n=Max(gq-gf)/2,0)	1.07	8.43	3.19	7.55
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.35	2.26	1.68	2.24
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.14	0.13	0.07	0.07
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.39	0.21	0.53	0.33
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	0.394	0.209	0.527	0.328

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 130.0 sec				
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                  0.000 0.000 0.000 0.000
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                        0.952 0.952 0.952 0.952
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 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	130.0 sec				
Adj. LT vol from Vol Adjustment Worksheet, v		73	204	35	115
v/c ratio from Capacity Worksheet, X		0.21	0.55	0.07	0.32
Protected phase effective green interval, g (s)		14.0	20.0	7.0	7.0
Opposing queue effective green interval, gq		2.14	16.85	6.38	15.10
Unopposed green interval, gu		26.86	15.15	50.62	41.90
Red time r=(C-g-gq-gu)		87.0	78.0	66.0	66.0
Arrival rate, qa=v/(3600(max[X,1.0]))		0.02	0.06	0.01	0.03
Protected ph. departure rate, Sp=s/3600		0.492	0.492	0.492	0.492
Permitted ph. departure rate, Ss=s(gq+gu)/(gu*3600)		0.22	0.23	0.31	0.23
XPerm		0.10	0.52	0.04	0.19
XProt		0.30	0.56	0.21	0.68
Case		1	1	1	1
Queue at beginning of green arrow, Qa		1.76	4.42	0.64	2.11
Queue at beginning of unsaturated green, Qu		0.04	0.95	0.06	0.48
Residual queue, Qr		0.00	0.00	0.00	0.00
Uniform Delay, d1		30.4	27.9	17.3	18.9

DELAY/LOS WORKSHEET WITH INITIAL QUEUE

Appr/ Lane Group	Initial Unmet Demand Q veh	Dur. Unmet Demand t hrs.	Uniform Delay Unadj. ds	Uniform Delay Adj. d1 sec	Initial Queue Param. u	Final Unmet Demand Q veh	Initial Queue Delay d3 sec	Lane Group Delay d sec
Eastbound								
L	0.0	0.00		30.4	0.00	0.0	0.0	29.5
T	0.0	0.00	46.5	39.5	0.00	0.0	0.0	40.1
	0.0						0.0	
Westbound								
L	0.0	0.00		27.9	0.00	0.0	0.0	29.7
TR	0.0	0.00	45.0	37.8	0.00	0.0	0.0	38.5
	0.0						0.0	
Northbound								
L	0.0	0.00		17.3	0.00	0.0	0.0	17.3
TR	0.0	0.00	39.5	28.9	0.00	0.0	0.0	29.1
	0.0						0.0	
Southbound								
L	0.0	0.00		18.9	0.00	0.0	0.0	19.4
TR	0.0	0.00	39.5	25.9	0.00	0.0	0.0	26.0
	0.0						0.0	

Intersection Delay 33.1 sec/veh Intersection LOS C

BACK OF QUEUE WORKSHEET

	Eastbound			Westbound			Northbound			Southbound		
LaneGroup	L	T		L	TR		L	TR		L	TR	
Init Queue	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Flow Rate	73	294		204	315		35	288		115	134	
So	1900	1900		1900	1900		1900	1900		1900	1900	
No.Lanes	1	2	0	1	2	0	1	2	0	1	2	0
SL	1071	1862		921	1798		1068	1719		739	1817	
LnCapacity	355	530		368	553		526	674		363	713	
Flow Ratio	0.1	0.2		0.2	0.2		0.0	0.2		0.2	0.1	
v/c Ratio	0.21	0.55		0.55	0.57		0.07	0.43		0.32	0.19	
Grn Ratio	0.33	0.28		0.40	0.31		0.49	0.39		0.49	0.39	
I Factor		1.000			1.000			1.000			1.000	
AT or PVG	4	4		3	3		3	3		3	3	
Pltn Ratio	1.33	1.33		1.00	1.00		1.00	1.00		1.00	1.00	
PF2	0.86	0.93		1.00	1.00		1.00	1.00		1.00	1.00	
Q1	1.5	8.3		4.8	9.5		0.6	7.6		2.1	3.2	
kB	0.5	0.6		0.5	0.6		0.6	0.7		0.5	0.7	
Q2	0.1	0.7		0.6	0.8		0.0	0.5		0.2	0.2	
Q Average	1.7	9.1		5.4	10.3		0.7	8.1		2.4	3.3	
Q Spacing	25.0	25.0		25.0	25.0		25.0	25.0		25.0	25.0	
Q Storage	0	0		0	0		0	0		0	0	
Q S Ratio												
70th Percentile Output:												
fB%	1.2	1.2		1.2	1.2		1.2	1.2		1.2	1.2	
BOQ	2.0	10.7		6.4	12.2		0.8	9.6		2.8	4.0	
QSRatio												
85th Percentile Output:												
fB%	1.6	1.5		1.6	1.5		1.6	1.5		1.6	1.6	
BOQ	2.6	13.8		8.3	15.6		1.1	12.4		3.7	5.2	
QSRatio												
90th Percentile Output:												
fB%	1.8	1.7		1.7	1.6		1.8	1.7		1.8	1.7	
BOQ	2.9	15.0		9.2	16.9		1.2	13.5		4.1	5.8	
QSRatio												
95th Percentile Output:												
fB%	2.0	1.9		1.9	1.8		2.1	1.9		2.0	2.0	
BOQ	3.4	16.9		10.5	19.0		1.4	15.2		4.8	6.7	
QSRatio												
98th Percentile Output:												
fB%	2.6	2.2		2.4	2.2		2.6	2.2		2.5	2.5	
BOQ	4.3	19.9		12.7	22.2		1.8	18.1		6.0	8.3	
QSRatio												

ERROR MESSAGES

No errors to report.

HCS+: Signalized Intersections Release 5.3

Analyst: KC
Agency: KLOA
Date: 11/9/2010
Period: PM Peak
Project ID: 10-076
E/W St: 47th St

Inter.: 47th/East
Area Type: All other areas
Jurisd: IDOT
Year : Existing 3-lane (signal)

N/S St: East Ave

SIGNALIZED INTERSECTION SUMMARY

	Eastbound L	Eastbound T	Eastbound R	Westbound L	Westbound T	Westbound R	Northbound L	Northbound T	Northbound R	Southbound L	Southbound T	Southbound R
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	T		L	TR		L	TR		L	TR	
Volume	65	335		241	425	63	80	261	284	185	249	62
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol						0			0			0

Duration 0.25 Area Type: All other areas

Signal Operations

Phase Combination		1	2	3	4			5	6	7	8
EB	Left	A		A	A	NB	Left	A		A	
	Thru			A	A		Thru			A	
	Right						Right			A	
	Peds						Peds				
WB	Left	A	A	A		SB	Left	A	A	A	
	Thru		A	A			Thru		A	A	
	Right		A	A			Right		A	A	
	Peds						Peds				
NB	Right					EB	Right				
SB	Right					WB	Right				
Green		6.0	14.0	22.0	5.0			7.0	8.0	36.0	
Yellow		3.0	3.0	4.0	3.0			3.0	3.0	4.0	
All Red		0.0	0.0	2.0	0.0			0.0	0.0	2.0	

Cycle Length: 125.0 secs

Intersection Performance Summary

Appr/ Lane Grp	Lane Group Capacity	Adj Sat Flow Rate (s)	Ratios v/c	Ratios g/C	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound								
L	371	1770	0.18	0.31	30.3	C		
T	936	3547	0.38	0.26	37.9	D	36.6	D
Westbound								
L	474	1770	0.54	0.41	27.3	C		
TR	1085	3478	0.47	0.31	35.0+	D	32.5	C
Northbound								
L	340	1770	0.25	0.31	32.3	C		
TR	942	3270	0.61	0.29	39.6	D	38.7	D
Southbound								
L	412	1770	0.47	0.48	21.5	C		
TR	1294	3441	0.25	0.38	27.0	C	25.0	C

Intersection Delay = 33.3 (sec/veh) Intersection LOS = C

HCS+: Signalized Intersections Release 5.3

Phone:
E-Mail:

Fax:

OPERATIONAL ANALYSIS

Analyst: KC
Agency/Co.: KLOA
Date Performed: 11/9/2010
Analysis Time Period: PM Peak
Intersection: 47th/East
Area Type: All other areas
Jurisdiction: IDOT
Analysis Year: Existing 3-lane (signal)
Project ID: 10-076
E/W St: 47th St N/S St: East Ave

VOLUME DATA

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
Volume	65	335		241	425	63	80	261	284	185	249	62
% Heavy Veh	2	2		2	2	2	2	2	2	2	2	2
PHF	0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
PK 15 Vol	17	88		63	112	17	21	69	75	49	66	16
Hi Ln Vol												
% Grade		0			0			0			0	
Ideal Sat	1900	1900		1900	1900		1900	1900		1900	1900	
ParkExist												
NumPark												
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
LGConfig	L	T		L	TR		L	TR		L	TR	
Lane Width	12.0	12.0		12.0	12.0		12.0	12.0		12.0	12.0	
RTOR Vol						0			0			0
Adj Flow	68	353		254	513		84	574		195	327	
%InSharedLn												
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000			0.129			0.521			0.199	
Peds Bikes		0			0			0			0	
Buses	0	0		0	0		0	0		0	0	
%InProtPhase	0.0			0.0			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		0.0	0.0	
Arriv. Type	4	4		3	3		3	3		3	3	
Unit Ext.	3.0	3.0		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		2.0	2.0	
Ext of g	2.0	2.0		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	A		A	A	NB	Left	A		A	
Thru			A	A		Thru			A	
Right						Right			A	
Peds						Peds				
WB Left	A	A	A		SB	Left	A	A	A	
Thru		A	A			Thru		A	A	
Right		A	A			Right		A	A	
Peds						Peds				
NB Right					EB	Right				
SB Right					WB	Right				
Green	6.0	14.0	22.0	5.0			7.0	8.0	36.0	
Yellow	3.0	3.0	4.0	3.0			3.0	3.0	4.0	
All Red	0.0	0.0	2.0	0.0			0.0	0.0	2.0	

Cycle Length: 125.0 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	65	335		241	425	63	80	261	284	185	249	62
PHF	0.95	0.95		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj flow	68	353		254	447	66	84	275	299	195	262	65
No. Lanes	1	2	0	1	2	0	1	2	0	1	2	0
Lane group	L	T		L	TR		L	TR		L	TR	
Adj flow	68	353		254	513		84	574		195	327	
Prop LTs	1.000	0.000		1.000	0.000		1.000	0.000		1.000	0.000	
Prop RTs		0.000			0.129			0.521			0.199	

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

	Eastbound			Westbound			Northbound			Southbound		
LG	L	T		L	TR		L	TR		L	TR	
So	1900	1900		1900	1900		1900	1900		1900	1900	
Lanes	1	2	0	1	2	0	1	2	0	1	2	0
fW	1.000	1.000		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		0.980	0.980	
fG	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fP	1.000	1.000		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		1.000	1.000	
fA	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fLU	1.000	0.952		1.000	0.952		1.000	0.952		1.000	0.952	
fRT		1.000			0.981			0.922			0.970	
fLT	0.950	1.000		0.950	1.000		0.950	1.000		0.950	1.000	
Sec.	0.463			0.354			0.555			0.250		
fLpb	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000	
fRpb		1.000			1.000			1.000			1.000	
S	1770	3547		1770	3478		1770	3270		1770	3441	
Sec.	863			659			1033			467		

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		68	1770	0.04	0.112	198	0.34
Perm		0	863	0.00	0.200	173	0.00
Left	L	68			0.31	371	0.18
Prot							
Perm							
Thru	T	353	3547	# 0.10	0.26	936	0.38
Right							
Westbound							
Prot		254	1770	# 0.14	0.184	326	0.78
Perm		0	659	0.00	0.224	148	0.00
Left	L	254			0.41	474	0.54
Prot							
Perm							
Thru	TR	513	3478	0.15	0.31	1085	0.47
Right							
Northbound							
Prot		42	1770	0.02	0.024	42	1.00
Perm		42	1033	0.04	0.288	298	0.14
Left	L	84			0.31	340	0.25
Prot							
Perm							
Thru	TR	574	3270	# 0.18	0.29	942	0.61
Right							
Southbound							
Prot		195	1770	# 0.11	0.144	255	0.76
Perm		0	467	0.00	0.336	157	0.00
Left	L	195			0.48	412	0.47
Prot							
Perm							
Thru	TR	327	3441	0.10	0.38	1294	0.25
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.53
Total lost time per cycle, L = 21.00 sec
Critical flow rate to capacity ratio, Xc = (Yc)(C)/(C-L) = 0.64

Control Delay and LOS Determination

Appr/ Lane Grp	Ratios v/c	Ratios g/C	Unf Del d1	Prog Adj Fact	Lane Grp Cap	Incremental Factor k	Del d2	Res Del d3	Lane Group Delay	Lane Group LOS	Approach Delay	Approach LOS
Eastbound												
L	0.18	0.31	30.8	0.976	371	0.11	0.2	0.0	30.3	C		
T	0.38	0.26	37.6	1.000	936	0.11	0.3	0.0	37.9	D	36.6	D
Westbound												
L	0.54	0.41	26.1	1.000	474	0.14	1.2	0.0	27.3	C		
TR	0.47	0.31	34.7	1.000	1085	0.11	0.3	0.0	35.0+	D	32.5	C
Northbound												
L	0.25	0.31	31.9	1.000	340	0.11	0.4	0.0	32.3	C		
TR	0.61	0.29	38.4	1.000	942	0.20	1.2	0.0	39.6	D	38.7	D
Southbound												
L	0.47	0.48	20.7	1.000	412	0.11	0.9	0.0	21.5	C		
TR	0.25	0.38	26.9	1.000	1294	0.11	0.1	0.0	27.0	C	25.0	C

Intersection delay = 33.3 (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 125.0 sec				
Total actual green time for LT lane group, G (s)	39.0	48.0	43.0	57.0
Effective permitted green time for LT lane group, g(s)	25.0	28.0	36.0	42.0
Opposing effective green time, go (s)	39.0	33.0	47.0	36.0
Number of lanes in LT lane group, N	1	1	1	1
Number of lanes in opposing approach, No	2	2	2	2
Adjusted LT flow rate, VLT (veh/h)	68	254	84	195
Proportion of LT in LT lane group, PLT	1.000	1.000	1.000	1.000
Proportion of LT in opposing flow, PLTo	0.00	0.00	0.00	0.00
Adjusted opposing flow rate, Vo (veh/h)	513	353	327	574
Lost time for LT lane group, tL	3.00	6.00	6.00	6.00
Computation				
LT volume per cycle, LTC=VLTC/3600	2.36	8.82	2.92	6.77
Opposing lane util. factor, fLUo	0.952	0.952	0.952	0.952
Opposing flow, Volc=VoC/[3600(No)fLUo] (veh/ln/cyc)	9.36	6.44	5.96	10.47
gf=G[exp(- a * (LTC ** b))]-tl, gf<=g	0.0	0.0	0.0	0.0
Opposing platoon ratio, Rpo (refer Exhibit 16-11)	1.00	1.33	1.00	1.00
Opposing Queue Ratio, qro=Max[1-Rpo(go/C),0]	0.69	0.65	0.62	0.71
gq, (see Exhibit C16-4,5,6,7,8)	0.00	9.67	0.00	17.90
gu=g-gq if gq>=gf, or = g-gf if gq<gf	25.00	18.33	36.00	24.10
n=Max(gq-gf)/2,0)	0.00	4.84	0.00	8.95
PTHo=1-PLTo	1.00	1.00	1.00	1.00
PL*=PLT[1+(N-1)g/(gf+gu/EL1+4.24)]	1.00	1.00	1.00	1.00
EL1 (refer to Exhibit C16-3)	2.16	1.85	1.80	2.29
EL2=Max((1-Ptho**n)/Plto, 1.0)				
fmin=2(1+PL)/g or fmin=2(1+Pl)/g	0.16	0.14	0.11	0.10
gdiff=max(gq-gf,0)	0.00	0.00	0.00	0.00
fm=[gf/g]+[gu/g]/[1+PL(EL1-1)], (min=fmin;max=1.00)	0.46	0.35	0.55	0.25
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	0.463	0.354	0.555	0.250

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 125.0 sec				
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				

APPENDIX "B-2"

47th Street Origination-Destination Study

Kenig, Lindgren, O'Hara, Aboona, Inc.

9575 West Higgins Road, Suite 400 Rosemont, Illinois 60018
p: 847-518-9990 f: 847-518-9987

MEMORANDUM TO: Ryan Gillingham, P.E.
Director of Public Works
Village of La Grange

FROM: Eric D. Russell, PTP, TSOS
Kelly K. Conolly, PE

DATE: December 24, 2010

SUBJECT: 47th Street Origin-Destination Study

This memorandum summarizes the results of an Origin-Destination (O-D) Study of traffic utilizing 47th Street in the Village of La Grange. The study area for 47th Street extends a distance of 1.5 miles from the east Village limits at East Avenue to the west Village limits at Gilbert Avenue.

The intent of this study is to identify the primary users of 47th Street and to quantify the volume of non-local through traffic on 47th Street in an effort to determine the most appropriate cross section for 47th Street that best benefits the La Grange community. Through traffic is defined as traffic that enters and exits the Village without stopping.

License plate survey was the method of data collection and analysis utilized in this study. License plate surveys are very beneficial and cost-effective for small-scale, limited O-D studies where many destinations are known. They are particularly adaptable to studies of single routes where traffic is too heavy to be stopped for driver interviews. The following summarizes the data collection efforts conducted for the study, procedures and finding from the data analysis, and general conclusions.

Data Collection Efforts

KLOA, Inc. organized a license plate survey of vehicles entering and exiting the Village on 47th Street at East Avenue and Gilbert Avenue. Surveys were also conducted at the major north-south gateways to the Village on La Grange Road at Ogden Avenue and Plainfield Road, respectively, as well as at major destination points within the Village, including Adventist La Grange Memorial Hospital, Lyons Township High School (north and south campuses), La Grange Road Metra station and Stone Avenue Metra station. The survey locations are shown in Figure 1.

The surveys were performed on Wednesday, September 29, 2010 from 6:30-8:30 A.M. and from 3:00-5:00 P.M. The time periods were selected to coincide with the peak street traffic and Metra commuting times, as well as the start/dismissal times at Lyons Township High School and the first work shift change at the Hospital. At each survey location on 47th Street and La Grange Road, personnel were stationed at the side of the roadway to record the license plates of vehicles passing the survey point.

While it was not possible to collect license data on every vehicle passing the survey point due to the volume and speed of the traffic, a generous sample size was collected for analysis, ranging from 28-40 percent of the peak period traffic on 47th Street and La Grange Road. At each of the major destination locations, personnel circulated through the parking lots to record the license plates of the parked cars. Because these vehicles were parked, all vehicle plates were obtained for the matching exercise.

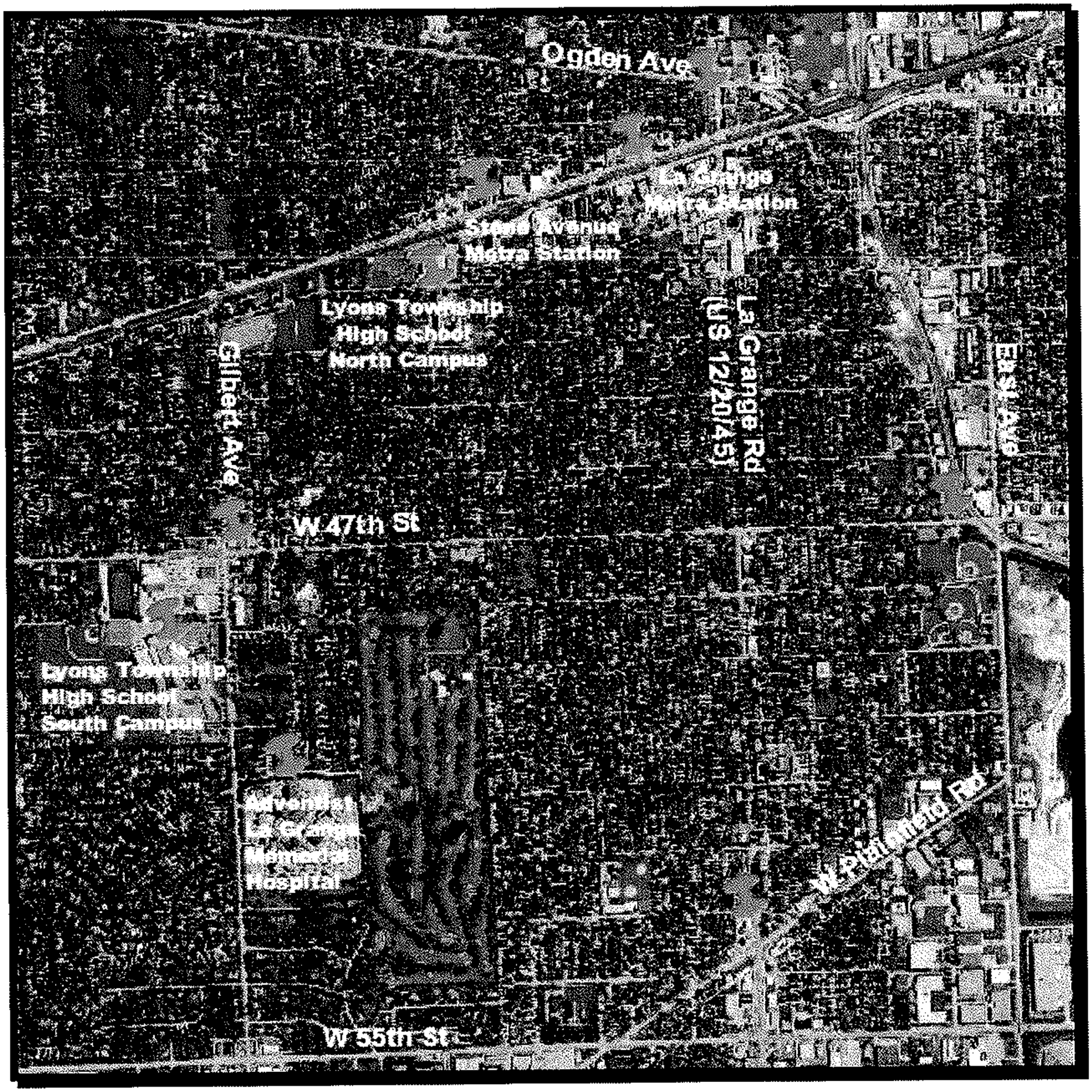


Figure 1
License Plate Data Collection Locations

Data Analysis

For the purpose of this study, the origin is the place that the vehicle was first observed and the destination is where it was last observed. The license plate data collected were input into a matching program that cross-matched similar license plates between origins and destinations. The matched data was beneficial in estimating the percentage of vehicles that entered the Village in the morning on 47th Street from either the east end of the Village (at East Avenue) or the west end of the Village (at Gilbert Avenue) and proceeded to (1) exit the Village from either the opposite end of 47th Street or from La Grange Road (at Ogden Avenue or Plainfield Road), or (2) remain in the Village and park at the major destination points noted above. Similarly, the program was used to estimate the percentage of vehicles that exited the Village in the evening on 47th Street at either the east end of the Village (at East Avenue) or the west end of the Village (at Gilbert Avenue) that originated from (1) outside of the Village from either the opposite end of 47th Street or from La Grange Road (at Ogden Avenue or Plainfield Road), or (2) the major destination points noted above.

Often with license plate surveys only a portion of the vehicles can be traced through the study. License plate sampling rates vary by survey location based on the vantage point of the observers, weather conditions and lighting levels, volume and speed of traffic, and quickness of data recording. License plate observations must also be matched at a minimum of two locations. If, for example, 50 percent of the license plates were recorded at one location and 50 percent were recorded at another location, it could generally be expected that only 25 percent of all license plates were observed at both locations. Consequently, a considerable amount of license plate data collected was not matched in this study. Since the origins and destinations of these vehicles are unknown, these vehicles are categorized in this study as "other local or non-local trips".

While the overall accuracy of the analysis is affected by the fact that the quantity of unmatched data exceeds the quantity of matched data, there remains a sufficient sample of matched data to provide meaningful conclusions on the origins and destinations of the users of 47th Street.

Table 1 and Figure 2 show the destination of the vehicles that entered the Village on 47th Street at Gilbert Avenue (i.e., eastbound traffic) during the morning peak period. Of this traffic, approximately 11 percent was determined to be through traffic while 12 percent was oriented to the major destination points and 77 percent was oriented to other local or non-local destinations.

Table 1 and Figure 3 show the destination of the vehicles that entered the Village on 47th Street at East Avenue (i.e., westbound traffic) during the morning peak period. Approximately 8 percent of this traffic was determined to be through traffic while 11 percent was oriented to the major destination points and 81 percent was oriented to other local or non-local destinations.

Table 2 and Figure 4 show the origin of the vehicles that exited the Village on 47th Street at Gilbert Avenue (i.e., westbound traffic) during the evening peak period. Approximately 8 percent of this traffic was determined to be through traffic while 15 percent originated from the major destination points and 77 percent originated from other local or non-local destinations.

Table 2 and Figure 5 show the origin of the vehicles that exited the Village on 47th Street at East Avenue (i.e., eastbound traffic) during the evening peak period. Of this traffic, approximately 18 percent was determined to be through traffic while 19 percent originated from the major destination points and 63 percent originated from other local or non-local destinations.

Table 1
Distribution of Morning Trip Destinations

	Traffic Entering the Village on 47th St	
Destination	Eastbound at Gilbert Ave	Westbound at East Ave
Adventist La Grange Memorial Hospital	4%	4%
La Grange Rd & Stone Ave Metra Stations	3%	3%
Lyons Township High School – North	2%	2%
Lyons Township High School – South	3%	2%
Other local or non-local destinations	77%	81%
Through traffic	11%	8%
Total	**100%**	**100%**

Table 2
Distribution of Evening Trip Origins

	Traffic Exiting the Village on 47th St	
Origin	Westbound at Gilbert Ave	Eastbound at East Ave
Adventist La Grange Memorial Hospital	5%	7%
La Grange Rd & Stone Ave Metra Stations	4%	6%
Lyons Township High School – North	3%	3%
Lyons Township High School – South	3%	3%
Other local or non-local origins	77%	63%
Through traffic	8%	18%
Total	**100%**	**100%**

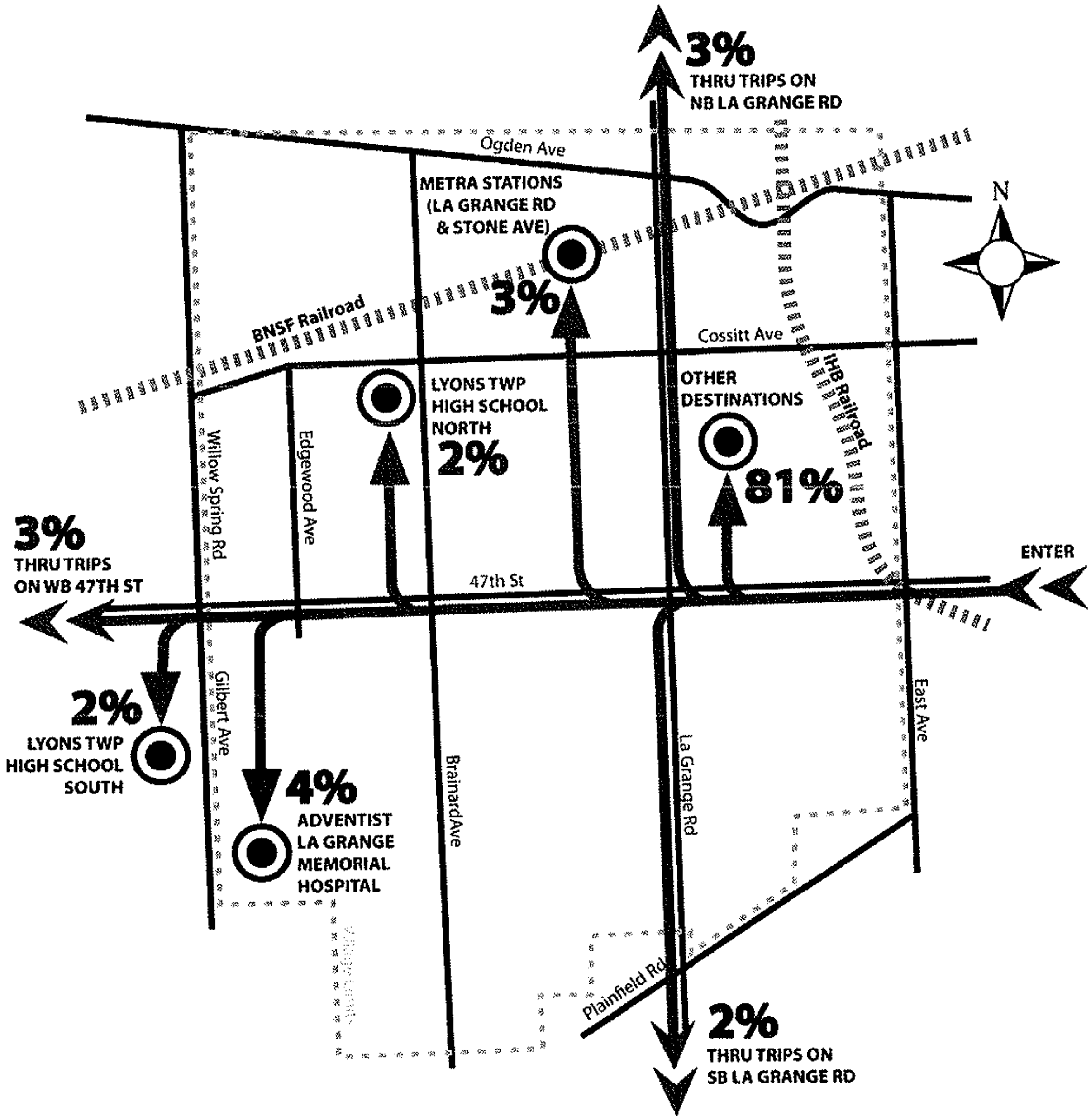


Figure 3
Distribution of Morning Trip Destinations
Westbound Traffic Movements on 47th Street

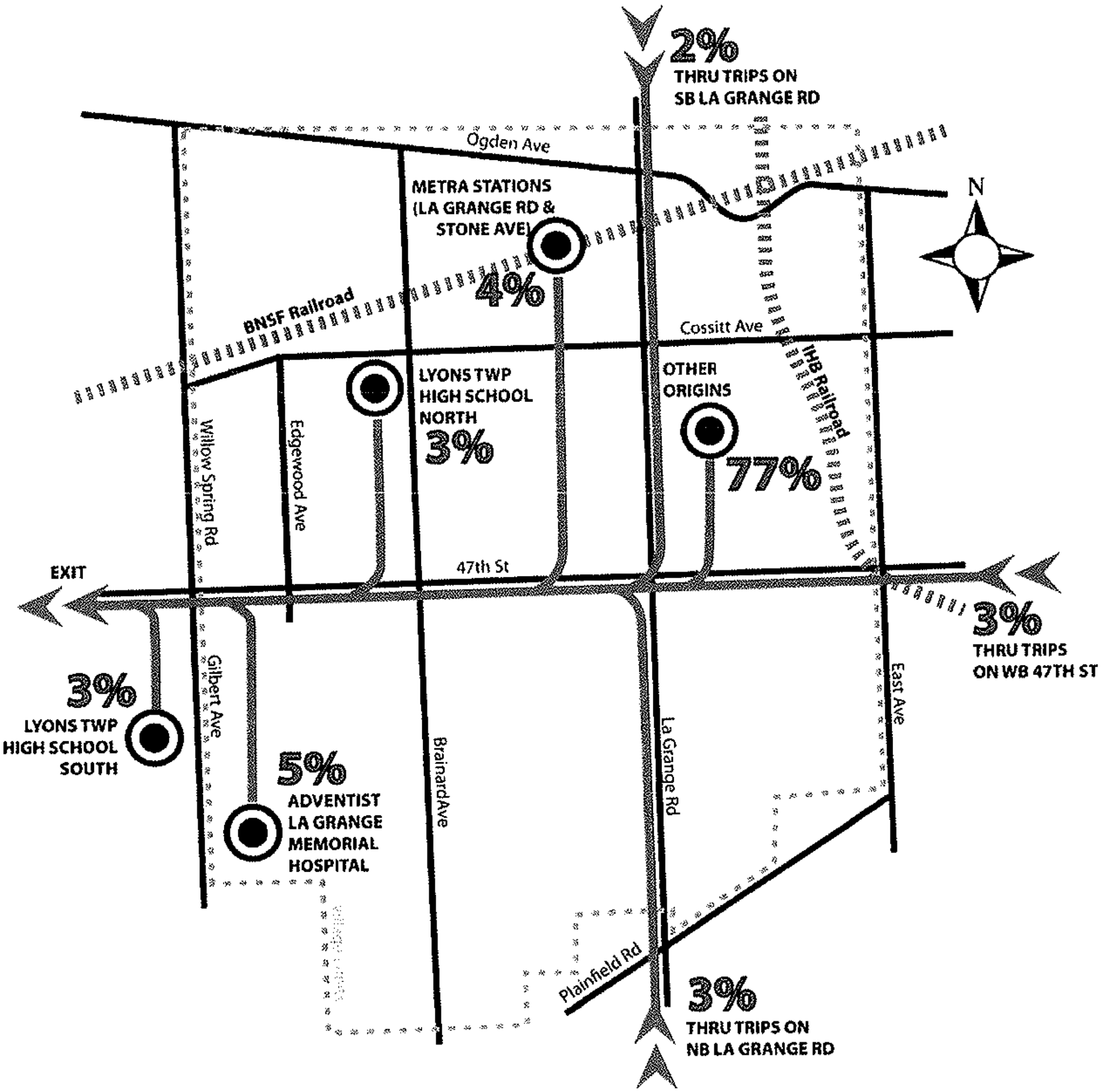


Figure 4
Distribution of Evening Trip Origins
Westbound Traffic Movements on 47th Street

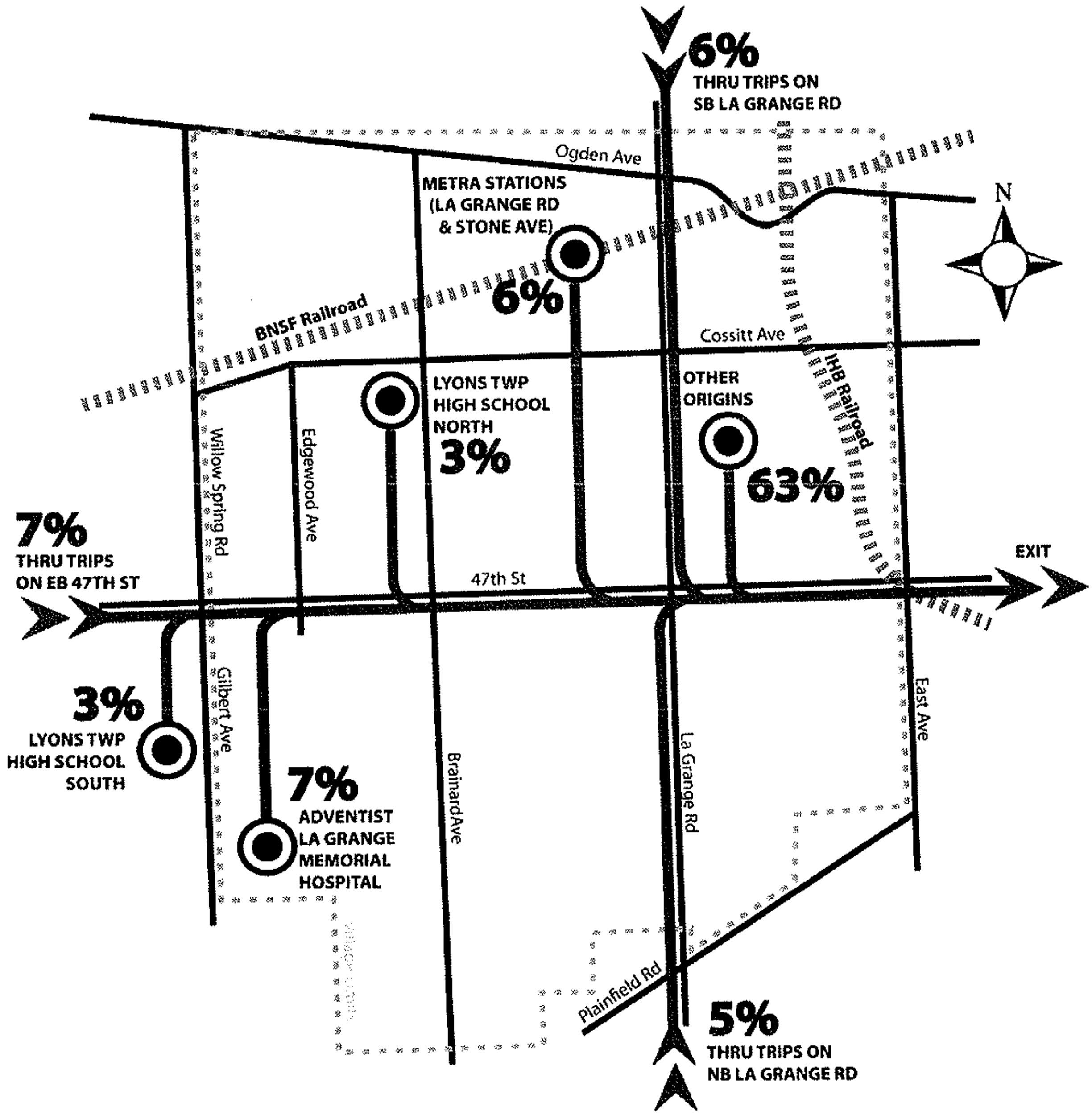


Figure 5
Distribution of Evening Trip Origins
Eastbound Traffic Movements on 47th Street

Conclusions

As noted in the 47th Street Speed Study prepared by KLOA, Inc. on January 6, 2010, 47th Street presently carries approximately 13,700-16,000 vehicles per day between East Avenue and Gilbert Avenue.

Based on the findings from this origin-destination study, approximately 11 - 19 percent of the traffic using 47th Street during the weekday peak periods was proven to be traffic originating from outside of the Village and destined to locations inside the Village or traffic originating from major locations inside the Village and destined to locations outside of the Village. Applying this same proportional relationship to the daily (24 hour) traffic count on 47th Street would indicate that at least 1,500-3,040 of the daily vehicles on 47th Street have their origins or destinations within the Village.

The findings from this origin-destination study also indicate that approximately 8 - 18 percent of the traffic using 47th Street during the weekday peak periods was proven to be through traffic originating from outside of the Village and destined to locations outside of the Village. Applying this same proportional relationship to the daily (24 hour) traffic count on 47th Street would indicate that at least 1,100-2,900 of the daily vehicles on 47th Street could be characterized as through traffic.

The origins and destinations of the remaining 63-81 percent of the traffic using 47th Street is unknown as the license plate data was not matched and could be traffic with local origins and/or destinations or could be through traffic.

Since the proportion of matched data with local origins or destinations is comparable if not slightly higher than the proportion of matched data reflecting through traffic, it is clear that any proposed changes to the design of 47th Street will likely have more of an affect on those that reside within the Village, are employed within the Village, utilize the Village's train stations, or have other business within the Village than those the are simply cutting through the Village en route to other destinations.

APPENDIX "B-3"

Feasibility Study to Signalize the Intersection of 47th Street and East Avenue

47^{th} Street and East Avenue
Traffic Signal Evaluation
La Grange, Illinois

Submitted by

Kenig, Lindgren, O'Hara, Aboona, Inc.

December 29, 2010

Executive Summary

The intersection of 47th Street with East Avenue is currently under all-way stop control. The Indiana Harbor Belt (IHB) railroad tracks cross the south leg of East Avenue and the west leg of 47th Street within close proximity to the intersection. 47th Street is a minor arterial that carries approximately 18,100 daily trips and East Avenue is a major collector that serves an industrial corridor and carries approximately 10,100 daily trips. During peak times as well as off peak, traffic constantly backs up for long distances and these queues get longer when a train crosses the roads and all traffic is stopped. Based on the existing traffic volumes and the requirements found in the Manual on Uniform Traffic Control Devices (MUTCD), a traffic signal is warranted at this intersection. Since the intersection falls within multiple jurisdictions and due to its proximity to the railroad crossings, the installation of such signal will require close coordination with but not limited to the Illinois Commerce Commission (ICC), Illinois Department of Transportation, Cook County Highway Department, Village of Brookfield and Village of La Grange to ensure a safe and proper interconnect is provided. This location is similar to many others in District One where a traffic signal is in close proximity to railroad crossings. Some of these existing locations in fact carry more traffic and have more travel lanes..

Based on our observations and analyses, the intersection should be signalized providing pre signals on the west and south legs of the intersection by guiding northbound and eastbound vehicles to stop before the railroad tracks. In addition to the installation of a traffic signal, the frontage road located south of the railroad tracks should be converted to one-way traffic from 47th Street to East Avenue. Furthermore, in order to enhance traffic flow along 47th Street, the eastbound to northbound left-turn lane will be extended west for approximately 75 feet. This will help accommodate the left-turning vehicles that under the proposed plan will stop before the railroad tracks.

Based on the results of the traffic simulation and taking into account the proposed geometric improvements, the intersection will operate much more efficiently and traffic queues will be normalized after a train has crossed the roads within three full cycle lengths.

Introduction

This report summarizes the results and findings of a traffic signal justification evaluation conducted by Kenig, Lindgren, O'Hara, Aboona, Inc. (KLOA, Inc.) for the intersection of 47th Street and East Avenue in La Grange, Illinois. The intersection is currently under all-way stop control and suffers from excessive delays and long queues particularly when a train crosses the south and west legs of the intersection.

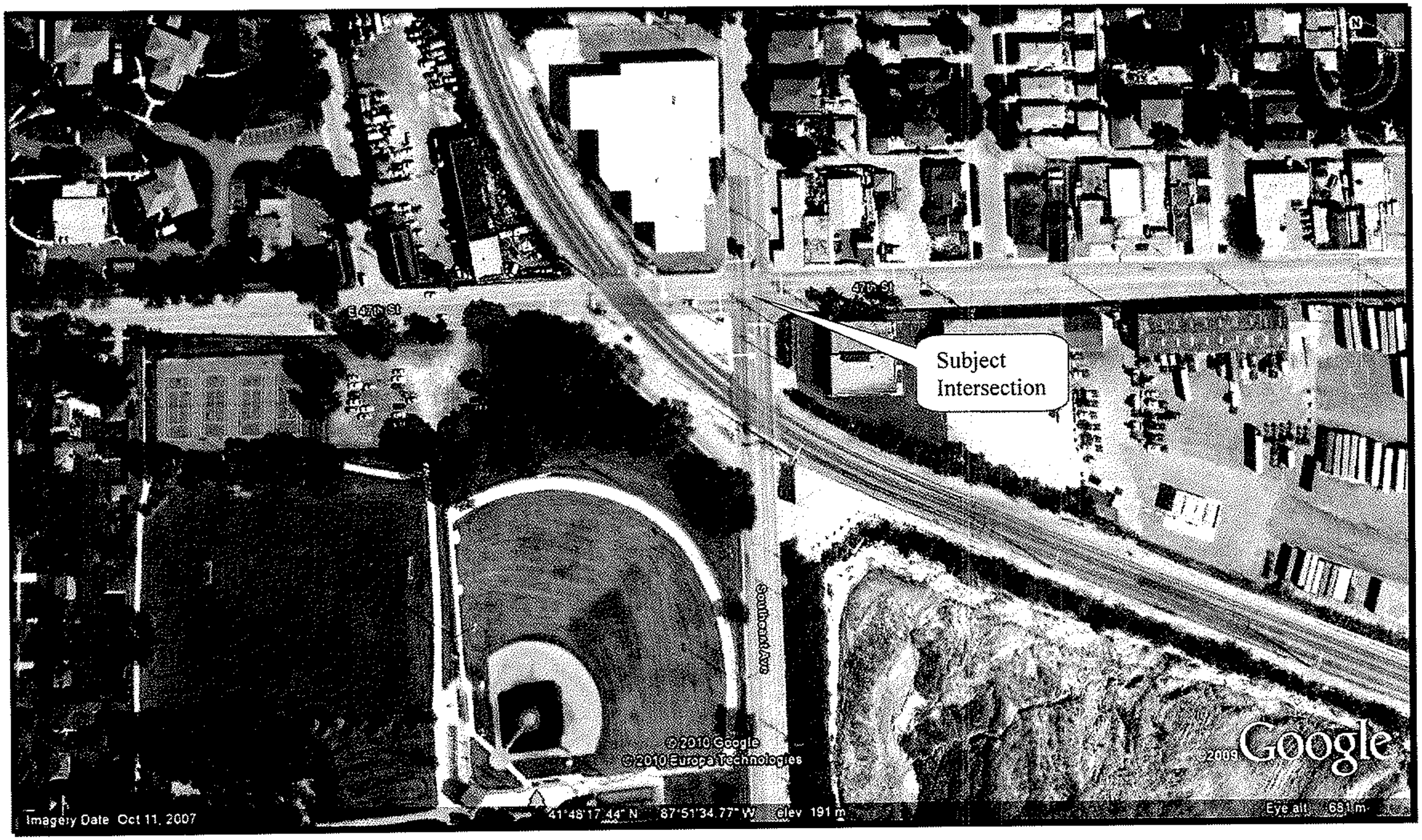
Existing Conditions

Existing transportation conditions in the vicinity of the site were documented based on a field visit conducted by KLOA, Inc. As shown on **Figure 1**, land uses to the north are a mixture of industrial and residential. The southwest quadrant of the intersection is occupied by the Sedgwick Park while the southeast quadrant of the intersection is occupied by a stone quarry.

Below is a description of the two intersecting roadways.

47th Street is an east-west arterial that provides two lanes in each direction and carries an average daily traffic (ADT) volume of 18,100 east of East Avenue and 12,100 west of East Avenue. At its unsignalized all-way stop control intersection with East Avenue, 47th street is widened to provide an exclusive left-turn lane, a through lane and an a combined through/right-turn lane on both approaches. It should be noted that, due to the presence of the IHB railroad tracks, vehicles traveling eastbound on 47th Street that desire to travel south on East Avenue can turn right before the intersection via a slip road located approximately 230 feet west of the intersection. This slip road also allows northbound to westbound left-turning vehicles on East Avenue to turn left before reaching the railroad tracks. 47th Street has a posted speed limit of ~~35~~ 30 mph and is under the jurisdiction of the Illinois Department of Transportation (IDOT) west of East Avenue and Village of Brookfield east of East Avenue.

East Avenue is a north-south minor arterial that in the vicinity of the site provides two lanes in each direction with a posted speed limit of 40 mph. Exclusive left-turn lanes are provided on both approaches of East Avenue at its unsignalized all-way stop controlled intersection with 47th Street. East Avenue carries an approximate ADT of 10,100 vehicles. As previously mentioned, there is a slip road that allows northbound to westbound left-turning vehicles on East Avenue to turn left before reaching the railroad tracks. East Avenue is under the jurisdiction of IDOT south of 47th Street and Cook County Highway Department (CCHD) north of 47th Street



Aerial View of Intersection

Figure 1

Existing Traffic Volumes

In order to determine current traffic conditions on the existing roadways, KLOA, Inc. conducted an eight-hour manual traffic count at the intersection of 47th Street with East Avenue. The traffic counts were conducted on Tuesday, September 29, 2009 from 6:00 to 10:00 A.M. and from 3:00 to 7:00 P.M. The traffic counts also distinguished between heavy vehicles and passenger vehicles. The results of the traffic counts showed that the weekday morning peak hour of traffic occurred from 7:00 to 8:00 A.M. and the weekday evening peak hour occured from 4:15 to 5:15 P.M. **Figure 2** illustrates the existing peak hour traffic volumes (inclusive of heavy vehicle traffic). **Figure 2A** illustrates the heavy vehicle traffic volumes during the peak hours.

47th Street and East Avenue Intersection Characteristics

The intersection of 47th Street and East Avenue carry a substantial volume of traffic on all approaches and the all-way stop control is not adequate to accommodate safely and efficiently the existing traffic volumes as long queues and delays are experienced on all approaches during most of the day. In addition, the IHB railroad tracks cross the west approach of 47th Street and the south approach of East Avenue and when a train crosses the tracks, traffic congestion is exacerbated and the queues and delays are magnified. Furthermore, the traffic queues that were increased when a train crosses the roads are not normalized for a long period of time thus creating longer delays and increasing driver frustration. The following is a summary of our observations based on our field visit.

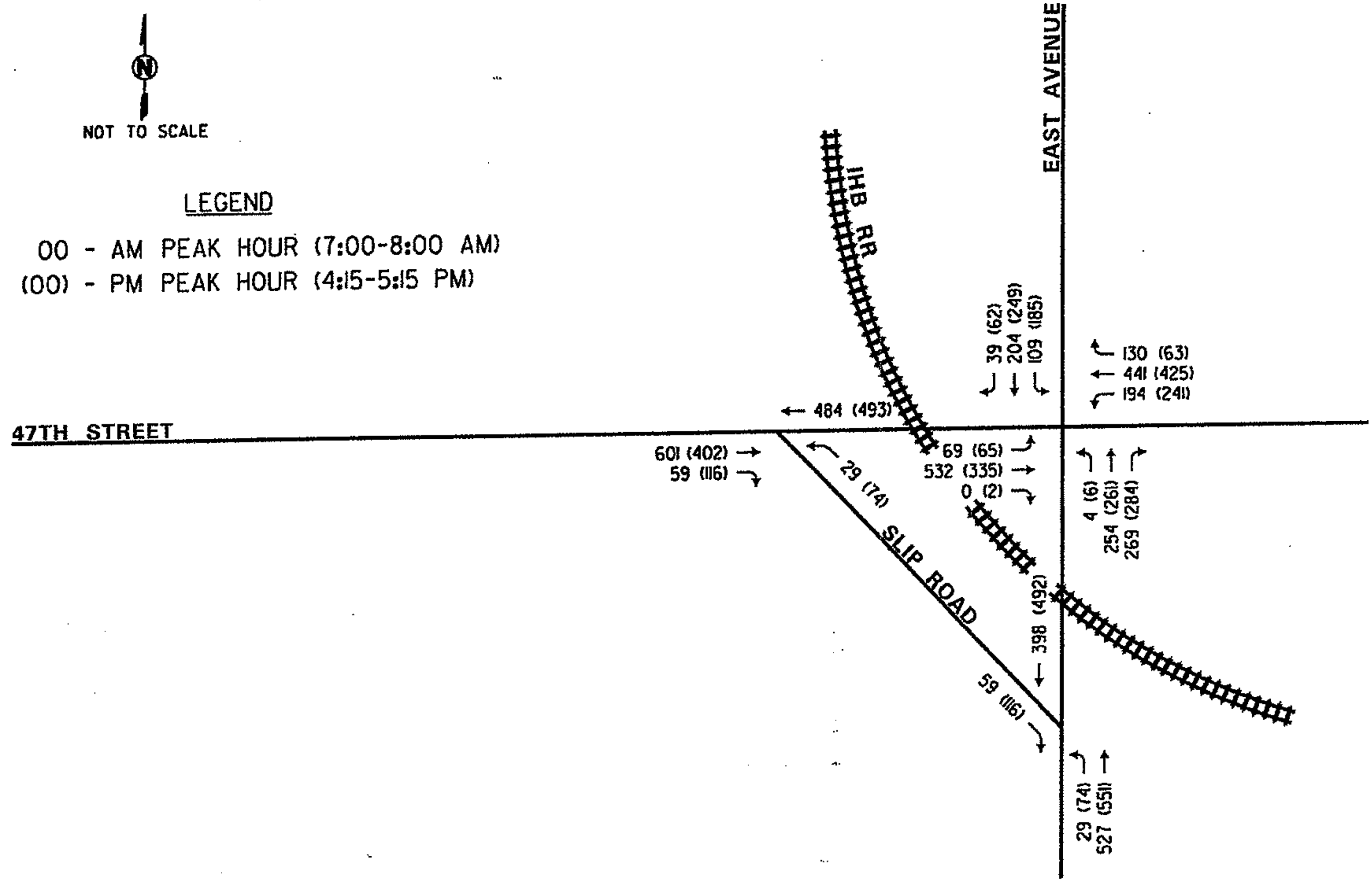
- The IHB three railroad tracks cross 47th Street approximately 115 feet west of East Avenue and East Avenue approximately 105 feet south of 47th Street.

- Traffic backups for eastbound traffic during the A.M. and P.M. peak periods were regularly between six to ten vehicles. However, when a train was crossing the tracks, these queues were almost doubled (15 to 20 vehicles) and were not normalized for approximately 20 minutes after the gates went up.

- Traffic backups for westbound traffic during the A.M. peak period were similar to the eastbound backups. However, in the afternoon the backups were 10 to 15 vehicles. When a train was crossing the tracks, these backups would double (20 to 30 vehicles) and were not normalized for approximately 20 minutes after the gates went up.

- Northbound traffic backups on East Avenue were regularly 20 vehicles during the afternoon. When a train would cross the tracks, these backups would extend significantly extending for almost 800 feet (30 to 35 vehicles).

- Southbound traffic backups were generally shorter with an average backup of five to eight vehicles.



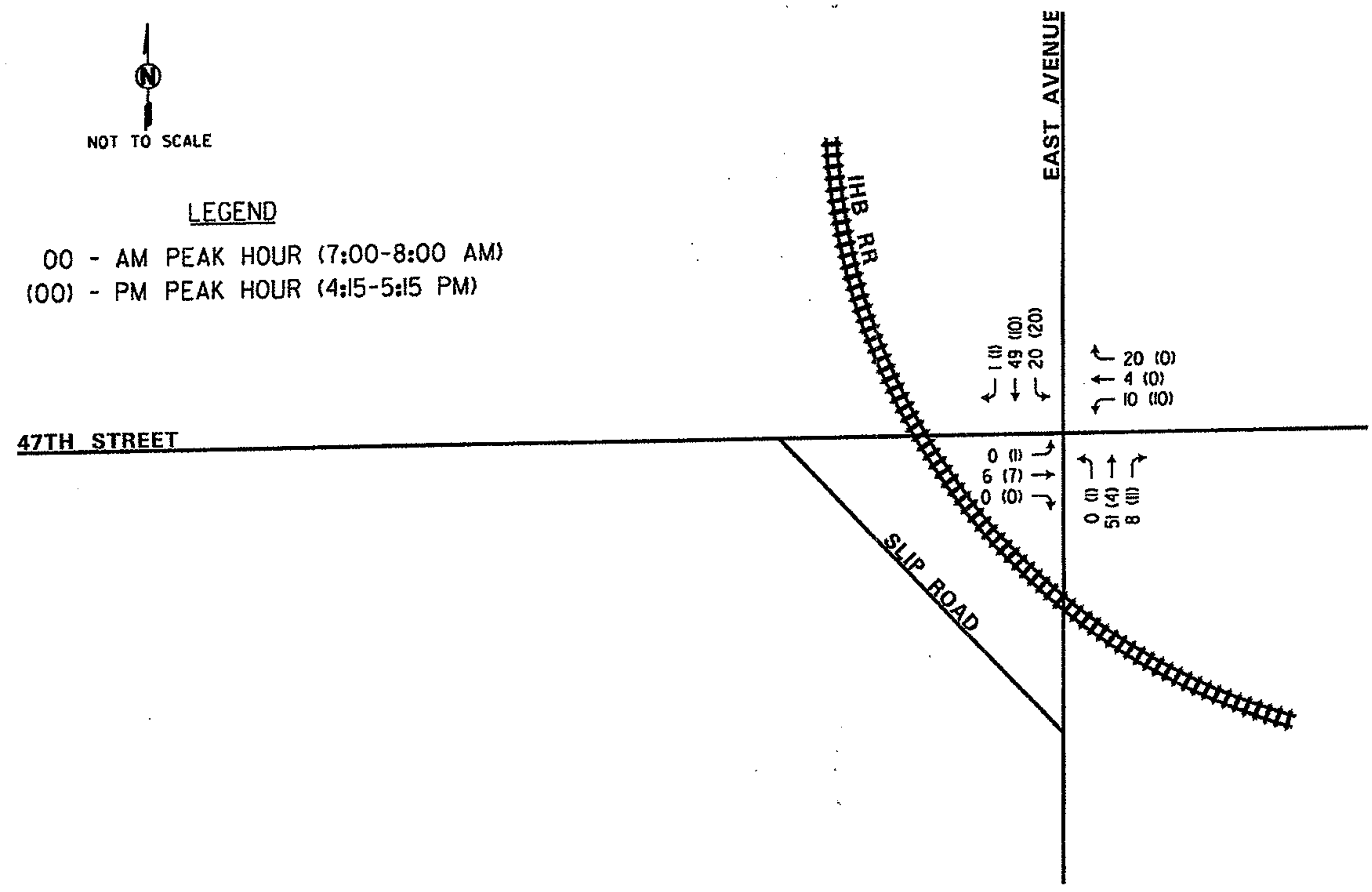
PROJECT:
47TH ST & EAST AVE
TRAFFIC SIGNAL
JUSTIFICATION
LAGRANGE, ILLINOIS

TITLE:
EXISTING PEAK HOUR TRAFFIC VOLUMES
(INCLUSIVE OF HEAVY VEHICLES)

PROJECT NO: 09-113

KLOA

FIGURE NO: 2



PROJECT: 47TH ST & EAST AVE TRAFFIC SIGNAL JUSTIFICATION LAGRANGE, ILLINOIS	TITLE: EXISTING PEAK HOUR HEAVY VEHICLE VOLUMES	PROJECT NO: 09-113 KLOA FIGURE NO: 2A

Based on our observations, three trains cross the roads during the morning period and five trains during the evening period. The average down time for the gates was about four minutes and twenty seconds during the morning period and five minutes during the evening period. Per the ICC data base (2006), there are 50 trains per day with a maximum train speed of 25 mph.

It should be noted that there are other intersections in the Chicago metropolitan area similar to 47th Street and East Avenue in which a railroad track crosses two approaches. One is the intersection of Irving Park Road (IL 19) and Wood Dale Road in Wood Dale, Illinois. Similar to the intersection of 47th Street with East Avenue, there is a slip road that allows vehicles to make a right-turn maneuver without crossing the railroad tracks. IL 19 and Wood Dale Road carry an average daily traffic (ADT) of 29,700 and 12,500, respectively. Both, IL 19 and Wood Dale Road, provide a five-lane cross-section. The railroad tracks cross Wood Dale Road approximately 65 feet north of its stop bar and Irving Park Road approximately 280 feet east of its stop bar. Given the short distance between the Wood Dale Road stop bar and the railroad tracks, there is a pre signal for southbound vehicles to direct them to stop before the tracks.

Another similar location is the intersection of North Avenue (IL 64) with Addison Road in Villa Park, Illinois. North Avenue carries an ADT of approximately 45,500 vehicles and Addison Road an ADT of approximately 13,000 vehicles. North Avenue at its intersection with Addison Road provides dual left-turn lanes, three through lanes and an exclusive right-turn lane on the east approach. The west approach provides dual left-turn lanes, two through lanes and a combined through/right-turn lane. Addison Road at its intersection with North Avenue provides dual left-turn lanes, a through lane and a combined through/right-turn lane on the south approach. The north approach provides dual left-turn lanes, two through lanes and an exclusive right-turn lane. The railroad tracks cross North Avenue approximately 205 feet west of its stop bar and Addison Road approximately 65 feet south of its stop bar. Similar to the intersection of 47th Street with East Avenue, there is a slip road that allows eastbound to southbound right-turning vehicles to make this maneuver without crossing the railroad tracks. Given the short distance between the Addison Road stop bar and the railroad tracks, there is a pre signal for northbound vehicles to direct them to stop before the tracks. North Avenue at its intersection with Addison Road provides dual left-turn lanes, three through lanes and an exclusive right-turn lane on the east approach. The west approach provides dual left-turn lanes, two through lanes and a combined through/right-turn lane. The south approach of Addison Road at its intersection with North Avenue provides dual left-turn lanes, a through lane and a combined through/right-turn lane. The north approach provides dual left-turn lanes, two through lanes and an exclusive right-turn lane.

The third similar location is the intersection of Palatine Road with Plum Grove Road in Palatine, Illinois. Palatine Road carries an ADT of approximately 14,700 vehicles and Plum Grove Road carries an ADT of approximately 6,000 vehicles on the north leg and 11,000 vehicles on the south leg. Both, Palatine Road and Plum Grove Road, provide a three lane cross-section.

All of these intersections carry more traffic and have either the same or more travel lanes than 47th Street and East Avenue and are operating efficiently under traffic signal control. An aerial photograph of these two intersections is included in the Appendix.

Accident Data

KLOA, Inc. also obtained accident data from IDOT for the intersection of 47th Street with East Avenue. A review of the accident data indicates that the intersection experiences an average of 18 accidents per year. The majority of these accidents are angle collisions which are primarily due to motorist confusion given multiple lanes and traffic congestion. As such, the provision of a traffic signal will help mitigate this condition and enhance the efficiency and safety at the intersection of 47th Street with East Avenue.

Signal Warrant Analysis

The intersection of 47th Street with East Avenue was examined to determine if a traffic signal is warranted under existing conditions. Installation of a traffic signal requires that one or more of the nine signal warrants outlined in the *Manual on Uniform Traffic Control Devices* (MUTCD 2009) is met. Of these nine warrants that can be applied in establishing the justification for a traffic signal, four were considered. These were the following:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 9, Intersection Near a Grade Crossing

Warrant 1, Eight-Hour Vehicular Volume states that the minimum vehicular volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. Given that both 47th Street and East Avenue provide two or more lanes, the required vehicles per hour on the major street is 600 (total of both approaches) and the required vehicles per hour on the minor street (one direction only) is 200. **Table 1** shows the hourly volumes at the intersection of 47th Street and East Avenue and whether the requirements for this warrant are satisfied or not.

Table 1

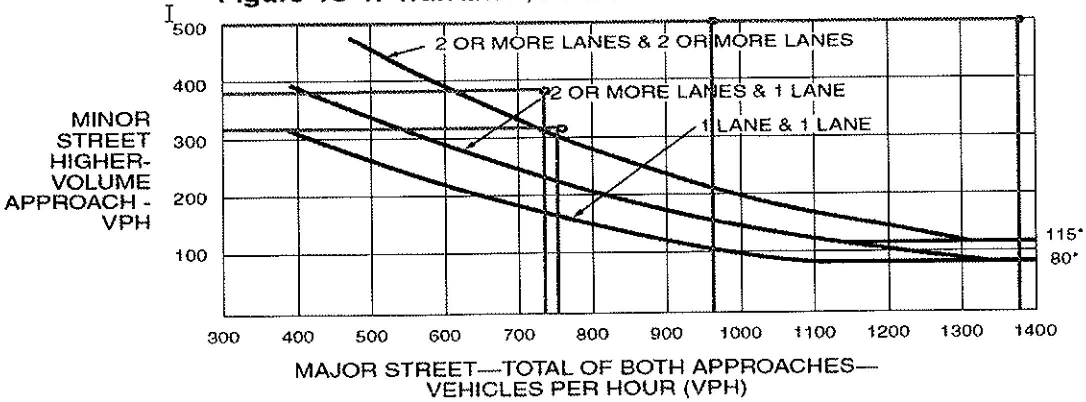
WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME (CONDITION A)

Time	47th Street Volume (Both Approaches)	East Avenue Volume (South Approach)	Warrant 1 Requirements Satisfied
6:00 A.M.	746	327	Yes
7:00 A.M.	1366	527	Yes
8:00 A.M.	940	509	Yes
9:00 A.M.	711	378	Yes
3:00 P.M.	915	465	Yes
4:00 P.M.	1064	555	Yes
5:00 P.M.	1162	554	Yes
6:00 P.M.	847	454	Yes

As can be seen from Table 1, the eight hour volume warrant is met for the eight hours traffic counts were conducted. As such, a traffic signal should be considered.

Warrant 2, Four-Hour is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. The need for a traffic control signal shall be considered when for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only) all fall above the applicable curve on Figure 4C-1 for the existing combination of approach lanes.

Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume

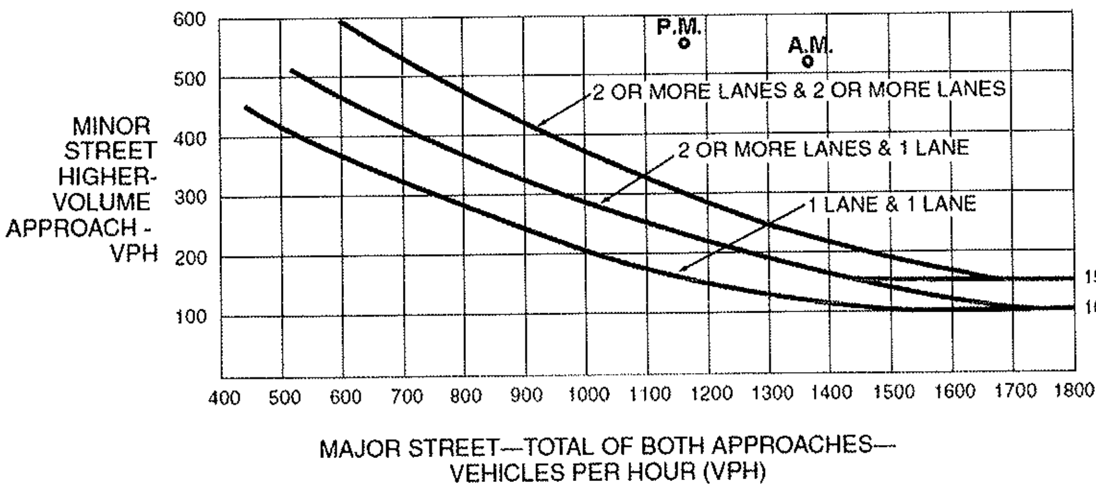


*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

As can be seen, the plotted points representing the vehicles per hour on the major street and the minor street fall above the applicable curve (two or more lanes and two or more lanes) on Figure 4C-1. As such, a traffic signal should be considered.

Warrant 3, Peak Hour is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor street traffic suffers undue delay when entering or crossing the major street. The need for a traffic control signal shall be considered when the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher volume minor street approach (one direction only) for one hour of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

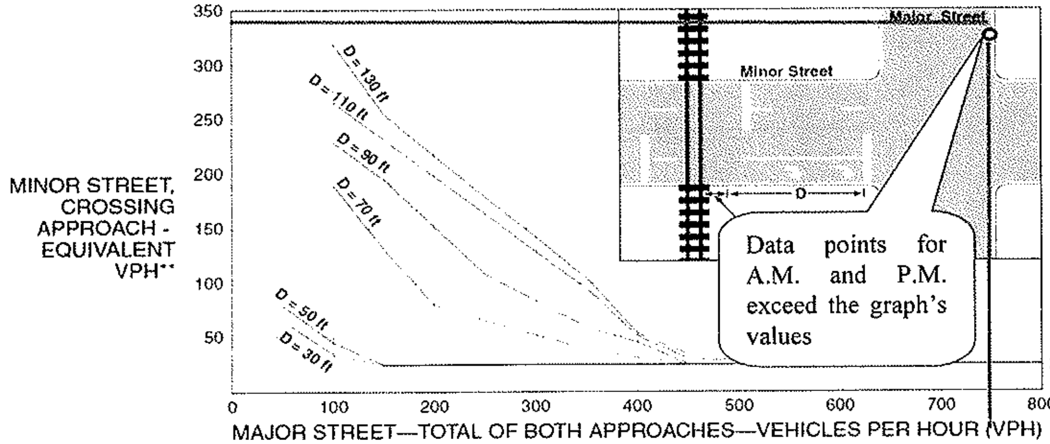
As can be seen, the plotted points representing the vehicles per hour on the major street and the minor street fall above the applicable curve (2 or more lanes & 2 or more lanes) on Figure 4C-3. As such, a traffic signal should be considered.

Warrant 9, Intersection Near a Grade Crossing is intended for use at a location where none of the conditions described in the other eight warrants found in the MUTCD are met, but the proximity to the intersection of a grade crossing on an intersection controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal. The need for a traffic signal shall be considered when both of the following criteria are met:

A. A grade crossing exists on an approach controlled by a STOP or Yield sign and the center of the track nearest the intersection is within 140 feet of the stop line or yield line on the approach; and

B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance.

Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing
(Two or More Approach Lanes at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

Given that the railroad tracks cross 47th Street and East Avenue 115 and 105 feet respectively from their stop line and based on a review of the existing traffic volumes and the requirements presented on Figure 4C-10, a traffic signal should be considered.

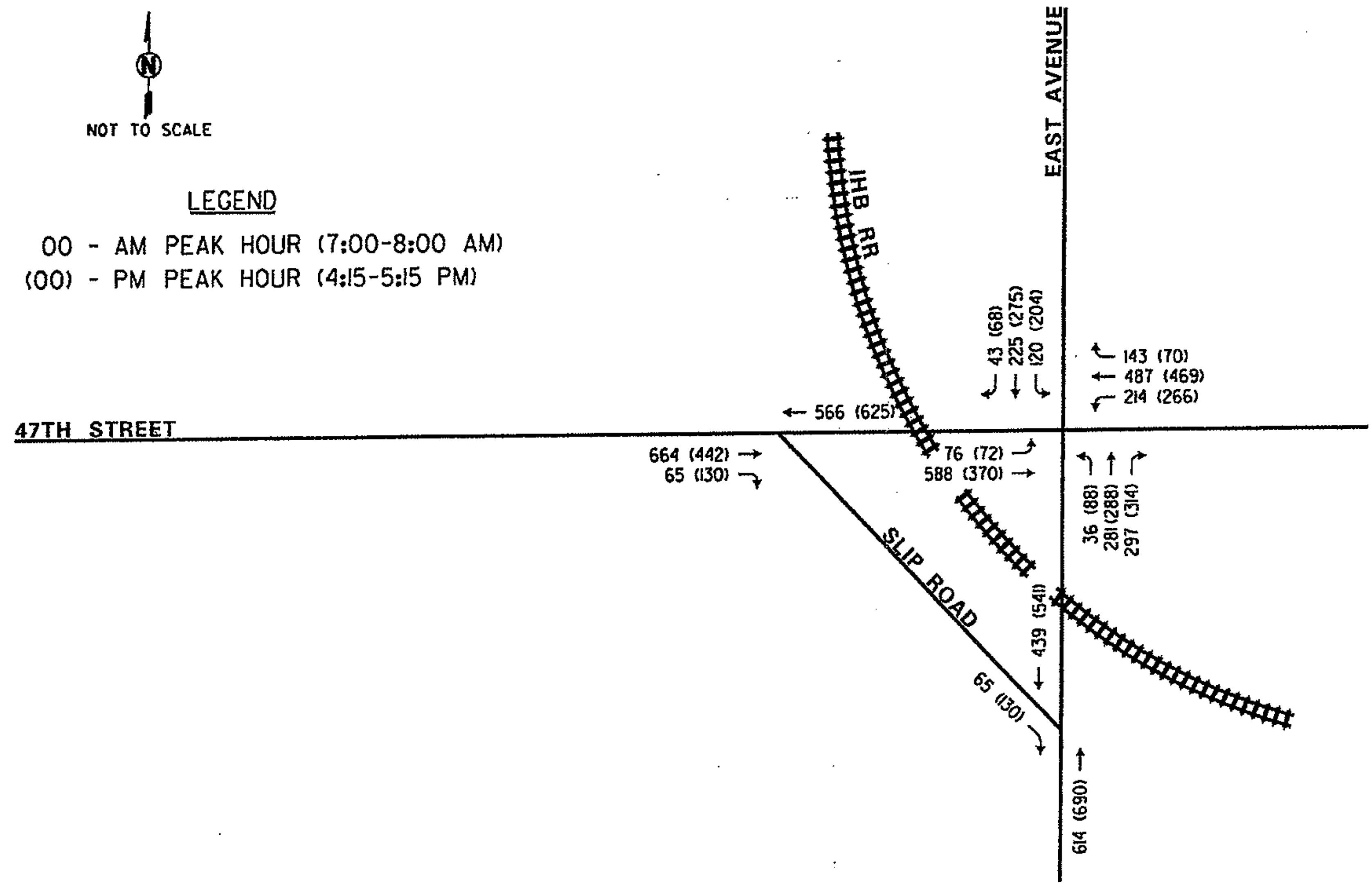
Based on the above, given that the four warrants that are applicable to this intersection are met and given that traffic volumes in the area will most likely continue to increase, a traffic signal should be installed.

Year 2030 Traffic Projections

The existing traffic volumes at the intersection of 47th Street with East Avenue were increased by ½ percent per year to reflect Year 2030 conditions in the area. This conservative growth factor given the fully built and mature area will take into account normal regional growth and any other developments in the surrounding area. Figure 3 shows the projected Year 2030 morning and evening peak hour traffic volumes.

Traffic Simulation Analysis

In order to analyze how well the intersection of 47th Street with East Avenue will operate with the installation of a traffic signal under existing conditions and Year 2030 future conditions, the intersection and the railroad tracks were simulated using the Synchro/SimTraffic 7 software. The traffic volumes, the number of trains and the duration of the trains crossing both roads was entered into the model and analyzed. Based on numerous simulation runs, the traffic queues on all approaches will be normalized within three to four minutes under existing conditions and within four to five minutes under Year 2030 future conditions thus reducing the delays and driver frustration currently experienced.



PROJECT: 47TH ST & EAST AVE TRAFFIC SIGNAL JUSTIFICATION LAGRANGE, ILLINOIS

TITLE: YEAR 2030 PROJECTED TRAFFIC VOLUMES

PROJECT NO: 09-113

KLOA

FIGURE NO: 3

Recommended Improvements

Based on the fact that a traffic signal is warranted at the intersection of 47th Street with East Avenue, some geometric and traffic control modifications will be necessary. Below is a summary of these modifications.

- Installation of a temporary traffic signal.
- Extension of the east to north exclusive left-turn lane to provide an additional 75 feet of storage west of the railroad tracks.
- Conversion of the slip road to only allow southeast bound traffic. This will shift the northbound to westbound left turns to the signal potentially increasing the delays and queue lengths.
- Provisions of pre signals for the eastbound and northbound traffic
- Striping the west leg and the south leg between their stop bars and the tracks to prohibit stacking of eastbound traffic east of the tracks and northbound traffic north of the tracks.
- Operating the left-turn movements from all approaches under a protected phase only. This will minimize the amount of track clearance needed and the potential for left-turn trap.

A preliminary geometric plan showing the proposed improvements is included in the Appendix.

Preliminary Cost Estimate

A preliminary cost estimate has been prepared for the proposed improvements at the intersection of 47th Street and East Avenue. This estimate is preliminary in nature and is intended to provide the Village of La Grange with an order of magnitude and does not include items such as right-of-way acquisition (if necessary), permit fees, engineering fees, etc. It also assumes the need to install temporary signals at this time.

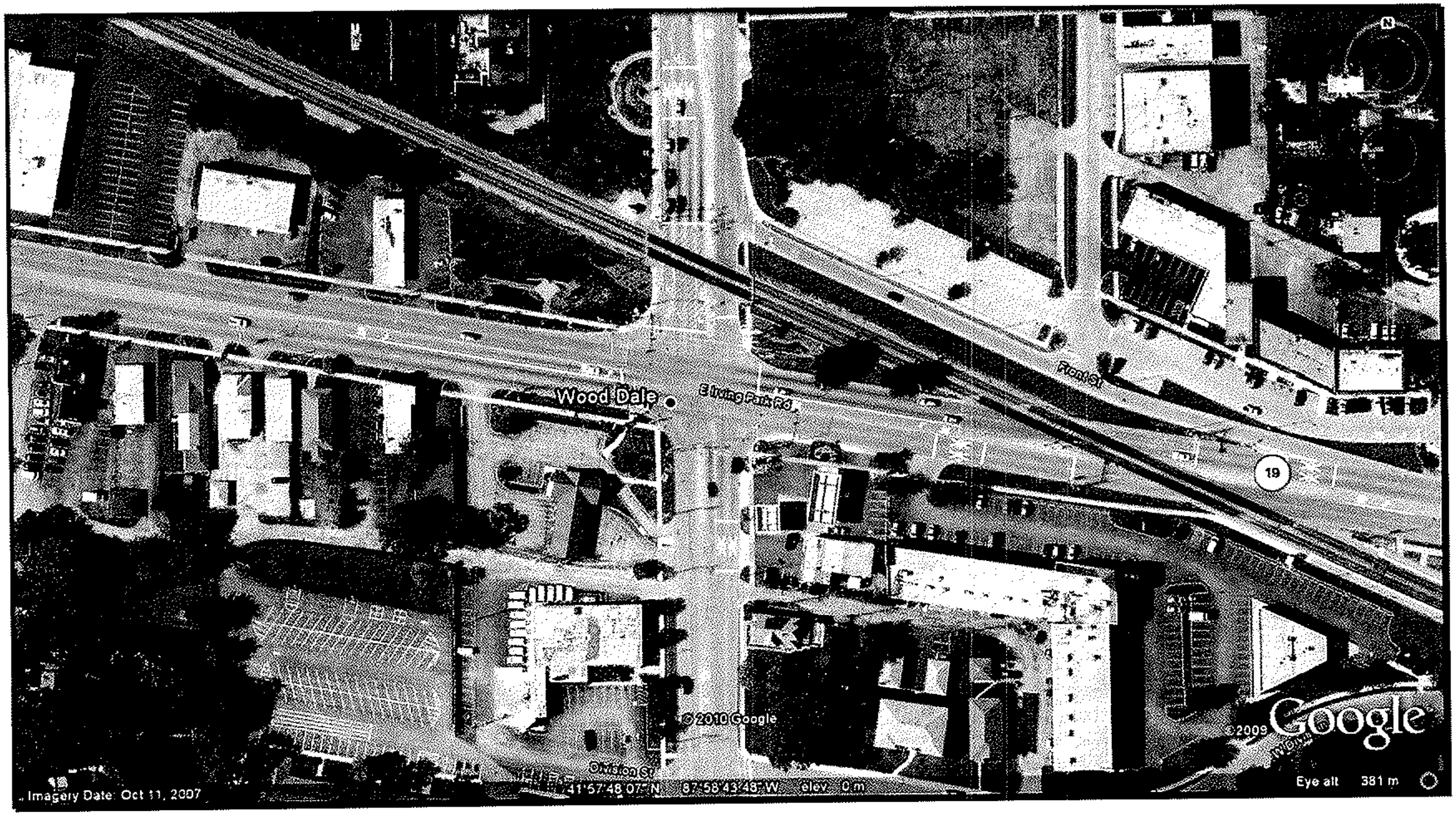
➢ Roadway Improvements:	$100,000 - $125,000
➢ Temporary Traffic Signal:	$100,000 - $150,000
➢ Interconnect to railroad crossing:	$500,000 - $1,000,000
Total	$700,000 - $1,275,000

It should be noted that the cost for the last item is only a ball park estimate and will be determined by the ICC by the amount of track clearance time needed, maximum train speed, and number of tracks that need equipment added to them. IHB will perform the construction in a force account basis (time and materials) and is typically not bid out. The Village of La Grange may be able to apply for "Grade Crossing Protection Funds" through the ICC. However, since 47th Street is under IDOT jurisdiction and the traffic signal would have to be operated and maintained by IDOT, the possibility of securing these funds may be very low.

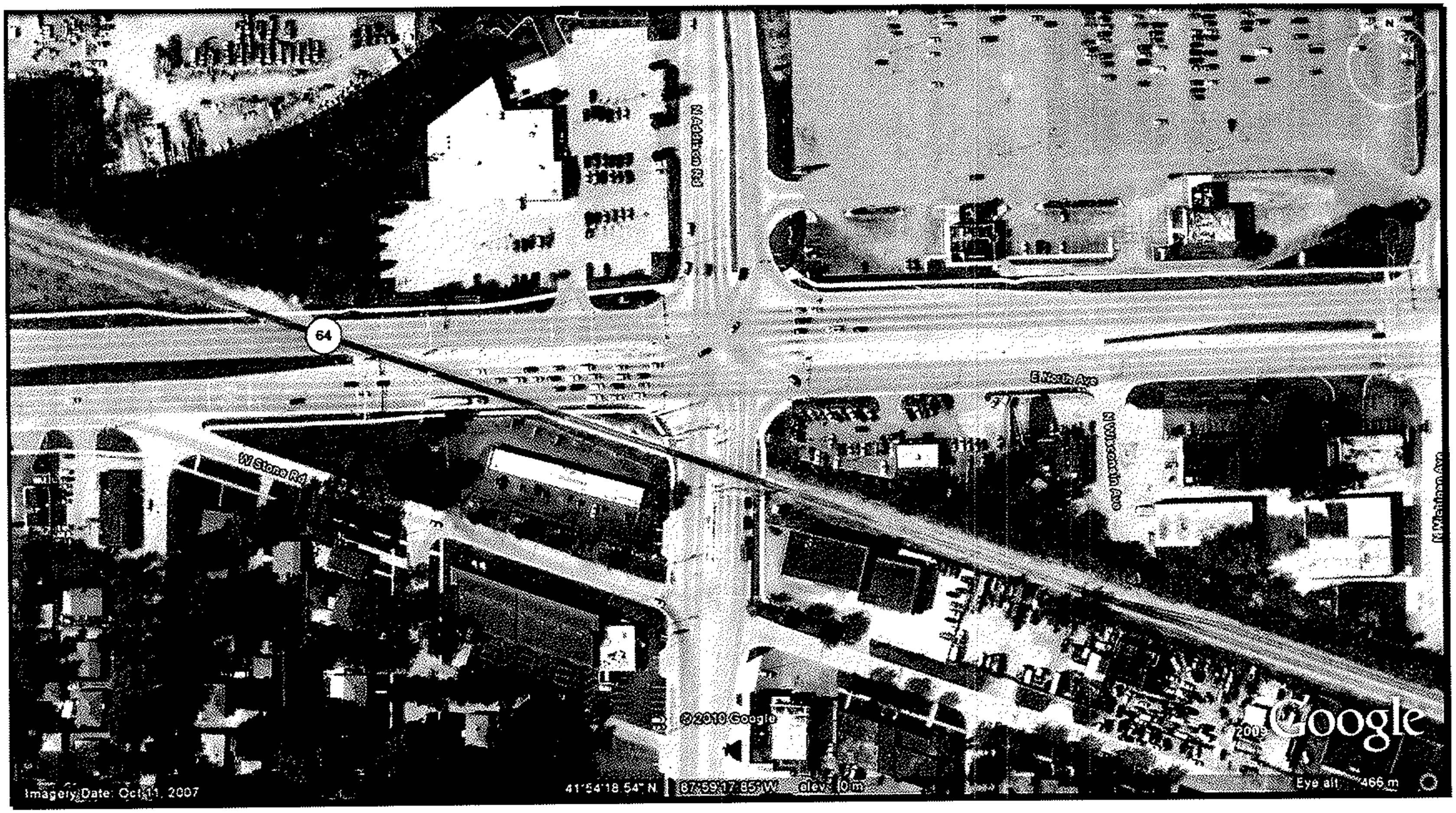
Conclusion

The intersection of 47th Street with East Avenue carries a significant amount of traffic and its existing traffic control (all-way stop) is not adequate to safely and efficiently handle the traffic volumes. The long queues and delays that are experienced at this intersection are exacerbated when a train crosses both roads and all traffic is stopped. Many of the accidents experienced at this intersection are the result of driver frustration and confusion due to the long delays experienced and the number of lanes on both roads. This situation is not unique and has been addressed at other locations throughout the Chicago metropolitan area with the appropriate traffic control, signage and striping (i.e., North Avenue with Addison Road in Villa Park, Illinois). Based on a review of the existing traffic volumes and the requirements set forth in the MUTCD for traffic signals, a traffic signal is warranted and should be installed.

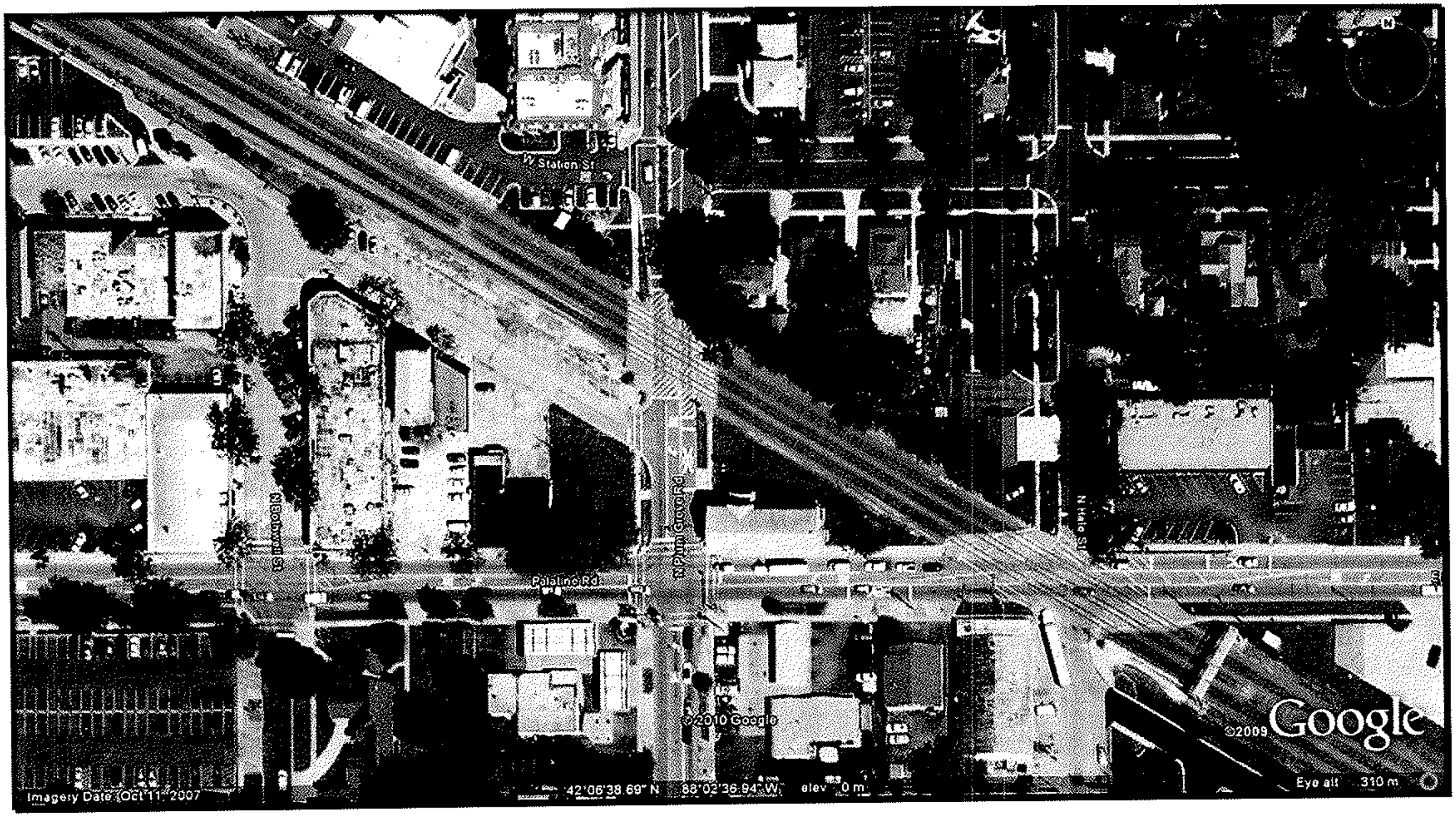
In summary, based on the above and the results of the traffic simulation, the installation of a traffic signal at the intersection of 47th Street with East Avenue will improve traffic conditions in the area by controlling the flow of traffic and normalizing the queues of traffic that occur after a train crosses the tracks in a more efficient manner. Furthermore, safety will be enhanced with the provision of pre signals, protected left-turns and appropriate striping and signage.



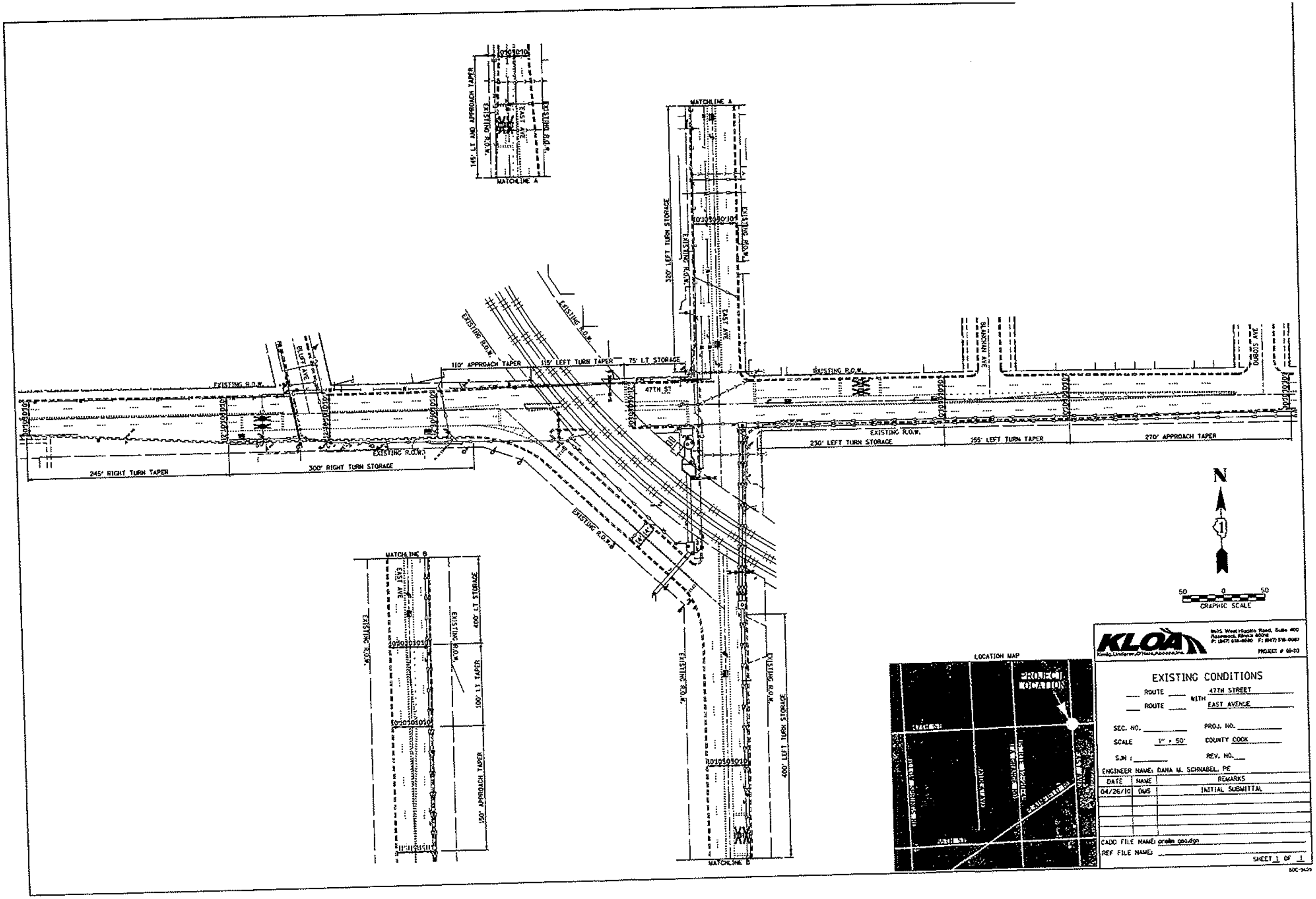
Irving Park Road and Wood Dale Road in Wood Dale, Illinois



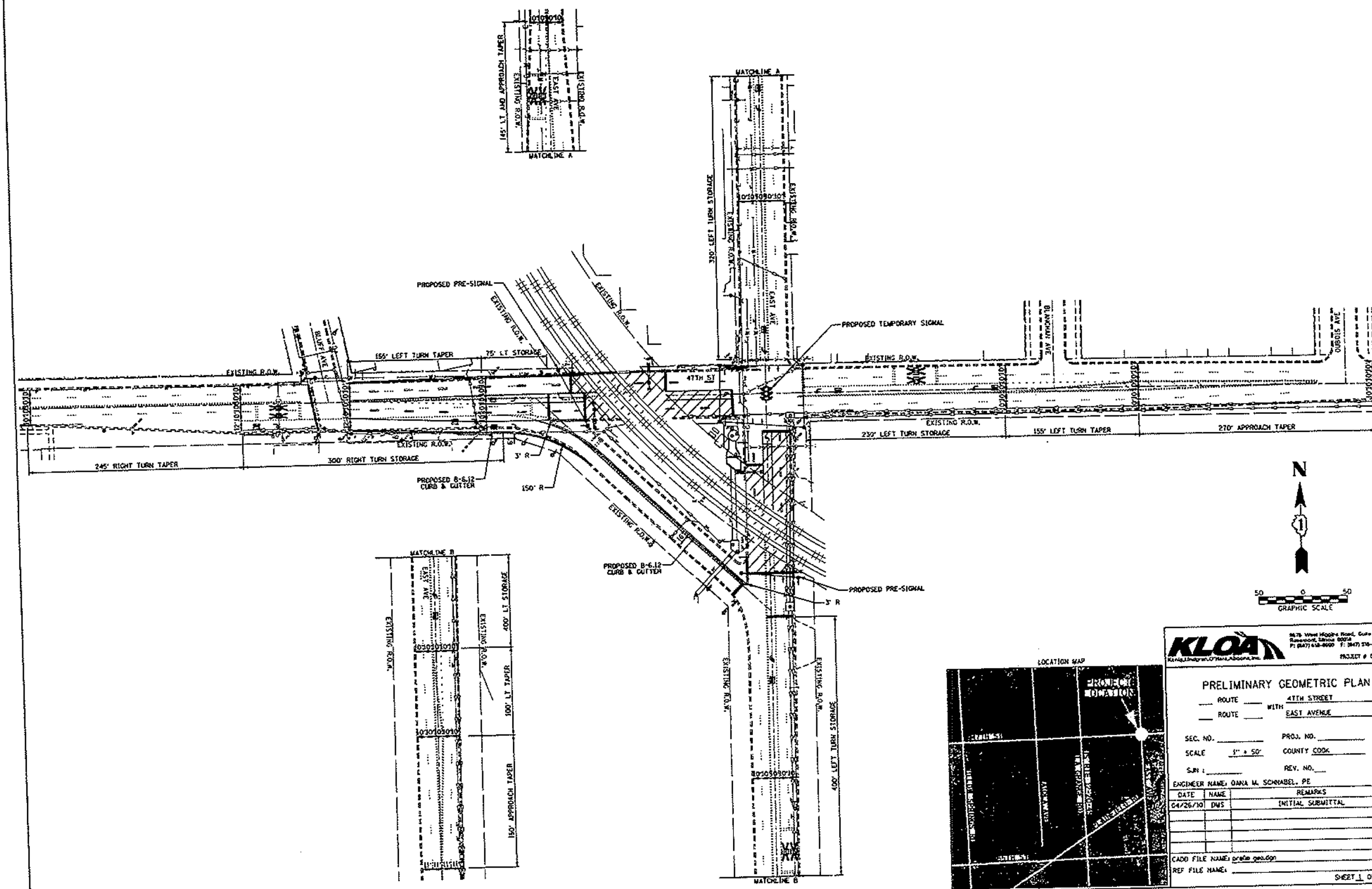
North Avenue and Addison Road in Villa Park, Illinois



Palatine Road and Plum Grove Road in Palatine, Illinois



EXISTING CONDITIONS
ROUTE 47TH STREET
WITH
ROUTE EAST AVENUE
SEC. NO.
PROJ. NO.
SCALE 1" = 50'
COUNTY COOK
SJN :
REV. NO.
ENGINEER NAME: DANA M. SCHNABEL, PE
DATE
NAME
REMARKS
04/26/10
DWS
INITIAL SUBMITTAL
CADD FILE NAME: prelim geo.dgn
REF FILE NAME:
SHEET 1 OF 1
LOCATION MAP
PROJECT LOCATION
GRAPHIC SCALE
50
0
50
N
47TH ST
EAST AVE
BLUFF AVE
BLANCHAN AVE
DUBOIS AVE
EXISTING R.O.W.
270' APPROACH TAPER
155' LEFT TURN TAPER
230' LEFT TURN STORAGE
320' LEFT TURN STORAGE
75' LT STORAGE
115' LEFT TURN TAPER
110' APPROACH TAPER
300' RIGHT TURN STORAGE
245' RIGHT TURN TAPER
400' LEFT TURN STORAGE
MATCHLINE A
MATCHLINE B
145' LT AND APPROACH TAPER
400' LT STORAGE
100' LT TAPER
150' APPROACH TAPER



Kenig, Lindgren, O'Hara, Aboona, Inc.

PROJECT # 09-113

PRELIMINARY GEOMETRIC PLAN

___ ROUTE ___ WITH 4TH STREET

___ ROUTE ___ EAST AVENUE

SEC. NO. ________ PROJ. NO. ________

SCALE 1" = 50' COUNTY COOK

SJN : ________ REV. NO. ___

ENGINEER NAME: DANA M. SCHNABEL, PE

DATE	NAME	REMARKS
04/26/10	DMS	INITIAL SUBMITTAL

CADD FILE NAME: prelim geo.dgn

REF FILE NAME: ________

SHEET 1 OF 1

APPENDIX "C"

Proposed Policy Governing the Use of In-street Pedestrian Crossing Signage

VILLAGE OF LA GRANGE
Department of Public Works

MEMORANDUM

TO: Robert Pilipiszyn

FROM: Ryan Gillingham

DATE: January 20, 2011

RE: Policy on In-Street Pedestrian Crossing Signs

As part of the Village's strategic goal of improving pedestrian safety throughout the Village, in-street pedestrian crossing signs (see Figure 1) have been installed at various pedestrian crossings to improve driver awareness and enhance pedestrian safety. These signs provide motorists with a visual reference within the roadway that pedestrians may be present. The increased use of these in-street signs throughout many communities including La Grange coincides with acceptance of these signs as approved devices in federal traffic sign standards, changes in State law, and heightened awareness of pedestrian safety issues. The federal standards and guidance for these signs contained within the 2009 Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is attached to this memorandum for your reference. Additionally the recently passed State law that states motorists must stop for pedestrians within the crosswalk, rather than just yielding, is also attached to this memorandum for your reference.

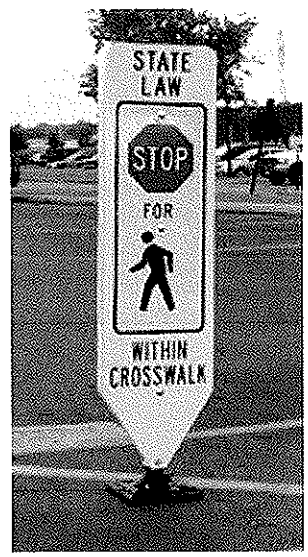


Figure 1

The Village first started deploying these in-street pedestrian crossing signs within the Central Business District as this area tends to have the greatest number of pedestrian and vehicle interactions. Specifically these signs have been deployed during weekends in the spring, summer and fall so as not to conflict with snow plowing operations. Additional in-street pedestrian crossing signs have been installed, such as at the intersection of Brainard Avenue and Burlington Avenues, based on requests by the Police Department and residents. Since use of the in-street pedestrian crossing signs with a STOP sign insert is in conflict with locations controlled by traffic signals, the Village has modified the current signs used at signalized locations to simply state "watch for pedestrians" without the STOP sign element to the sign.

The current locations of the in-street pedestrian signs include the following:

Location	Deployment	Type
47th Street / 9th Avenue – Mid-block crossing	All times from April 1 to November 30	R1-6a – Stop For Pedestrians
La Grange Road at Cossitt Avenue	Weekends from April 1 to November 30	Watch For Pedestrians
La Grange Road at Harris Avenue	Weekends from April 1 to November 30	Watch For Pedestrian
La Grange Road at Calendar Avenue	Weekends from April 1 to November 30	R1-6a – Stop For Pedestrians
La Grange Road at Burlington Avenue	Weekends from April 1 to November 30	Watch For Pedestrians
La Grange Road at Hillgrove Avenue	Weekends from April 1 to November 30	Watch For Pedestrians
Burlington Avenue and Brainard Avenue	All times from April 1 to November 30	R1-6a – Stop For Pedestrians
Brainard Avenue at Bell Avenue	All times from April 1 to November 30	R1-6a – Stop For Pedestrians
Burlington Avenue at Stone Avenue Station	All times from April 1 to November 30	R1-6a – Stop For Pedestrians
Parking Garage Entrances on 6th Avenue	All times	R1-6a – Stop For Pedestrians

In addition to the use of the in-street pedestrian crossing signs shown in the picture above, school crossing guards for the Village also utilize similar but portable/collapsible in-street minicades on a daily basis to warn motorists of children crossing the street.

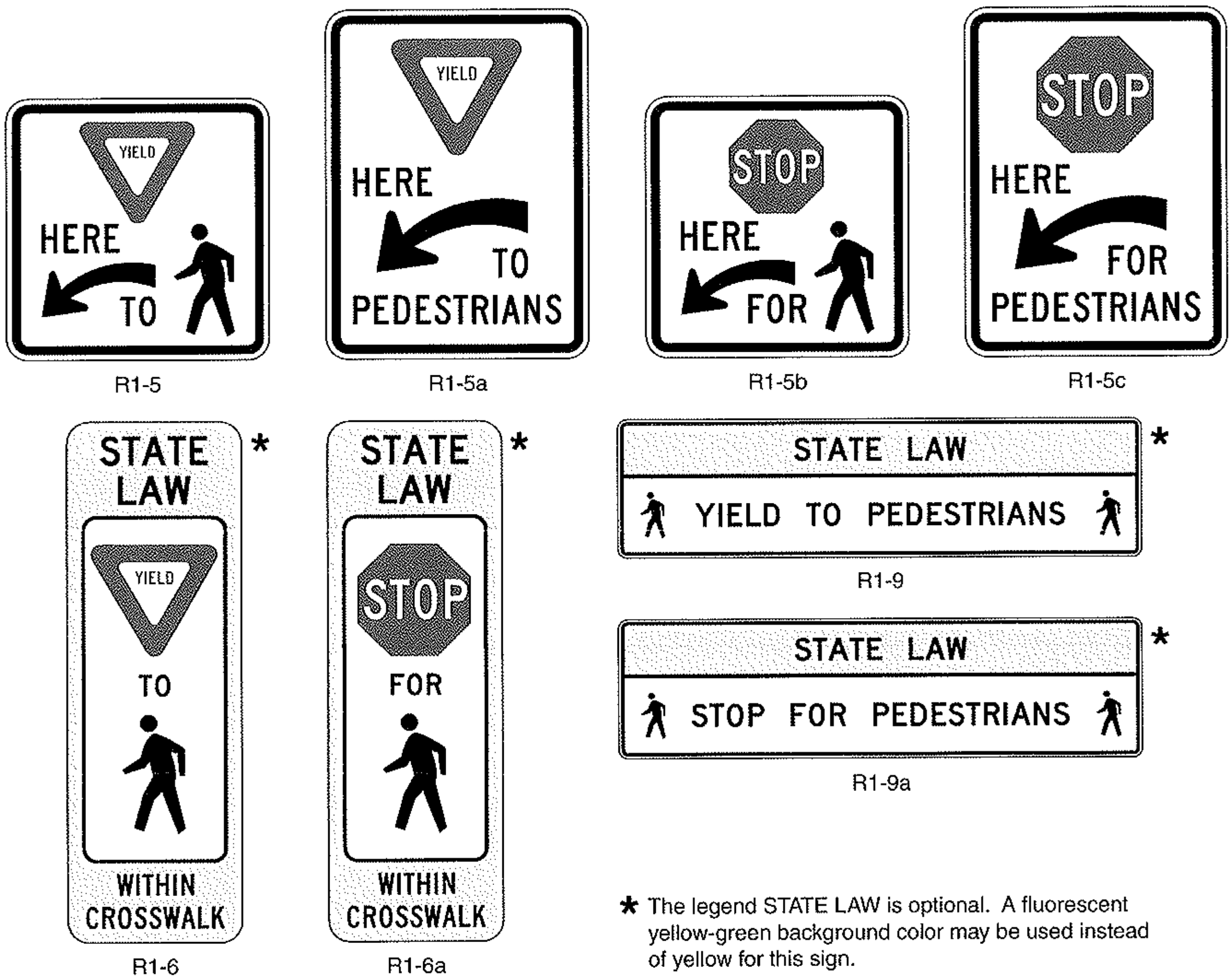
In order to provide a consistent application of these in-street pedestrian signs throughout the Village, and to avoid the over-deployment which could result in motorist desensitization to these signs, a proposed policy for the implementation of these signs is provided below.

Proposed Policy

The following guidelines shall be used by staff for the deployment of In-Street Pedestrian Crossing Signs (R1-6b) throughout the Village:

1. The provisions of the Manual on Uniform Traffic Control Devices (MUTCD) shall be followed. The particular sections of this code are attached to this memorandum for reference.
2. Relevant speed, volumes, accident records, pedestrian counts, sight obstructions and demographic analysis shall be reviewed when considering In-Street Pedestrian Crossing Sign installations.
3. The sign should only be used at key locations, such as high pedestrian volume crosswalks, to avoid overuse.
4. The sign shall only be used at existing crosswalk locations.
5. The sign shall only be used as an in-street sign, not on the outside shoulder or parking lane. When installed, the sign shall not impede or obstruct any traffic movement including through or turning movements. The preferred location is on the center line or the median island of the roadway.
6. The sign shall be used seasonally due to safety issues with the use of the sign during the winter and to prevent damage during the winter because of plowing operations.
7. The sign shall only be used on streets that are classified as collectors or arterials.
8. The use of in-street minicades within school zones will be allowed provided that the school agrees to be responsible for installing and removing the signs on a daily basis on school days only. Additionally the signs cannot be deployed during Village snow plowing operations.
9. In-street pedestrian crossing signs or minicades can be temporarily deployed during special events such the Hometown Holiday event.

Figure 2B-2. Unsignalized Pedestrian Crosswalk Signs



05 A Pedestrian Crossing (W11-2) warning sign may be placed overhead or may be post-mounted with a diagonal downward pointing arrow (W16-7P) plaque at the crosswalk location where Yield Here To (Stop Here For) Pedestrians signs have been installed in advance of the crosswalk.

Standard:

06 **If a W11-2 sign has been post-mounted at the crosswalk location where a Yield Here To (Stop Here For) Pedestrians sign is used on the approach, the Yield Here To (Stop Here For) Pedestrians sign shall not be placed on the same post as or block the road user's view of the W11-2 sign.**

Option:

07 An advance Pedestrian Crossing (W11-2) warning sign with an AHEAD or a distance supplemental plaque may be used in conjunction with a Yield Here To (Stop Here For) Pedestrians sign on the approach to the same crosswalk.

08 In-Street Pedestrian Crossing signs and Yield Here To (Stop Here For) Pedestrians signs may be used together at the same crosswalk.

Section 2B.12 <u>In-Street and Overhead Pedestrian Crossing Signs (R1-6, R1-6a, R1-9, and R1-9a)</u>

Option:

01 The In-Street Pedestrian Crossing (R1-6 or R1-6a) sign (see Figure 2B-2) or the Overhead Pedestrian Crossing (R1-9 or R1-9a) sign (see Figure 2B-2) may be used to remind road users of laws regarding right-of-way at an unsignalized pedestrian crosswalk. The legend STATE LAW may be displayed at the top of the R1-6, R1-6a, R1-9, and R1-9a signs, if applicable. On the R1-6 and R1-6a signs, the legends STOP or YIELD may be used instead of the appropriate STOP sign or YIELD sign symbol.

02 Highway agencies may develop and apply criteria for determining the applicability of In-Street Pedestrian Crossing signs.

Standard:

03 **If used, the In-Street Pedestrian Crossing sign shall be placed in the roadway at the crosswalk location on the center line, on a lane line, or on a median island. The In-Street Pedestrian Crossing sign shall not be post-mounted on the left-hand or right-hand side of the roadway.**

04 **If used, the Overhead Pedestrian Crossing sign shall be placed over the roadway at the crosswalk location.**

05 **An In-Street or Overhead Pedestrian Crossing sign shall not be placed in advance of the crosswalk to educate road users about the State law prior to reaching the crosswalk, nor shall it be installed as an educational display that is not near any crosswalk.**

Guidance:

06 *If an island (see Chapter 3I) is available, the In-Street Pedestrian Crossing sign, if used, should be placed on the island.*

Option:

07 If a Pedestrian Crossing (W11-2) warning sign is used in combination with an In-Street or an Overhead Pedestrian Crossing sign, the W11-2 sign with a diagonal downward pointing arrow (W16-7P) plaque may be post-mounted on the right-hand side of the roadway at the crosswalk location.

Standard:

08 **The In-Street Pedestrian Crossing sign and the Overhead Pedestrian Crossing sign shall not be used at signalized locations.**

09 **The STOP FOR legend shall only be used in States where the State law specifically requires that a driver must stop for a pedestrian in a crosswalk.**

10 **The In-Street Pedestrian Crossing sign shall have a black legend (except for the red STOP or YIELD sign symbols) and border on a white background, surrounded by an outer yellow or fluorescent yellow-green background area (see Figure 2B-2). The Overhead Pedestrian Crossing sign shall have a black legend and border on a yellow or fluorescent yellow-green background at the top of the sign and a black legend and border on a white background at the bottom of the sign (see Figure 2B-2).**

11 **Unless the In-Street Pedestrian Crossing sign is placed on a physical island, the sign support shall be designed to bend over and then bounce back to its normal vertical position when struck by a vehicle.**

Support:

12 The Provisions of Section 2A.18 concerning mounting height are not applicable for the In-Street Pedestrian Crossing sign.

Standard:

13 **The top of an In-Street Pedestrian Crossing sign shall be a maximum of 4 feet above the pavement surface. The top of an In-Street Pedestrian Crossing sign placed in an island shall be a maximum of 4 feet above the island surface.**

Option:

14 The In-Street Pedestrian Crossing sign may be used seasonably to prevent damage in winter because of plowing operations, and may be removed at night if the pedestrian activity at night is minimal.

15 In-Street Pedestrian Crossing signs, Overhead Pedestrian Crossing signs, and Yield Here To (Stop Here For) Pedestrians signs may be used together at the same crosswalk.

Section 2B.13 Speed Limit Sign (R2-1)

Standard:

01 **Speed zones (other than statutory speed limits) shall only be established on the basis of an engineering study that has been performed in accordance with traffic engineering practices. The engineering study shall include an analysis of the current speed distribution of free-flowing vehicles.**

02 **The Speed Limit (R2-1) sign (see Figure 2B-3) shall display the limit established by law, ordinance, regulation, or as adopted by the authorized agency based on the engineering study. The speed limits displayed shall be in multiples of 5 mph.**

03 **Speed Limit (R2-1) signs, indicating speed limits for which posting is required by law, shall be located at the points of change from one speed limit to another.**

Public Act 096-1165

HB0043 Enrolled LRB096 03462 AJT 13486 b

AN ACT concerning transportation.

Be it enacted by the People of the State of Illinois, represented in the General Assembly:

Section 5. The Illinois Vehicle Code is amended by changing Sections 11-1002 and 11-1002.5 as follows:

(625 ILCS 5/11-1002) (from Ch. 95 1/2, par. 11-1002)

Sec. 11-1002. Pedestrians' right-of-way at crosswalks. (a) When traffic control signals are not in place or not in operation the driver of a vehicle shall stop and yield the right-of-way~~, slowing down or stopping if need be to so yield,~~ to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.

(b) No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a moving vehicle which is so close as to constitute an immediate hazard.

(c) Paragraph (a) shall not apply under the condition stated in Section 11-1003 (b).

(d) Whenever any vehicle is stopped at a marked crosswalk or at any unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle.

(e) Whenever stop signs or flashing red signals are in place at an intersection or at a plainly marked crosswalk between intersections, drivers shall yield right-of-way to pedestrians as set forth in Section 11-904 of this Chapter.

(Source: P.A. 79-857.)

(625 ILCS 5/11-1002.5)

Sec. 11-1002.5. Pedestrians' right-of-way at crosswalks; school zones.

(a) For the purpose of this Section, "school" has the meaning ascribed to that term in Section 11-605.

On a school day when school children are present and so close thereto that a potential hazard exists because of the close proximity of the motorized traffic and when traffic control signals are not in place or not in operation, the driver of a vehicle shall stop and yield the right-of-way~~, slowing down or stopping if need be to so yield,~~ to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.

For the purpose of this Section, a school day shall begin at seven ante meridian and shall conclude at four post meridian.

This Section shall not be applicable unless appropriate signs are posted in accordance with Section 11-605.

(b) A first violation of this Section is a petty offense with a minimum fine of $150. A second or subsequent violation of this Section is a petty offense with a minimum fine of $300.

(c) When a fine for a violation of subsection (a) is $150 or greater, the person who violates subsection (a) shall be charged an additional $50 to be paid to the unit school district where the violation occurred for school safety purposes. If the violation occurred in a dual school district, $25 of the surcharge shall be paid to the elementary school district for school safety purposes and $25 of the surcharge shall be paid to the high school district for school safety purposes. Notwithstanding any other provision of law, the entire $50 surcharge shall be paid to the appropriate school district or districts.

For purposes of this subsection (c), "school safety purposes" has the meaning ascribed to that term in Section 11-605.

(Source: P.A. 95-302, eff. 1-1-08.)

Section 99. Effective date. This Act takes effect upon becoming law.

Effective Date: 07/22/2010