Reevaluation of Environmental Assessment

FEDERAL STREET MULTIMODAL CONNECTOR PROJECT

HPP 8000(17)

St. Albans, Vermont

Prepared for **Federal Highway Administration, Vermont Agency of Transportation, and City of St. Albans, VT**

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1

Introduction

1.1 Project Overview

The Federal Street Multimodal Connector Project ("Project" or "Proposed Action"), proposed by the City of St. Albans, Vermont (the City), would reconstruct the Federal Street Corridor to improve its use by automobiles, trucks, pedestrians, bicyclists, and public transit. Currently, US Route 7 (North and South Main Street) bisects the City's downtown, which results in heavy north-south passenger and commercial traffic and congestion and detracts from the downtown human environment. The Project encompasses a series of south to north trending streets one block west of Main Street that currently function as an informal bypass for Main Street through the City. These streets include Lemnah Drive, Allen Street, Market Street, Catherine Street, and Federal Street. The Federal Street Corridor includes a mix of residential, commercial and industrial land uses.

1.2 Recent Developments and Need for NEPA Reevaluation

As the Project was allocated funds through the Federal Highway Administration ("FHWA") *Safe, Accountable, Flexible, Efficient, Equitable Transportation Equity Act: A Legacy for Users* ("SAFETEA-LU"), a federal bill enacted in 2005, it was subject to an analysis conducted in compliance with the requirements of the National Environmental Policy Act of 1969 ("NEPA"), the Council on Environmental Quality (CEQ) Regulations 40 CFR 1500 and 1508, and Federal Highway Administration (FHWA) Technical Advisory T6640.8A as well as FHWA regulations implementing NEPA as described in 23 CFR 771. An Environmental Assessment ("EA") was prepared and a Finding of No Significant Impact ("FONSI") issued on April 26, 2013.

Subsequent to the issuance of the FONSI, the following developments have occurred that: a) mandate a reevaluation of the EA for select resources; or b) preclude the realization of the Proposed Action as described in the EA and therefore mandate an assessment of the impacts associated with new Action Alternatives relative to the original Proposed Action:

a) The City conducted outreach with abutting landowners, primarily the New England Central Railway ("NECR"), to make the necessary arrangements to construct the intersection improvements for the Proposed Action. During the course of this coordination, it became clear that construction of the Proposed Action for the intersection of Lemnah Drive at Lower Welden Street and the intersection of Lake, Catherine, and Federal Streets would not be possible, due primarily to concerns regarding conflicts with NECR rail yard operations (current and future).

b) The City found that, due to fiscal constraints, it was not possible to obtain the buildings and land between Catherine and Market Streets. This was the proposed location of a municipal parking lot which would replace on-street parking in the area (including the spaces proposed for elimination associated with the Giroux Furniture Building), required to construct the Proposed Action; a signalized intersection and one-way traffic circulation improvements at Federal, Lake, Market, and Catherine Streets.

c) As replacement parking could not be realized as desrived in the preceding point b), the City was not able to reach an agreement to obtain the triangular-shaped parcel at the corner of Lake Street and Market streets, which includes parking spaces for the adjacent business in the Giroux Furniture building. These spaces are required in order to execute the Proposed Action; to realign the Federal/Lake/Catherine/Market Street intersection.

d) Two changes in traffic patterns have occurred:

    - Houghton Street has been closed to traffic following the reoccupation of the State office building on Houghton Street by Mylan Technologies.
    - A new State office building and parking garage have been constructed and opened on Lake and Federal Street, with a Lake Street hotel project planned.

- The stormwater designs have been redesigned due to Right-of-Way ("ROW") constraints, resulting in changes to the wetland buffer impacts.

In response to these developments, the City has undertaken a reanalysis of traffic demands and patterns for a suite of new intersection Alternatives. The purpose of this document is to describe the development of the alternatives and assess the potential

impacts of the Revised Proposed Action. Each of the resources included in the EA has been reevaluated for potential impacts under the Revised Proposed Action, including historic properties (per Section 106 of the National Historic Preservation Act of 1972) and resources subject to protection under Section 4(f) of the Department of Transportation Act.

2

Revised Proposed Action and Alternatives

2.1 Introduction

Based on the developments that have occurred subsequent to the FONSI as outlined in **Section 1.2**, new Action Alternatives were developed for four intersections within the Federal Street Corridor. The Action Alternatives are discussed below and depicted on **Figures 2.2-1, 2.3-1, 2.3-2, 2.4-1** and **2.5-1**.

2.2 Nason Street Connector and Lemnah Drive at Nason Street

2.2.1 Original Proposed Action

The original Proposed Action as described in the EA was stop control on Nason Street approaches with left-turn lanes provided on all approaches except Nason Street westbound.

Subsequent to the issuance of the FONSI, concerns regarding the implementation of the Proposed Action include:

- The analysis of the 2030 future year traffic projections indicated the possibility that vehicles may queue back beyond the existing railroad crossing (approximately 115 feet west of the Lemnah Drive/Nason Connector intersection) once the stop sign control is moved from Lemnah Drive.

- The possibility of a vehicle stopping on the tracks in the left or the through/right turn lane exists if they do not heed the signs "Do not Stop on Tracks."

2.2.2 Revised Proposed Action

The Revised Proposed Action is a two-way stop with single lane approaches on both of the Nason Street approaches, versus the original two (2) lane eastbound approach (separate left and through/right lanes) originally proposed (see **Figure 2.2-1**). In addition, to the single eastbound lane, a ten (10) foot paved shoulder will be constructed between the travel lane and the sidewalk. If a motorist does not heed the warning signs to not stop on the railroad tracks, and a train approaches, the motorist can move off the tracks using the paved shoulder area.

2.3 Lemnah Drive and Allen Street at Lower Welden

2.3.1 Original Proposed Action

The original Proposed Action as described in the EA was a single lane roundabout with right-turn slip lane on Lower Welden Street eastbound approach.

Subsequent to the issuance of the FONSI, concerns regarding the implementation of the Proposed Action include:

- Based on discussion with the NECR and Operators, the Right-of-Way (ROW) acquisition required to construct the proposed roundabout would interfere unduly with railyard operations and/or preclude future expansion of the NECR railyard.

- The NECR Operator stated they cannot eliminate any of the grade crossings at Lower Welden because they are needed for the current railyard operation as well as potential future expansion. The original roundabout design was based on being able to eliminate at least the two easterly grade crossings.

- The functionality of the original roundabout would be hampered by the necessity for a railroad preemption. Stacking within the roundabout may occur, hampering traffic flow in any direction (as opposed to a signalized intersection, which would allow for north/south movements along Lemnah Drive and Allen Street to continue).

Four new Action Alternatives were developed for this intersection. These are summarized in the comparative matrix provided as **Figure 2.3-1**, including LOS and construction costs. The operational analysis presented in the following section incorporate the results of a new traffic network analyses performed by VHB in 2015 in consideration of land use changes and changes in traffic patterns since the publication of the EA. The methodology and results of this network analysis are presented in **Chapter 3**.

2.3.2 New Alternative 1A & 1B: Two-Way Stop

New Alternative 1 is for two-way stop control on Lower Welden Street with left-turn lanes on Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound (see **Figure 2.3-1)**.

2.3.2.1 Evaluation

New Alternative 1A is stop control on the eastbound and westbound Lower Welden Street approaches. It is expected to provide LOS F operations on these minor street approaches with long delays and queues. Specifically, during the 2030 future year weekday evening peak hour the westbound approach from Lower Welden Street is expected to operate at LOS F with a delay of 175 seconds and a 95th percentile queue of 325 feet and the eastbound left-turn is expected to operate at LOS F with a delay of over 500 seconds and a 95th percentile queue of 700 feet. This eastbound queue extends well beyond the railroad crossing on Lower Welden Street.

Conversely, with stop control on the northbound and southbound approaches (New Alternative 1B), it is the Lemnah Drive and Allen Street minor street approaches that are expected to provide LOS F with long delays and queues. In 2010, delays are expected to exceed 300 seconds on the stop controlled approaches of Lemnah Drive and Allen Street, the 95th percentile queues on the northbound Lemnah Drive approach are expected to be 125 feet for the left-turn lane and 250 feet for the shared through/right lane and the 95th percentile queue on the southbound Allen Street approach are expected to be 275 feet for the left-turn lane and 350 feet for the shared through/right lane during the weekday evening peak hour. The delays and queues on the minor street approaches of Lemnah Drive and Allen Street will be even longer by the forecast year of 2030.

Based on the LOS results for New Alternatives 1A and 1B being appreciably different from the Original Proposed Action and for the additional reasons cited in **Figure 2.3-1**, neither was selected for further evaluation.

2.3.3 New Alternative 2: Four-Way Stop

New Action Alternative 2 is for a four-way stop control intersection with left-turn lanes on Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound (see **Figure 2.3-1)**.

2.3.3.1 Assessment

New Alternative 2 is expected to provide LOS D on the northbound movement from Lemnah Drive and LOS C on the other approaches through the 2030 forecast year during the weekday morning peak hour. During the weekday evening peak hour, the northbound approach from Lemnah Drive and the southbound approach from Allen Street are expected to operate at LOS E while the eastbound and westbound Lower Welden Street approaches are expected to operate at LOS D through the 2030 forecast year. However, the 95th percentile queues on the critical eastbound approach are expected to extend beyond the railroad crossing on Lower Welden Street. A review of peak hour volumes with consideration of the 12-hour temporal distribution experienced at the Lake Street, Catherine Street and Federal Street intersection indicates that the intersection of Lower Welden Street at Lemnah Drive and Allen Street likely meets the minimum volumes identified for multi-way stop sign installation in the Manual on Uniform Traffic Control Devices[1] (MUTCD).

Based on the LOS results for New Alternative 2 being appreciably different from the Original Proposed Action and for the additional reasons cited in **Figure 2.3-1**, New Alternative 2 was not selected for further evaluation.

2.3.4 New Alternative 3: Signalized

New Action Alternative 3 is for a signalized intersection, evaluated with and without left-turn lanes on the Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound approaches (see **Figure 2.3-1)**.

2.3.4.1 Assessment

Although the operational analysis indicates that a signal would operate at acceptable levels of service (LOS D without left-turn lanes and LOS C with left-turn lanes), an inspection of the peak hour volumes indicates that the Warrant 3 (Peak Hour) from the MUTCD is not satisfied.

Based on the LOS results for New Alternative 3 being different from the Original Proposed Action and for the additional reasons cited in **Figure 2.3-1**, New Alternative 3 was not selected for further evaluation.

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[1] Manual on Uniform Traffic Control Devises (MUTCD) 2009 Edition.

2.3.5 New Alternative 4: Mini Roundabout (Revised Proposed Action)

New Action Alternative 4 is a single lane roundabout with a right-turn lane on the eastbound Lower Welden Street approach (see **Figures 2.3-1** and **2.3-2**).

2.3.5.1 Assessment

The original Proposed Action provided a single lane roundabout with a right-turn lane on the eastbound Lower Welden Street approach. The updated evaluation with the modified traffic volumes revealed that all approaches at a roundabout are expected to operate at LOS B or better based on the Synchro analysis and LOS A based on the NCHRP methodology through the 2030 forecast year during both the weekday morning and weekday evening peak hours. It is should be noted that the critical eastbound approach on Lower Welden Street, which crosses the railroad tracks, is projected to have a 95th percentile queue of approximately 25 feet or one vehicle (staying clear of the railroad crossing).

Based on the LOS for New Alternative 4 being comparable to the original Proposed Action, the favorable decrease in ROW impacts compared to the original Proposed Action, and the cost estimate relative to New Action Alternatives 1A/B, 2, and 3, New Action Alternative 4 was selected as the Revised Proposed Action).

2.4 Catherine, Federal, and Market Streets at Lake Street

2.4.1 Original Proposed Action

The original Proposed Action as described in the EA was for signal control with single lane approaches on both Lake Street approaches; separate left, through, and right-turn lanes on Federal Street southbound approach; left and through/right-turn lanes on Catherine Street northbound approach (one-way); and one-way traffic flow southbound on Market Street.

Subsequent to the issuance of the FONSI, concerns regarding the implementation of the Proposed Action include:

- The City has been unable to acquire or negotiate an easement on the triangular parcel adjoining and northwest of the Giroux Furniture Building, which currently provides parking for the building. Without the use of this parcel, the direct southbound through movements from Federal Street onto a one-way southbound Market Street are not possible. To retain the circulation pattern as described for the Proposed Action, southbound traffic would have

to make a right (west) turn on Lake Street and a left (south) turn on Market Street. The signal phasing for this scenario would be inefficient, and blocked cars turning left into Market Street could create a queue that stacks into the intersection. Accordingly, the proposal to make Catherine Street a one-way northbound street must be abandoned so that it can accept the southbound through movement from Federal Street.

- Removal of the buildings at 26-34 Catherine Street (immediately south of Giroux Furniture Building) and construction of a municipal parking lot is no longer feasible due to financial constraints on property acquisition.

- Based on discussions with the NECR Operators, active railroad preemption of a traffic control signal at the Lake/Federal/Catherine Street intersection will be a problem due to the proximity of the rail yard and the Amtrak station. The active preemption equipment needs to be placed far enough away to provide time to service the most restrictive signal phase (pedestrian) before clearing the eastbound Lake Street approach prior to the gates dropping. In order to service the pedestrian and eastbound clearance, the rail yard and train station will be situated between the active preemption equipment and Lake Street crossing. Therefore, false preemption actuations are the concern and based on the railroads investigation these could be upwards of 20 false preemptions a day. Options to the active preemption to keep vehicles off the tracks needed to be explored.

- Expansion of the traffic signal layout to place the eastbound Lake Street stop line west of the railroad tracks was determined to provide the best option to avoid false preemption actuations while positively keeping the tracks clear when trains approach. However, this expanded approach results in increase lost time for eastbound vehicles which translates to a reduced level of service for the intersection.

2.4.2 Revised Proposed Action

The revised Proposed Action is for signal control with single lane approaches on Catherine Street northbound, Market Street northbound, and Lake Street westbound; left/through and right-turn lanes on Federal Street southbound approach; left-turn and through/right-turn lanes; an exclusive pedestrian phase and signal phasing to accommodate the railroad crossing (see **Figure 2.4-1**).

2.5 Allen Street and Catherine Street at Stebbins Street and Market Street

2.5.1 Original Proposed Action

This intersection is located at the southern end of the proposed Market Street and Catherine Street one-way pair. The original Proposed Action as described in the EA, called for one-way circulation northbound from Allen Street to Catherine Street and the southbound traffic flow was from Market Street to Allen Street. Stebbins Street (two way traffic flow) intersected Allen/Catherine Street from the east and the approach was stop sign controlled. The Market Street (one way traffic flow) left turn movement intersected Allen/Catherine Street across from Stebbins Street from the west, and its movement were controlled by a stop sign.

Based on the constraints discussed in the preceding **Section 2.4.1**, the original Proposed Action cannot be implemented.

2.5.2 Revised Proposed Action

The revised Proposed Action is for two-way traffic flow and single multiuse lanes on all approaches with stop control on Stebbins Street and Market Street (see **Figure 2.5-1**).

3

Environmental Consequences & Mitigation

3.1 Overview

As described above, the Revised Proposed Action warranted a reevaluation of Project area resources to compare their impacts to the original Proposed Action, as described in the EA. This section of the EA Reevaluation includes all the resources analyzed in the EA and is presented in the same sequence as the EA. It should be noted that the regulatory contexts, methodologies for resource assessment and impact analysis, and affected environment remain essentially unchanged since the issuance of the FONSI. Therefore, unlike the EA, Chapter 3 of this document addresses only the environmental consequences of original Proposed Action and the revised Proposed Action.

As the Revised Proposed Action includes changes at select intersections and to the stormwater treatment practice along the Nason Street Connector, leaving all other components of the original proposed Action intact, the environmental consequences of the Revised Proposed Action are unchanged from the original Proposed Action for the majority of the resources described below.

3.2 Traffic

3.2.1 Traffic Network Development

The traffic volumes increases and diversions associated with the proposed State office building development project and the Houghton Street closure project were distributed throughout the study area based on existing flow patterns. The traffic volume networks for this assessment include all intersections considered in the EA, as

well as the additional intersections included in the Houghton Street closure project (Lake Street at: Houghton Street and South Elm Street and Lower Welden Street at: Houghton Street and South Elm Street). It should be noted that data collected for the Houghton Street closure project did not include an evaluation of the weekday morning peak hour condition. Therefore, the weekday morning peak hour adjustments associated with the Houghton Street closure were estimated based on a comparison between the weekday morning and weekday evening peak hour volumes. **Figures 3-1** through **3-4** show the net difference in traffic volumes at each intersection from the original EA Proposed action to the updated scenario.

The 2010 and 2030 Updated Proposed Action weekday morning and weekday evening peak hour traffic volume networks were developed by adding the net difference in traffic volumes (associated with the proposed State office building development project and the Houghton Street closure project) to the originally developed Proposed Action traffic volume networks. **Figures 3-5** through **3-8** show the 2010 and 2030 Updated Proposed Action weekday morning and weekday evening peak hour traffic volume networks.

Due to the diversions associated with the Houghton Street closure, the most substantial traffic volume increases generally occurred along Lemnah Drive, Allen Street, and Catherine Street. During the 2010 weekday evening peak hour, volumes at the Lemnah Drive/Lower Welden Street intersection are projected to increase by 175 vehicles and volumes at the Catherine Street/Market Street/Stebbins Street intersection are projected to increase by 340 vehicles under this scenario. The most substantial decreases in volume generally occurred along Lake Street north of Houghton Street with a reduction of 270 vehicles anticipated during the 2010 weekday evening peak hour. Volume adjustments along other study area streets, particularly along Main Street, are substantially smaller in nature.

3.2.2 Traffic Operational Analyses

To assess the quality of traffic flow, capacity analyses were conducted to determine how well the study area intersections will serve the forecasted traffic demands placed upon them. The traffic performance measures and the evaluation criteria used in the operational analyses are based on the methodology presented in the 2000 Highway Capacity Manual.[2] Proposed roundabouts were evaluated using two analysis tools: Synchro version 8 and the National Cooperative Highway Research Program (NCHRP) 572 Roundabout Analysis worksheet.

A primary result of capacity analysis is the assignment of level of service (LOS), which is a qualitative measure describing operational conditions at a given facility under specific traffic volume demands. Six levels of service are defined ranging in letter

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[2] 2000 Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C.

designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustifiable. LOS E reflects a condition of longer delay, but can be considered acceptable in a congested area, particularly in cases where traffic control devices and other measures are taken to improve safety or physical/geometric improvements are not considered to avoid environmental, historical, or property impacts.

The operational analysis for this updated evaluation was limited to study area intersections that experience traffic volume increases of approximately 75 peak hour trips[3] or more compared to the previous analysis presented in the EA (as shown in **Figures 3-1** through **3-4**) and/or where geometric or traffic control modifications (from those assumed in the EA) are being considered. Each of the new Action Alternatives for the four intersections as outlined in **Chapter 2** were evaluated.

The results of the updated 2010 and 2030 signalized, unsignalized, and roundabout operational analyses are summarized in **Tables 3.2-1**, **3.2-2**, and **3.2-3** respectively. A comparison between the results of this updated analysis and the original Proposed Action revealed similar operations at most intersections. Specifically, most intersections are expected to operate at the same LOS. Copies of the updated operational analyses are provided in the **Appendix**.

3.2.2.1 Upper and Lower Newton Streets

The signalized intersections of Lower Newton Street at Federal Street, US Route 7 at Lake Street and US Route 7 at Fairfield Street are all expected to operate at LOS C through the 2030 forecast year. The operations are consistent with the findings of the EA because there are no design modifications and the changes in peak hour traffic volumes was relatively small at these three intersections.

The signalized intersection of US Route 7 at Upper Newton Street and Lower Newton Street is expected to operate at LOS C during the weekday morning peak hour and just below capacity (v/c ratio of 0.98) at LOS E during the weekday evening peak hour in the 2030 forecast year. As discussed in the original EA traffic evaluation, these operations are partially attributed to incorporating safety measures and exclusive pedestrian phases into the intersection's operation.

[3] The VTrans Traffic Impact Study Guideline identify 75 additional peak hour trips at an intersection as the threshold for determining the geographic scope of the evaluation.

3.2.2.1 Catherine, Federal, and Market Streets at Lake Street

The proposed signalized intersection of Catherine Street, Federal Street, and Market Street at Lake Street is expected to operate at LOS D in 2010, but drop to LOS E by the 2030 forecast year. Although the overall intersection is expected to operate below capacity through the 2030 forecast year, long queues are expected by the forecast year along Catherine Street northbound (300 to 625 feet for the 50th and 95th percentile queues, respectively) and Lake Street westbound (375 to 775 feet for the 50th and 95th percentile queues respectively) during the critical weekday evening peak hour. These queues are a result of the single lane approaches, which are necessary to avoid property impacts, the exclusive pedestrian phase, and the modified signal timings necessary to accommodate preemption with the railroad. The Catherine Street northbound and Lake Street westbound 95th percentile queues are approximately 250 feet longer in comparison to the results associated with the original Proposed Action.

3.2.2.2 Lemnah Drive and Allen Street at Lower Welden Street

The intersection of Lower Welden Street at Lemnah Drive and Allen Street was evaluated as a roundabout, a signal, and a stop control intersection (both two-way and four-way) (see **Chapter 2** for discussion of the analysis of New Action Alternatives). The original Proposed Action provided a single lane roundabout with a right-turn lane on the eastbound Lower Welden Street approach.

The Revised Proposed Action is a mini-roundabout, which is operationally very similar to the original Proposed Action and therefore provides a comparable LOS.

3.2.2.3 Nason Street Connector and Lemnah Drive at Nason Street

The minor street approaches of Nason Street at the proposed unsignalized intersection with Nason Street Connector and Lemnah Drive are expected to operate at LOS C and LOS D in 2010. By the 2030 forecast year, the minor street operations on Nason Street are expected to drop to LOS E during the weekday morning peak hour and LOS D (westbound) and F (eastbound) during the weekday evening peak hour. This critical eastbound approach is expected to experience delays of 55 seconds or less and a 95th percentile queue of 175 feet in the 2030 forecast year peak hour

conditions. The minor street approaches of Stebbins Street (westbound) and Market Street (eastbound) at the unsignalized intersection of Allen Street and Catherine Street are expected to operate at LOS C or better through the forecast year of 2030.

3.3.1 Environmental Consequences

The updated traffic evaluation, which accounts for traffic volume changes associated with the proposed State office building development project and the Houghton Street closure project as well as new Action Alternatives at several study area intersections revealed comparable traffic operations at most Project intersections as compared to the original Proposed Action.

3.3.1.1 Nason Street Connector / Lemnah Drive at Nason Street

The Revised Proposed Action for this intersection is a four-way unsignalized intersection with left-turn lanes on Nason Street Connector (northbound) and Lemnah Drive (southbound) and single lane approaches under stop control on Nason Street. This configuration is expected to provide acceptable operations (LOS D or better) in 2010. By the 2030 forecast year the Nason Street eastbound approach is anticipate to drop to LOS F, but with manageable delays of no greater than 55 seconds and a 95th percentile queue of 175 feet. An eastbound bypass shoulder on Nason Street has been included in the design due the railroad crossing on approximately 80 west of the intersection. Additionally the City should consider the installation of a "Do Not Stop on Tracks" (R8-8) sign on the eastbound Nason Street approach to the railroad tracks.

The LOS for the original Proposed Action for both the 2010 and 2030 Build Alternatives is very similar to that of the Revised Proposed Action described above. The only change is that the westbound movement from Nason Street for the 2030 weekday evening period declines from LOS C to D, which is still an acceptable condition. Therefore, the new design for this intersection does not result in an impact greater than that described in the EA and additional analysis or mitigation is not required.

3.3.1.2 Lemnah Drive/Allen Street at Lower Welden Street

A single lane mini-roundabout with an eastbound right-turn lane on Lower Welden Street, which is substantially similar to the Proposed Action from the original EA

assessment, provides the best traffic operations (LOS B and LOS A) with short approach delays of 13 seconds or less and 95th percentile queues of one vehicle or less through the 2030 forecast year. Accordingly, the mini-roundabout does not result in an impact greater than that described in the EA and additional analysis or mitigation is not required.

3.3.1.3 Allen Street/Catherine Street at Stebbins Street/Market Street

The Revised Proposed Action for this intersection is a four-way unsignalized intersection with single lane approaches and stop control on Stebbins Street and Market Street. Because this Revised Proposed Action includes two-way streets as opposed to the one-way Market and Catherine Streets of the original Proposed Action, the resulting LOS cannot be compared directly to that of the original Proposed Action. Nevertheless, this arrangement is expected to provide good operations (LOS C or better) through the 2030 forecast year. Accordingly, the new design for this intersection does not result in an impact greater than that described in the EA and additional analysis or mitigation is not required.

3.3.1.4 Catherine Street/Federal Street/ Market Street at Lake Street

A signal with single lane approaches on Catherine Street northbound, Market Street northbound, and Lake Street westbound, an exclusive pedestrian phase, and signal phasing to accommodate the railroad crossing is expected to operate at LOS D during the weekday morning and LOS E (below capacity with a v/c of 0.91) during the weekday evening peak hour through the 2030 forecast year. This outcome (i.e., LOS E in 2030) is the same as for the original Proposed Action. Accordingly, the new design for this intersection does not result in an impact greater than that described in the EA and additional analysis or mitigation is not required.

Although the overall intersection is expected to operate below capacity through the 2030 forecast year, long queues are expected by the forecast year along Catherine Street northbound (300 to 625 feet for the 50th and 95th percentile queues respectively) and Lake Street westbound (375 to 775 feet for the 50th and 95th percentile queues respectively) during the critical weekday evening peak hour. These queues are a result of the single lane approaches, which are necessary to avoid property impacts, the exclusive pedestrian phase, and the modified signal timings necessary to accommodate preemption with the railroad.

3.3 Wetlands

3.3.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original Project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

Potential impacts to wetland areas were evaluated by overlaying the proposed limits of grading for the Revised Proposed Action on mapping of existing conditions. The overlay plans were then assessed to determine direct and indirect effects on wetlands within the Study Area. The resulting estimates of wetland impacts for the original Proposed Action and Revised Proposed Action are reported in **Table 3.3-1**.

Table 3.3-1 Impacts to State and Federally Regulated Jurisdictional Wetlands – Original Proposed Action

Type of Impact	Original Proposed Action Area of Impact (sf)	Revised Proposed Action Area of Impact (sf)
Permanent Wetland Impact	1,531	1,506
Temporary Wetland Impact	360	0
Subtotal Wetland Impacts (Direct)	**1,891**	**1,506**
Class II Wetland Buffer – Permanent	13,008	22,238
Class II Wetland Buffer – Temporary	1,605	0
Subtotal Wetland Buffer Impacts (Indirect)	**14,613**	**22,238**
Total Impacts	**16,504**	**23,744**

3.3.1.1 Revised Proposed Action

The relocation of the stormwater treatment facility from its original proposed location and the process of design advancement have implications for impacts to regulated wetlands and wetland buffers. Indirect wetland impacts are slightly less for the revised location, reflecting the design change that has the pond outfall being positioned outside the wetland. However, relocating the pond so that it lies closer to Wetland B and between two prongs of this feature means that wetland buffer impacts are higher for the Revised Proposed Action (see **Table 3.3-1**). However, due to the topographic setting and the need to provide positive drainage, there are no alternate locations for the stormwater pond (see **Section 3.4.1.1**). The pond has been purposefully designed to avoid direct wetland impacts.

Although wetland buffer impacts have increased by approximately 7,625 square feet, the necessary wetland authorization from the DEC Wetlands Program (Individual Wetland Permit) remains the same as for the original Proposed Action. Mitigation measures as described in the EA remain applicable and will be employed for the Revised Proposed Action.

3.4 Surface Waters

3.4.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.4.1.1 Revised Proposed Action

The stormwater wet pond located adjacent to the Nason Street connector cannot be located in the previously contemplated location due to elevation constraints between the Project and surrounding parcels, which include the railroad corridor. At the property line, the previously proposed location has an existing grade between 383.6 and 379.0. The stormwater feature will be required to discharge into Wetland B (**Figure 3.3-1**), which is at an elevation of 378.5. Therefore, the pond would be required to be located entirely within cut, which severely limits the available footprint such that a pond in that location cannot meet the Vermont Stormwater Treatment Standards as outlined in the 2002 Vermont Stormwater Management Manual (VSMM). The current proposed location allows the pond to be located partially in cut and partially in fill, which improves the overall project soil balancing. It is located entirely outside the wetland and provides stormwater treatment and control meeting the water quality and channel protection criteria of the VSMM for the proposed impervious area associated with the Nason Street connector.

The plans for the crossing of Stevens Brook remain substantially the same as for the original Proposed Action, and therefore no change in impact is anticipated.

3.5 Groundwater & Drinking Water Resources

3.5.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.5.1.1 Revised Proposed Action

The Revised Proposed Action would have no effect on groundwater resources or surface drinking water sources as state designated resources are located a considerable distance from the Study Area. This determination is identical to the original Proposed Action.

3.6 Floodplains & Floodways

3.6.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.6.1.1 Revised Proposed Action

There are no Zone A (100-year) special flood hazard areas within the Study Area. The nature of the redevelopment is such that little change is proposed to occur with respect to finished elevation or surface water flow patterns. In addition, the Revised Proposed Action would result in systematic stormwater management improvements that would help alleviate flooding within portions of the Study Area. The replacement of the bridge over Stevens Brook would not change hydraulic/hydrologic conditions at this conveyance. Accordingly, there would be no substantial impact to floodplains and floodways as a result of the Revised Proposed Action. This determination is identical to the original Proposed Action.

3.7 Farmlands

3.7.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

This section describes the occurrence of farmland (prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance) with the Study Area and describes the environmental consequences of the No-Action Alternative and the Proposed Action with respect to farmland.

3.7.1.1 Revised Proposed Action

The Revised Proposed Action would have no effect on important farmland due to the designation of the entire Study Area as an "urban cluster". Because the entire Study Area lies within a UC, there are no "Important Farmlands" subject to the provisions of § 658.2 of the FPPA. This determination is identical to the original Proposed Action.

3.8 Wildlife

3.8.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.8.1.1 Revised Proposed Action

The Revised Proposed Action would have minimal effect on wildlife habitat due to the designation of the entire Study Area as an Urban Cluster and the fact that the majority of the Proposed Action would occur along areas previously developed. This determination is identical to the original Proposed Action.

The replacement of the Stevens Brook bridge may result in minor, temporary disturbance to aquatic habitat during construction, as per the original Proposed Action.

3.9 Threatened & Endangered Species

3.9.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.9.1.1 Revised Proposed Action

The Revised Proposed Action would have no impact on threatened or endangered species as there are no known populations of threatened or endangered species within the Study Area. This determination is identical to the original Proposed Action.

3.10 Air Quality

3.10.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

The original EA microscale air quality analysis was based on the three worst study area intersections by volume and level of service (US Route 7 at Upper Newton Street / Lower Newton Street, Lake Street at Federal Street / Catherine Street, and US Route 7 at St Albans State Highway / Nason Street Connector). Based on the traffic network analysis conducted by VHB in 2015 as part of this reevaluation, these intersection are only expected to experience an increase of 75 trips or less during the critical weekday evening peak hour as a result of the additional projects within the Study Area described previously. This represents an increase of only 2 to 4 percent when compared to the original Proposed Action traffic volumes. It should also be pointed

out that the Revised Proposed Action does not change significantly enough to degrade the traffic operations at the critical Project intersections.

3.10.1.1 Revised Proposed Action

Because the overall changes in the roadway design and traffic volumes are relatively minor at the critical Project intersections (as compared to the original Proposed Action), the overall air quality analysis results and conclusions are not expected to change. Additional air quality analysis does not appear to be necessary.

3.11 Noise

3.11.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

Based on the traffic network analysis conducted by VHB in 2015 as part of this reevaluation, the most substantial increase in traffic volume is expected to occur along Allen Street in the vicinity of Lower Welden Street, Market Street, and Catherine Street. The only sensitive noise receptors identified in this area are located on the eastside of the intersection of Lower Welden Street at Lemnah Drive / Allen Street (Receptor - R11 as described in the EA), where the intersection design has been modified to a mini roundabout and the Allen Street alignment has been shifted slightly to the east, holding the existing Allen Street eastern curb line except within 150 ft of the mini roundabout. Because of this minor shift in roadway alignment and the increase in traffic volume, these residences along the east side of Allen Street may experience slightly higher sound levels than reported in the EA noise analysis (61 dBA for 2030 Build). However, even if these receptor locations experienced an increase in sound level high enough to approach the noise abatement criteria (NAC) of 66 dBA, which is not anticipated, the construction of a noise barrier would not be feasible or reasonable because of numerous access points, which prevents the construction of a continuous barrier of sufficient length to achieve appropriate sound level reductions.

3.11.1.1 Revised Proposed Action

Because the changes in the roadway design and traffic volumes are relatively minor throughout most of the Study Area (as compared to the original Proposed Action), the overall EA noise analysis results and conclusions are not expected to change. Additional noise analysis does not appear to be necessary.

3.12 Parks, Recreation & Conservation Land

3.12.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

The only park of note within or close to the Study Area is Taylor Park.

3.12.1.1 Revised Proposed Action

The Revised Proposed Action would have no direct effect on Taylor Park as it lies outside of the Study Area. No other public recreation areas or Section 6(f) properties occur in the Study Area, thus there would be no direct impacts to any of these recreational resources.

The Revised Proposed Action may have an indirect beneficial effect on Taylor Park by improving congestion and mobility within the vicinity of the Park. This determination is identical to the original Proposed Action.

3.13 Historic Resources

3.13.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.13.1.1 Revised Proposed Action

Under the Revised Proposed Action, there are no new effects to historic resources. A smaller portion of the Central Vermont Railroad Headquarters Historic District will be incorporated into the Project; however, the Revised Proposed Action proposes less land than the original Proposed Action. There are no adverse effects to historic

buildings, structures, or landscapes. The Determination of Effect remains No Adverse Effect, which is identical to that of the original Proposed Action.

3.14 Archaeological Resources

3.14.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.14.1.1 Revised Proposed Action

As indicated in the EA, archeological surveys of the ROW for the Nason Street Connector determined that the portion of the archeological site within the APE is not significant and that the Project would have no adverse effect on archaeological resources. This determination is identical for the Revised Proposed Action as to the original Proposed Action.

3.15 Acquisitions (Right-of-way)

3.15.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

This section identifies changes in the type and location of properties that would be impacted and/or acquired as a result of the Revised Proposed Action relative to the original Proposed Action, as well as any businesses and residences that would be relocated. It had been determined in the EA that relocation costs would be incurred for tenants located in the block between Market Street and Catherine Street. However, the revised alignment only impacts one of the four (4) properties previously identified as having the potential for impacts.

3.15.1.1 Revised Proposed Action

For purposes of this discussion, three categories of ROW impact were defined:

- **ROW Acquisitions** represent areas of new permanent public ROW for use in construction of new or improved roadways as well as their future maintenance.
  - Under the Revised Proposed Action, only one of the previously impacted properties between Catherine and Market Street would need to be acquired. This is the property at 36 Catherine St; N/F Stanislas, at the corner of Catherine Street, Stebbins Street and Market Street across from Allen Street. The other two buildings and the parking area for the historic Giroux building would no longer be acquired. One additional parcel not previously identified for impacts would need to be acquired to facilitate the realignment, this one is on the southeast corner of the Stebbins and Allen Street intersection, 22 Stebbins St; N/F Lewis.
  - Overall, the ROW area to be acquired in the Market Street, and Catherine Street area for the Revised Proposed Action would be substantially reduced relative to the original Proposed Action.
  - Allen Street from Lower Welden Street to Market/Stebbins Street, has been realigned from the original Proposed Action and the Revised Proposed Action would impact much less NECR property in the Beartown rail yard.
  - Under the Revised Proposed Action, the construction of the mini-roundabout at the intersection of Lower Welden Street/Allen Street & Lemnah Drive would result in less ROW impact and acquisition of NECR property because the mini-roundabout is physically smaller than the roundabout of the original Proposed Action and can be shifted eastward away from the railroad.
  - As noted in the EA, most of the ROW for the Nason Street Connector located at the southern end of the Study Area was recently acquired by the City. No change in this Connector road location is proposed for the Revised Proposed Action.
- **Permanent Easements** would be required for locating new traffic control and stormwater infrastructure outside of the permanent ROW. For the Revised Proposed Action, there is essentially no change in the permanent easements being sought for the Project. The City will seek a traffic signal equipment easement for the Lake/Federal/Catherine Street intersection and an easement for the stormwater pond alongside the Nason Street Connector.
- **Temporary Easements** are those areas outside of the existing ROW that would be used for regrading, landscaping and temporary construction access

but would not be subject to additional permanent use by the public in maintaining the roadway facility. The temporary easements for the revised design are essentially the same areas as previously approved.

3.16 Environmental Justice

3.16.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.16.1.1 Revised Proposed Action

The Revised Proposed Action would not have a disproportionate and adverse effect on minority and low-income populations. This determination is identical to that of the original Proposed Action. The Revised Proposed Action acquires less property than proposed in the original Proposed Action, and no additional buildings are being affected. For any land required, just compensation will be provided in accordance with the Uniform Act. Any mitigation required will be fairly distributed to the impacted properties.

3.17 Hazardous Materials

3.17.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.17.1.1 Revised Proposed Action

There is no work proposed by the Revised Proposed Action that is outside the area of the original Proposed Action. Therefore, the conclusions remain the same and the findings are identical to that of the original Proposed Action.

3.18 Cumulative Impacts

3.18.1 Environmental Consequences

This section describes the effects that the Revised Proposed Action has on the resources identified within the original project Study Area. It compares the results of the Revised Proposed Action to the original Proposed Action to assess if a change to the original EA findings is anticipated.

3.18.1.1 Revised Proposed Action

The incremental effects of the Federal Street Multimodal Connector Project, when considered in combination with that of the past, present, and reasonably foreseeable actions noted above constitutes only a minor cumulative impact. They do not rise to a significant level and each project would mitigate its individual impacts. In fact, coupled with the Downtown Streetscape Project and multimodal transit center, the Project would result in positive impacts with respect to Traffic, Bicycle and Pedestrian access and Surface Water quality.

Based on this finding, no additional mitigation or action is warranted beyond that provided for the direct and indirect impacts. This determination for the Revised Proposed Action is identical to that of the original Proposed Action.

3.19 Summary of Mitigation & Project Commitments

The list of mitigation and project commitments included in the EA remain applicable for this reevaluation for the Revised Proposed Action.

4

Section 4(f) Resources

4.1 Introduction

The original and the Revised Proposed Action would reconstruct the Federal Street corridor to improve its use by automobiles, trucks, pedestrians, bicyclists, and public transit, alleviating heavy north-south passenger and commercial traffic and congestion on Main Street.

The Revised Proposed Action warranted a reevaluation of resources in order to determine if impacts relative to the original Proposed Action, as described in the EA. This section of the EA Reevaluation addresses the changes to the use of the Section 4(f) resources. Resources remain the same as discussed in the original EA.

4.2 Proposed Action

The project elements remain the same for the Revised Proposed Action. What have changed are some of the intersections, as described in Section 3.2, Traffic. This section addresses the updated ROW impacts and the effects on Section 4(f) resources. The Section 4(f) resources remain the same as those in the original Proposed Action.

4.3 Revised Proposed Action

4.3.1 Public Parks, Recreation Areas, Wildlife and Waterfowl Refuges

No public parks or recreation areas are present within the Federal Street corridor. The nearest public park is Taylor Park just east of Main Street. Also, no state or federal

wildlife or waterfowl refuges are present within the corridor. This determination remains the same for the Revised Proposed Action.

4.3.2 Archaeological Resources

The currently undeveloped and southernmost portion of the Federal Street corridor where the Nason Street Connector is proposed was identified during Project scoping as being archeologically sensitive. A Phase I Archeological Site Identification Survey performed in May and June, 2012 and supplemental field testing in July 2012 determined that no significant archeological resources are present within the APE for the Project. Accordingly, a determination of No Adverse Effect on archeological resources was made and therefore no archeological resources worthy of protection under Section 4(f) are present within the Federal Street corridor. This determination remains the same for the Revised Proposed Action.

4.3.3 Historic Resources

The Revised Proposed Action will require the acquisition of Right-of-Way from the following historic (Section 4(f)) resources including:

- Willard Furniture Manufacturing Company
- 163 Federal Street
- 174 Federal Street
- Central Vermont Railroad Headquarters Historic District
- St. Albans Historic District
- Federal/Lake/Catherine Street Intersection Historic District

The Revised Proposed Action will not require parking space acquisitions from the Giroux Furniture Company building property, as the original Proposed Action would for access to Market Street. The resources are described in detail in the original EA.

4.4 Use of Historic Resources

This section discusses the use of land from historic properties associated with the Proposed Action. Use of land from each individually listed or eligible property, as well as each of the contributing resources within each of the three affected districts, are presented in revised **Figures 4.4-1** through **4.4-8**. These drawings were produced by overlaying the proposed ROW and slope limits for the Revised Proposed Action onto the property or district boundaries to measure the area affected. All areas of new permanent ROW were included in impact calculations, including slope impacts in the relatively few occurrences where the permanent slope limits extend beyond the

permanent ROW. **Tables 4.4-1** through **4.4-4** compare the original Proposed Action to the Revised Proposed Action.

4.4.1 Central Vermont Railroad Headquarters District

Because of its large size, acquisition from the CVR Headquarters Historic District would occur in three of the five Project design segments.[4] Impacts to the District are summarized by segment in **Table 4.4-1** and shown on **Figures 4.4-1** through **4.4-3**.

Overall, permanent ROW impacts decrease considerably from the original to Revised Proposed Action (-67,634 sq. ft.), primarily as a result of the reduction in land acquisition in Segment 3, where a large parking lot was eliminated and also in Segment 2 where Allen Street was retained in its existing location and widened versus relocated westward onto Railroad property Slope impacts are somewhat higher for the Revised Proposed Action (+26,181 sq. ft.) since roadway improvements will match adjacent properties using easements to grade slopes onto property retained by the railroad or other private entities, particularly along the west side of Allen Street in Segment 2. Overall, the combined ROW and slope impacts in the CVRR Historic District are reduced by approximately 41,453 sq. ft., or 33 percent.

Table 4.4-1 Impacts to the Central Vermont Railroad Headquarters Historic District (ORIGINAL PROPOSED ACTION)

Segment	Permanent ROW Impacts (sq ft)	Slope Impacts (sq ft)
Segment 1 - Proposed Nason Street Connector (South Main St. to Nason St.)	0	0
Segment 2 - Lemnah Drive and Allen Street (Nason St. to Stowell St.)	20,877	4,155
Segment 3 - Allen / Catherine / Federal St. (Stowell St. to Kingman St.)	82,445	12,179
Segment 4 - Federal St. (Kingman St. to Lower Newton St.)	1,164	4,731
Segment 5 - Lower Newton St. (Federal St. to North Main St.)	0	0
Total	104,486	21,065

[4] For a definition of the five design segments, see **Section 2.4** of this EA.

Table 4.4-1A **Impacts to the Central Vermont Railroad Headquarters Historic District (REVISED PROPOSED ACTION)**

Segment	Permanent ROW Impacts (sq ft)	Slope Impacts (sq ft)
Segment 1 - Proposed Nason Street Connector (South Main St. to Nason St.)	0	0
Segment 2 - Lemnah Drive and Allen Street (Nason St. to Stowell St.)	24,388	32,771
Segment 3 - Allen / Catherine / Federal St. (Stowell St. to Kingman St.)	11,772	10,860
Segment 4 - Federal St. (Kingman St. to Lower Newton St.)	692	3,615
Segment 5 - Lower Newton St. (Federal St. to North Main St.)	0	0
Total	36,852	47,246

4.4.2 St. Albans Historic District

Because of its large size, acquisition from the St. Albans Historic District would occur in two of the five Project design segments for the original Proposed Action.[5] The Revised Proposed Action requires impacts in only one segment of the District, reducing impacts from a total of 2,824 sq. ft. for the original Proposed Action to 1,216 sq. ft. for the Revised Proposed Action, or more than 50 percent. The Impacts to the District are summarized by segment in **Table 4.4-2** and **Table 4.4-2A** and shown on **Figures 4.4-4** and **4.4-7**.

Table 4.4-2 **Impacts to the St. Albans Historic District (ORIGINAL PROPOSED ACTION)**

Segment	Permanent ROW Impacts (sq ft)	Slope Impacts (sq ft)
Segment 1 - Proposed Nason Street Connector (South Main St. to Nason St.)	0	0
Segment 2 - Lemnah Drive and Allen Street (Nason St. to Stowell St.)	0	0
Segment 3 - Allen / Catherine / Federal St. (Stowell St. to Kingman St.)	0	2,324
Segment 4 - Federal St. (Kingman St. to Lower Newton St.)	0	500
Segment 5 - Lower Newton St. (Federal St. to North Main St.)	0	0
Total	0	2,824

[5] For a definition of the five design segments, see **Section 2.4** of this EA.

Table 4.4-2A **Impacts to the St. Albans Historic District (REVISED PROPOSED ACTION)**

Segment	Permanent ROW Impacts (sq ft)	Slope Impacts (sq ft)
Segment 1 - Proposed Nason Street Connector (South Main St. to Nason St.)	0	0
Segment 2 - Lemnah Drive and Allen Street (Nason St. to Stowell St.)	0	0
Segment 3 - Allen / Catherine / Federal St. (Stowell St. to Kingman St.)	0	1,216
Segment 4 - Federal St. (Kingman St. to Lower Newton St.)	0	0
Segment 5 - Lower Newton St. (Federal St. to North Main St.)	0	0
Total	0	1,216

4.4.3 Giroux Furniture Company Building

The original Proposed Action required land acquisition from the Giroux Furniture Company Building Parcel, however, the Revised Proposed Action does not require any acquisitions or impacts. The impacts to the property are summarized by segment in **Table 4.4-3** and **Table 4.4-3A** and shown on **Figures 4.4-6** and **4.4-7**.

Table 4.4-3 **Impacts to the Giroux Furniture Company Building Parcel (ORIGINAL PROPOSED ACTION)**

	ROW Impacts (sq ft)	Slope Impacts (sq ft)	Requires Demolition of Giroux Bldg
Proposed Action	636	6,597	No

Table 4.4-3A **Impacts to the Giroux Furniture Company Building Parcel (REVISED PROPOSED ACTION)**

	ROW Impacts (sq ft)	Slope Impacts (sq ft)	Requires Demolition of Giroux Bldg
Revised Proposed Action	0	0	No

4.4.4 Willard Manufacturing Company Building Parcel

The original Proposed Action did not require land acquisition, however, the Revised Proposed Action requires property acquisition for the construction of a smooth transition from Allen Street to Catherine Street and the construction of the Allen/Catherine/ Stebbins/Market Street intersection. The acquisition requires some green space from the northwest corner of the property. While this land is associated with the building, it does not include any character defining features whose lose would damage the historic integrity of the building. The acquisition will not affect the building, and this results in a No Adverse Effect to the building parcel. The impacts to the property are summarized by segment in **Table 4.4-4** and **Table 4.4-4A** and shown on **Figure 4.4-5**.

Table 4.4-4 Impacts to the Willard Manufacturing Company Building Parcel (ORIGINAL PROPOSED ACTION)

	ROW Impacts (sq ft)	Slope Impacts (sq ft)	Requires Demolition of Willard Bldg
Proposed Action	0	0	No

Table 4.4-4A Impacts to the Willard Manufacturing Company Building Parcel (REVISED PROPOSED ACTION)

	ROW Impacts (sq ft)	Slope Impacts (sq ft)	Requires Demolition of Willard Bldg
Revised Proposed Action	2,911	1,422	No

4.4.5 Federal/Lake/Catherine Streets Intersection Historic District

This Historic District is not yet listed in the National Register, but was determined eligible by the VTrans Historic Preservation Officer during Section 106 consultations for this Project. The entire District, which consists of four properties on the corners of the intersection of Federal, Lake and Catherine Streets, lies within either the CVR Headquarters Historic District or the St. Albans Historic District, use of which is discussed in the preceding sections. Use of land from this eligible Historic District is shown in **Figure 4.4-4**.

4.4.6 163 Federal Street

The Proposed Action would not result in any permanent incorporation of land from the National Register eligible property at 163 Federal Street and therefore no use of a Section 4(f) resource. This is identical to the findings for the original Proposed Action.

4.4.7 174 Federal Street

The Proposed Action would make no changes to this National Register eligible property and therefore there would be no use of a Section 4(f) resource. This is identical to the findings for the original Proposed Action.

4.5 Section 4(f) De Minimis Determination

The Revised Proposed Action results in a change to ROW impacts, the overall Determination of Effect (DOE) remains No Adverse Effects, and the Section 4(f) De Minimis Determination still applies, identical to that of the original Proposed Action.

4.6 Measures to Minimize Harm

Based on coordination with the VTrans Historic Preservation Officer and the VTrans Archeology Officer, it has been determined that the Project will have no adverse effect on above-ground historic properties and no adverse effect on archeological resources that meet the Section 4(f) provisions of preservation in place. The finding is that there is only a *de minimis* effect on historic properties. The Determination of Effect and the conditions outlined in the Original Proposed Action (Appendix J of the EA) still apply for the Revised Proposed Action.

4.7 Coordination

Coordination and consultations among federal, state, and local agencies with jurisdiction over historic properties has occurred both prior to and during the preparation of the EA. No additional coordination has occurred since the issuance of the FONSI and Section 4(f) De Minimis determination.

4.8 Conclusion

The Proposed Action involves *de minimis* impacts to three of the seven Section 4(f) resources determined to be present within the Study area:

- Central Vermont Railroad Headquarters Historic District – Listed
- Federal/Lake/Catherine Streets Intersection Historic District – Determined Eligible
- Willard Manufacturing Company Building Parcel – Listed

No public parks, recreation areas, wildlife or waterfowl refuges are present within the Project corridor. No archeological sites that are eligible for protection under Section 4(f) are present within the Project corridor.

Impacts to Section 4(f) resources are restricted to ROW impacts and impacts caused by regrading within the Project slope limits where such regrading extends beyond the ROW. Measures to minimize harm include the conditions imposed by the VTrans Historic Preservation Officer as well as Project mitigation and commitments as described in the EA, which include measures to minimize construction related impacts.

5

Agency Coordination / Participation

5.1 Summary

There has been no new Agency coordination since the issuance of the FONSI.

Figures

Revised Intersection Designs

2.2-1 Revised concept for Nason St / Nason Street Connector & Lemnah Drive concept

2.3-1 Options matrix for Lower Welden Street & Lemnah Drive/Allen Street Intersection

2.3-2 Revised Mini Roundabout for the Lower Welden Street & Lemnah Drive/Allen Street concept

2.4-1 Revised Lake Street & Federal Street / Catherine Street concept

2.5-1 Revised Stebbins Street/Market Street & Allen Street / Catherine Street concept

Traffic network update

3-1 2010 AM Peak Hour Volumes, Net Difference

3-2 2010 PM Peak Hour Volumes, Net difference

3-3 2030 AM Peak Hour Volume

3-4 2030 PM Peak Hour Volumes, Net difference

3-5 2010 AM Peak Hour Volumes, Updated Proposed Action

3-6 2010 PM Peak Hour Volumes, Updated Proposed Action

3-7 2030 AM Peak Hour Volume, Updated Proposed Action

3-8 2030 PM Peak Hour Volumes, Updated Proposed Action

Revised Impacts

3.3-1 Wetlands Impacts

4.4-1 4(f) impacts

4.4-2 4(f) impacts

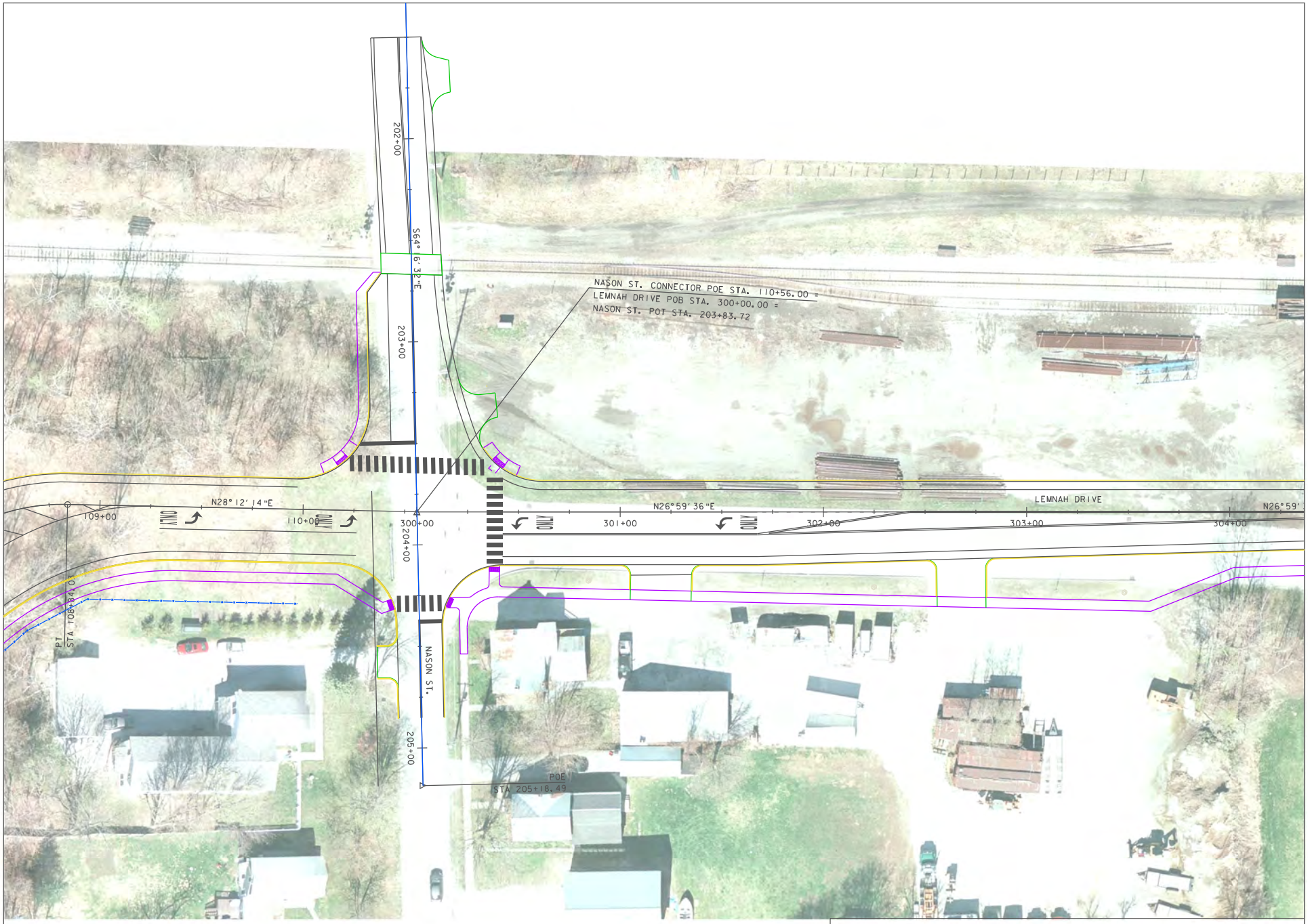
4.4-3 4(f) Impacts

4.4-4 4(f) Impacts

4.4-5 4(f) Impacts

4.4-6 4(f) Impacts

4.4-7 4(f) Impacts



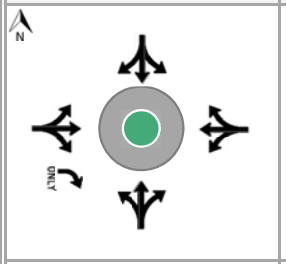
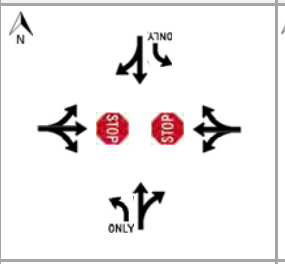
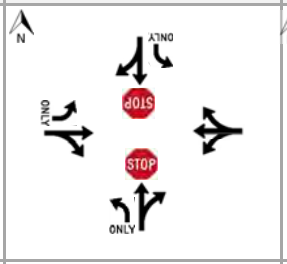
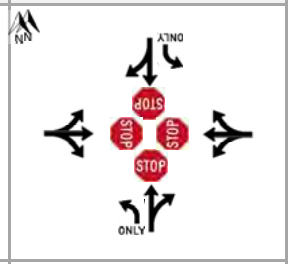
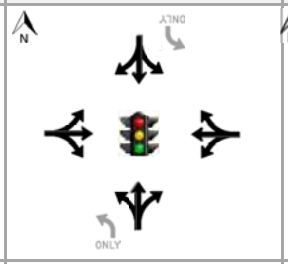
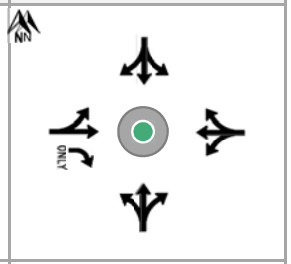
FEDERAL STREET MULTIMODAL CONNECTOR

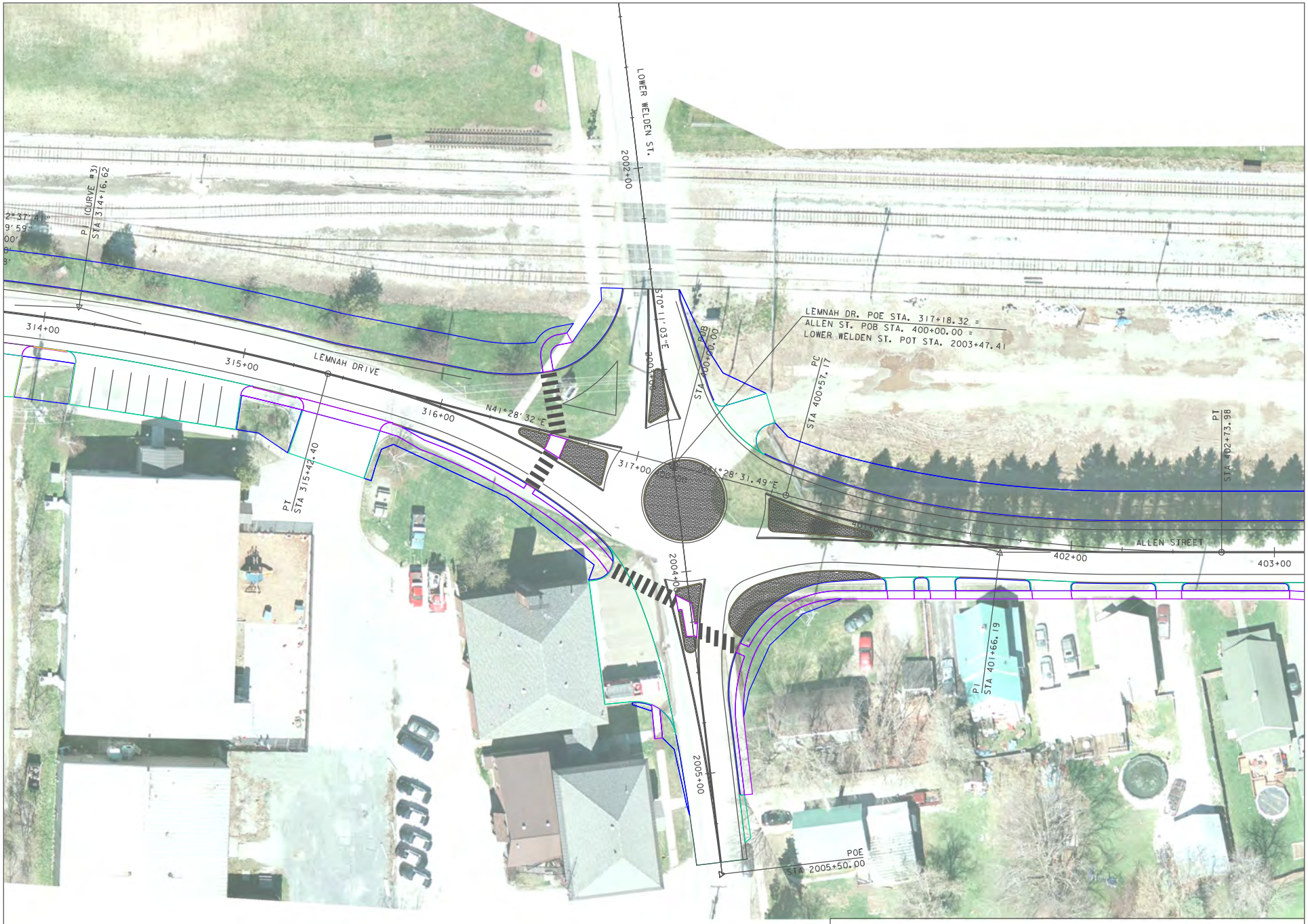
FIGURE 2.2-1

Figure 2.3-1

Lemnah Drive / Allen Street / Lower Welden Street

Intersection Alternatives

	Original Proposed Action	New Action Alternatives				Revised Proposed Action
Metric	**Roundabout**	**1A: Two-Way Stop**	**1B: Two-Way Stop**	**2: All-Way Stop**	**3: Traffic Signal**	**4: Mini-Roundabout**
Geometric Configuration						
Level of Service *2030 PM Peak*	LOS **A/B**	LOS **F** *(Minor approaches)*	LOS **F** *(Minor approaches)*	LOS **D/E**	LOS **C** w/ LT lanes LOS **D** no LT lanes	LOS **B**
Notes *Advantage* *Disadvantage*	● Best overall traffic operations ●Queues may extend into roundabout during train crossing ● Difficult to accommodate fifth intersection approach ● Increased ROW & railroad impacts ● Need to widen road across 4 railroad tracks	● 95th percentile queue on EB approach extends through RR crossing ● Queues block access to Mylan, gas station, Houghton St ● Northbound left turn lane requires relocation of daycare parking	● Queues do not block RR crossing or Mylan driveway ● Orientation of stop signs counter to goal of promoting north/south movement in City ● ROW impacts from left turn lanes on NB, SB, and EB approaches ● Northbound left turn lane requires relocation of daycare parking	● 95th percentile queue on EB approach extends through RR crossing ● Queues block access to Mylan ● Northbound left turn lane requires relocation of daycare parking	● Signal can better accommodate regular pulses of traffic ● EB approach STOP bar ~200' away from signal. ● Access issues from Mylan Drive to EB stop bar. ● Projected volumes do not meet peak hour signal warrant. ● Annual operating costs	● Second best traffic operations ● Smaller footprint than full roundabout ● Footprint moved west (compared to full roundabout) to minimize RR impacts.
Construction Cost *Over single lane base intersection improvements*	*Not estimated due to extent of ROW impacts*	$140,000 *(left turn lanes)*	$130,000 *(left turn lanes)*	$140,000 *(left turn lanes)*	$125,000 *(signal only)* $265,000 *(signal + turn lanes)*	$90,000 *(minor widening + islands)*



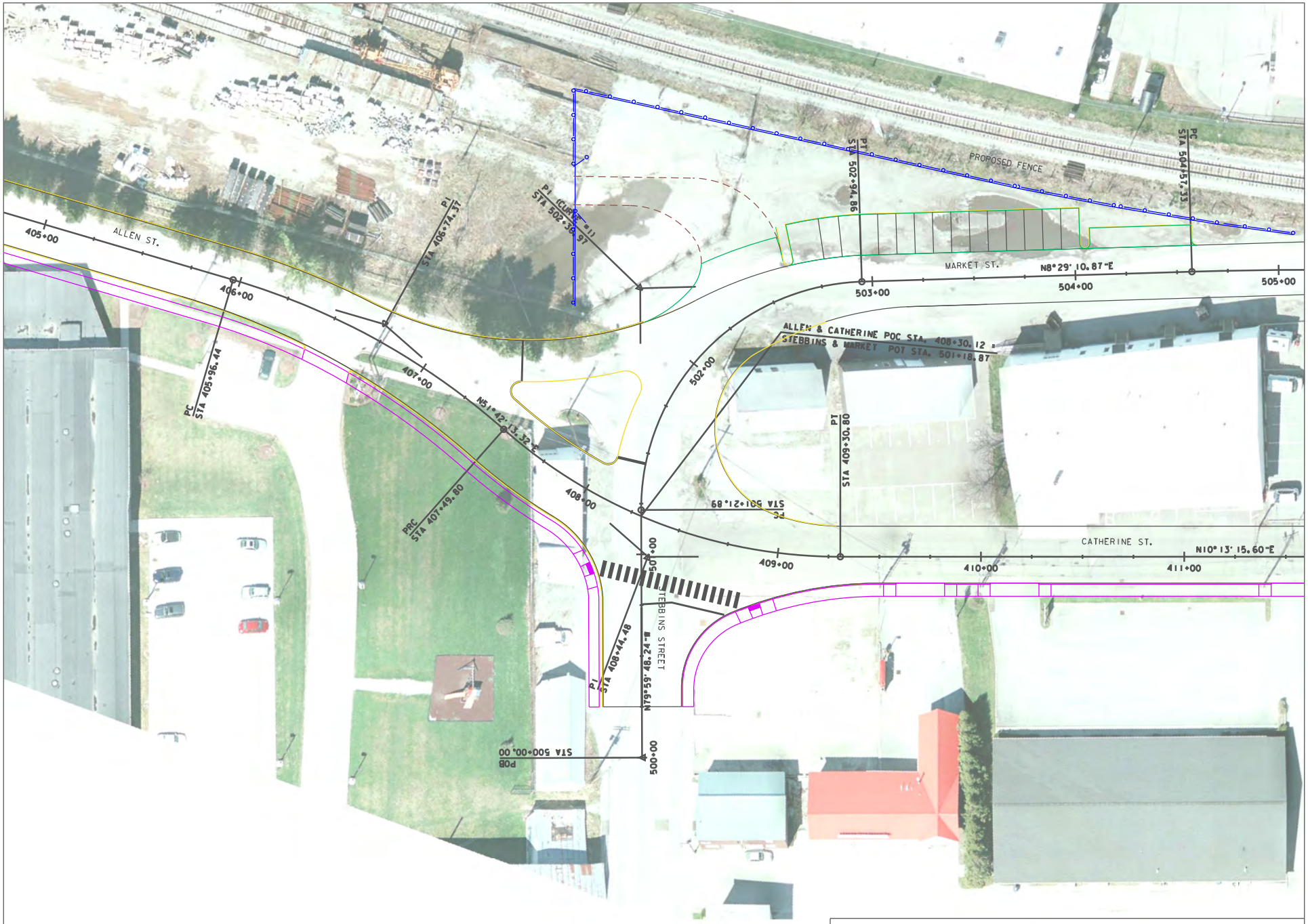
FEDERAL STREET MULTIMODAL CONNECTOR

FIGURE 2.3-2

FEDERAL STREET MULTIMODAL CONNECTOR

vhb

FIGURE 2.4-1



FEDERAL STREET MULTIMODAL CONNECTOR

FIGURE 2.5-1

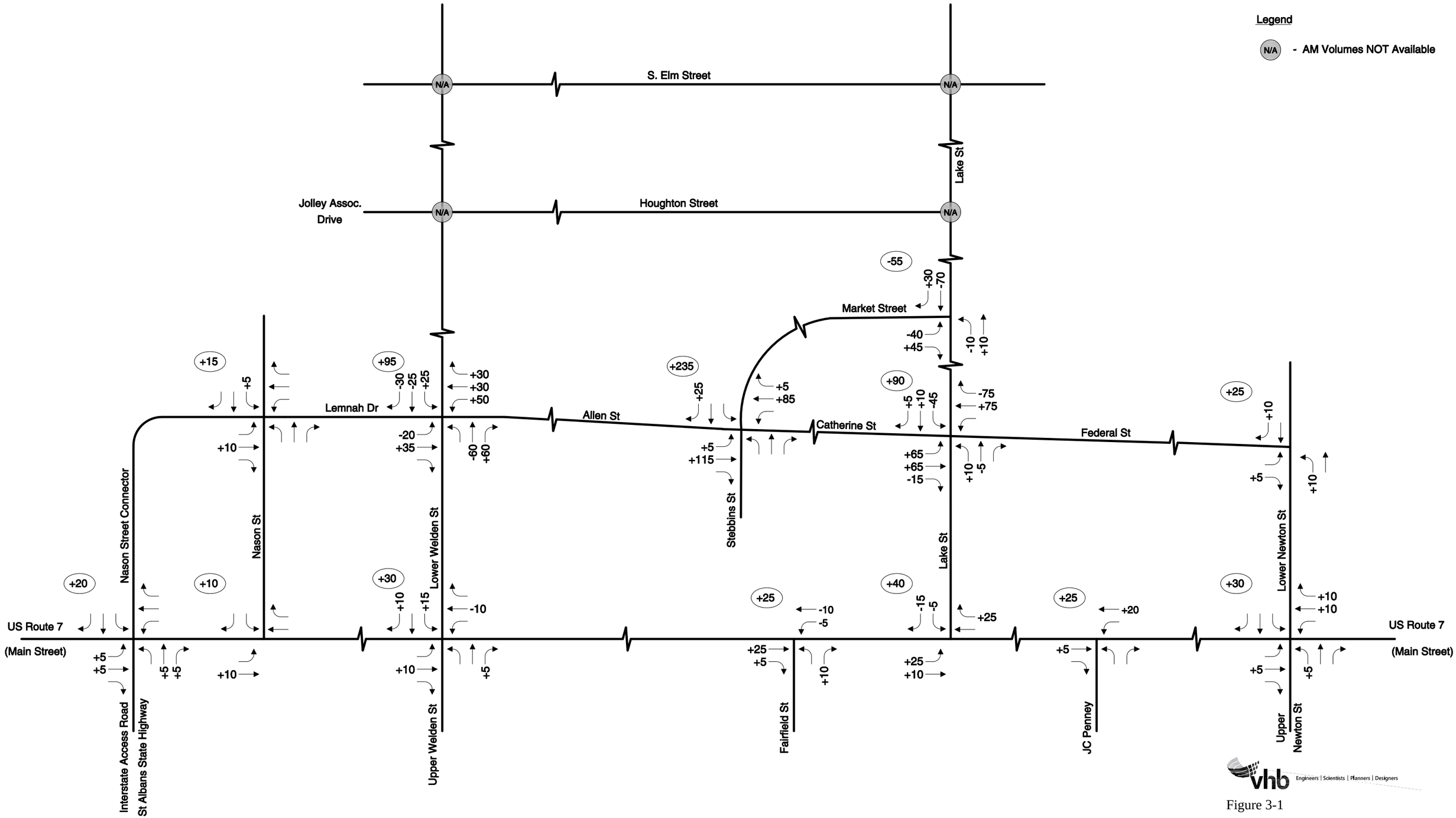


Figure 3-1
2010 AM Peak Hour Volumes
Net Difference
EA Reevaluation

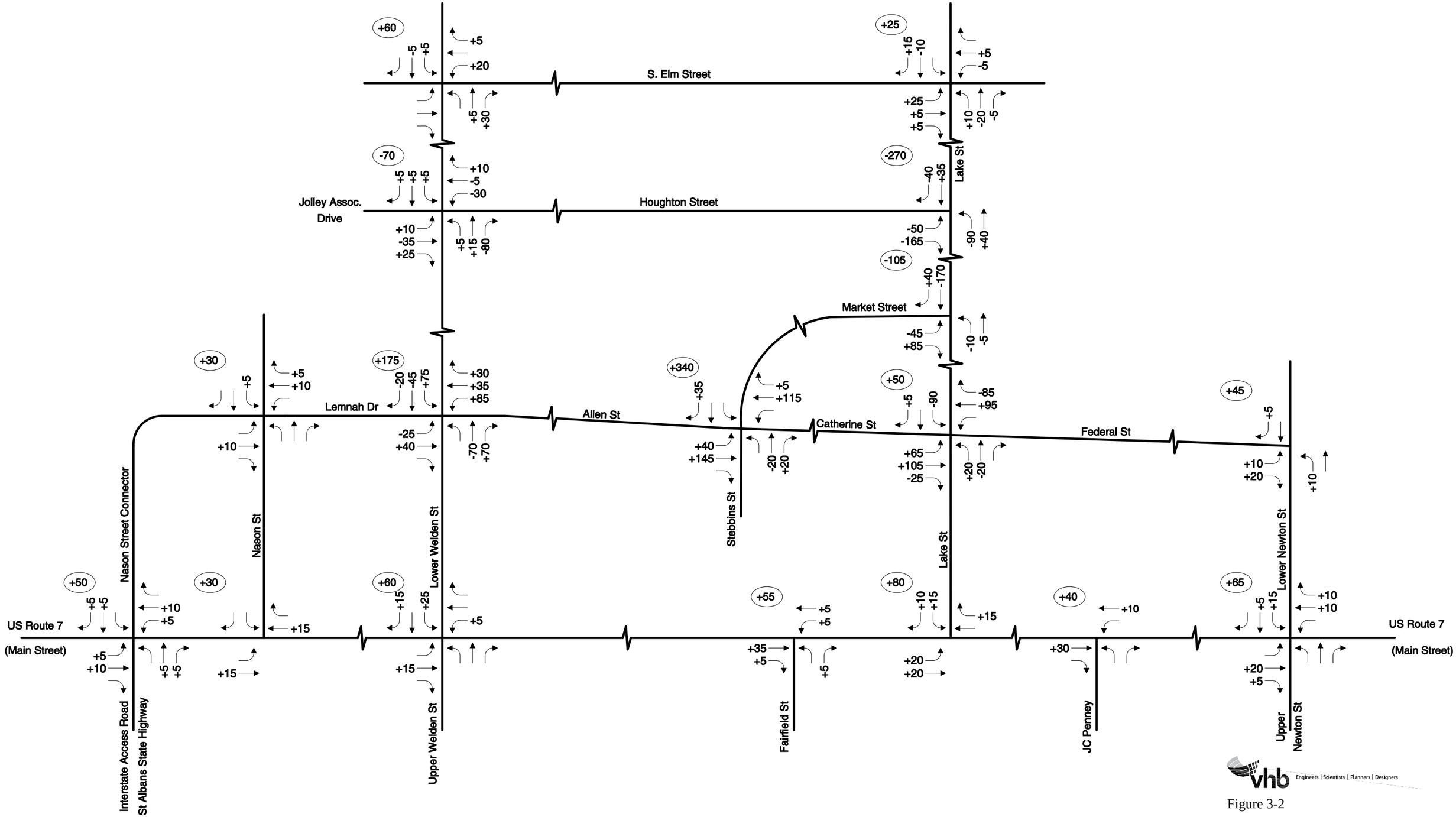


Figure 3-2

2010 PM Peak Hour Volumes
Net Difference
EA Reevaluation

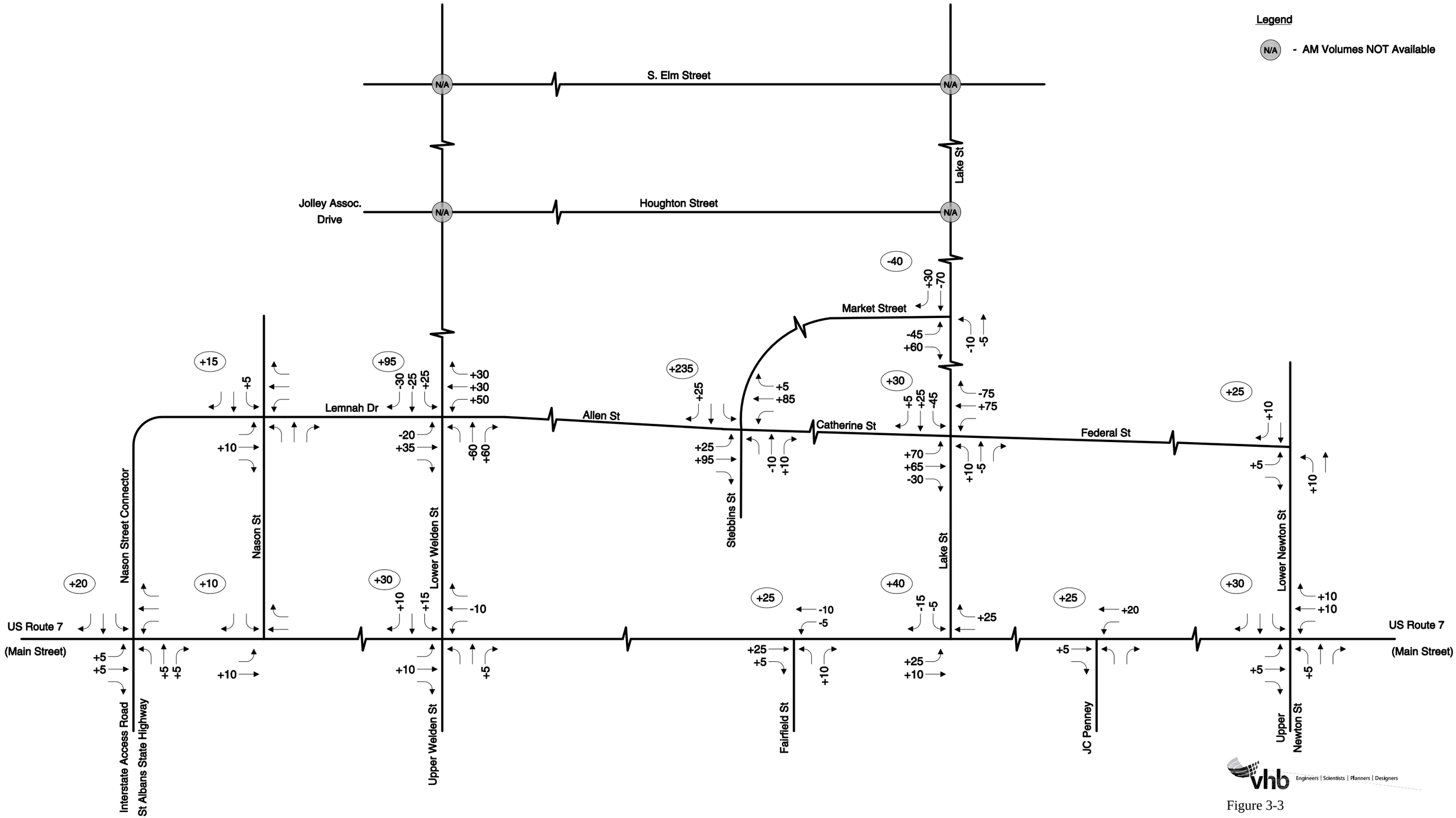


Figure 3-3
2030 AM Peak Hour Volumes
Net Difference
EA Reevaluation

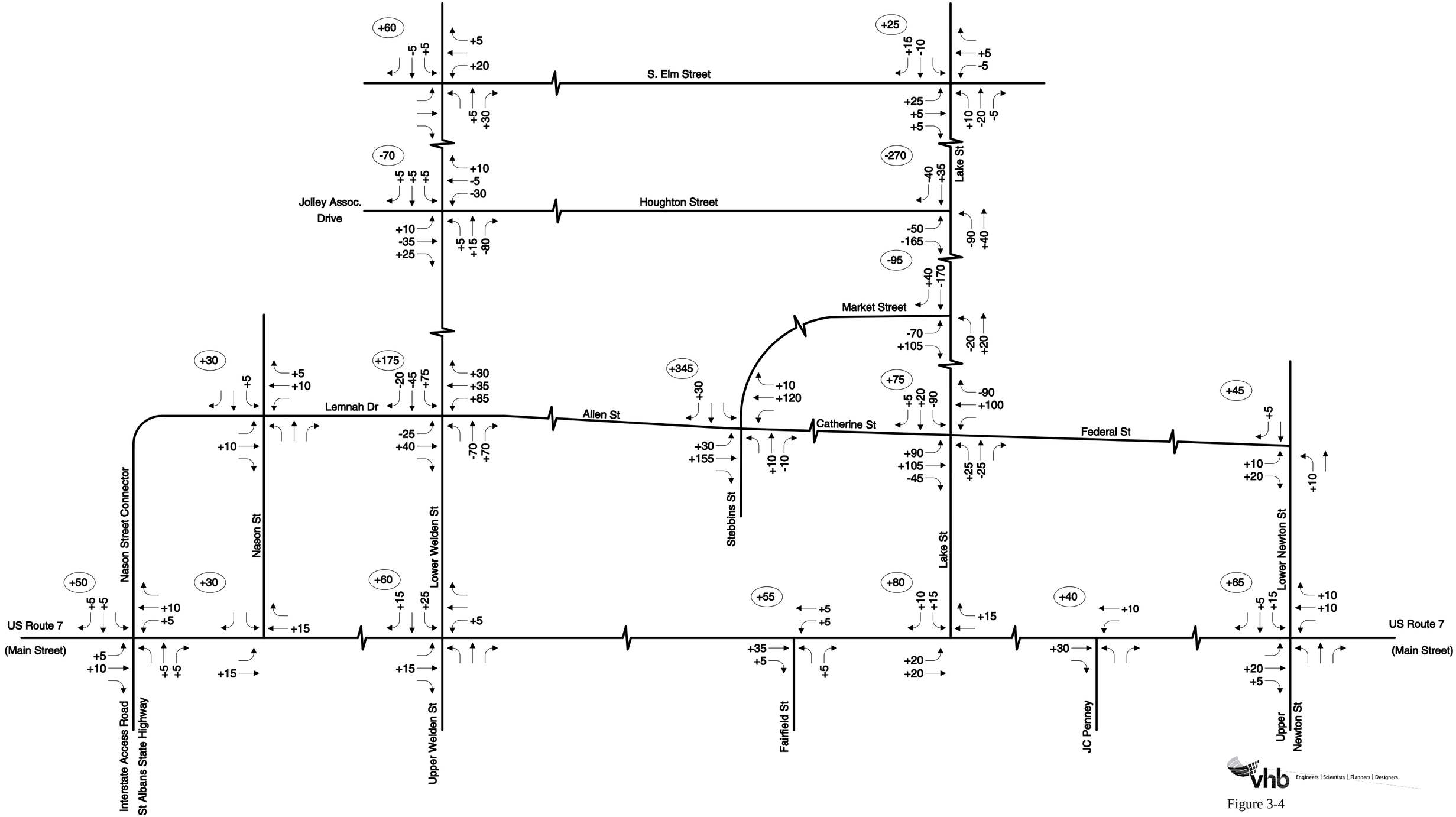


Figure 3-4

2030 PM Peak Hour Volumes
Net Difference
EA Reevaluation

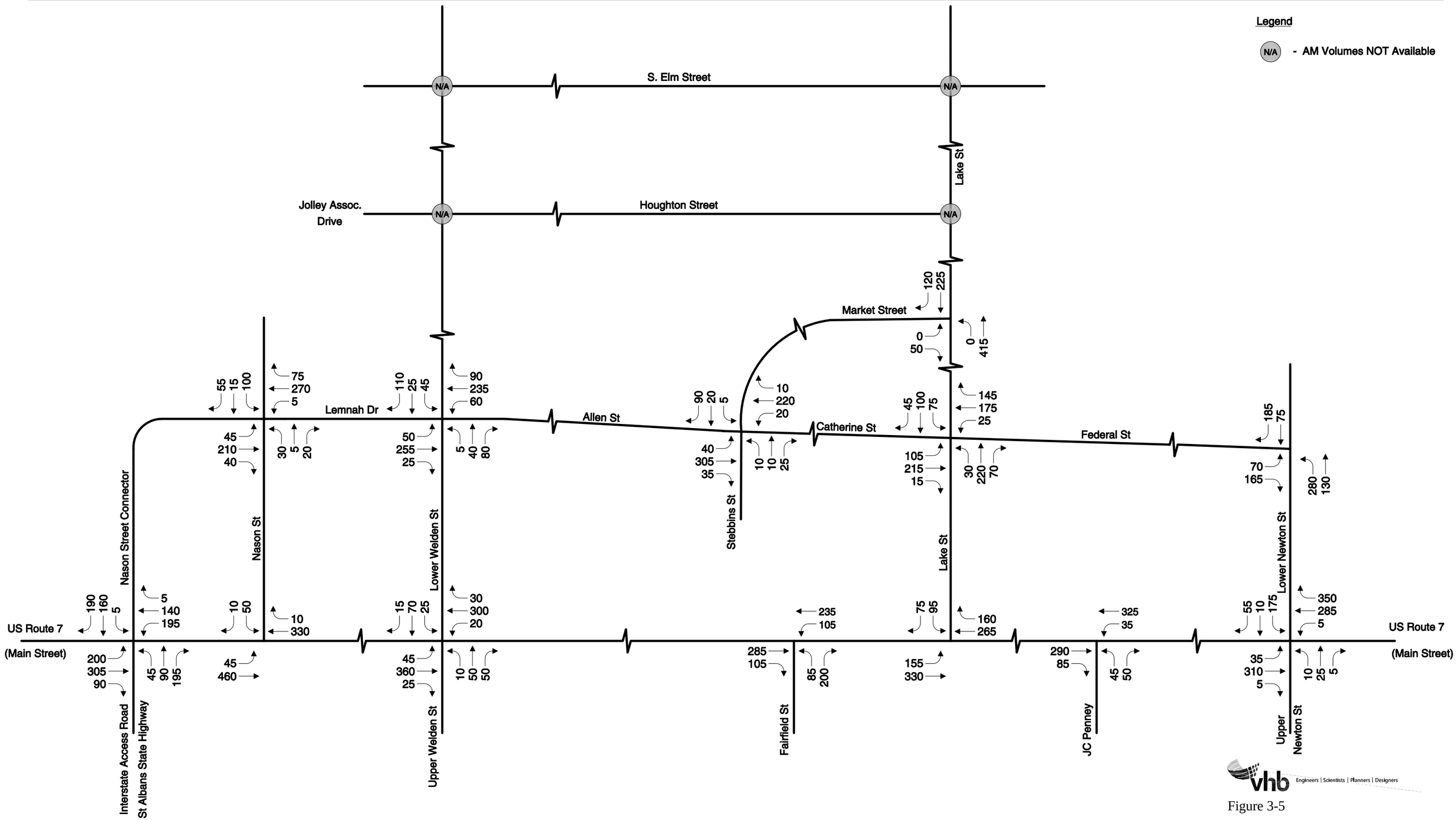


Figure 3-5

2010 AM Peak Hour Volumes
Updated Proposed Action
EA Reevaluation

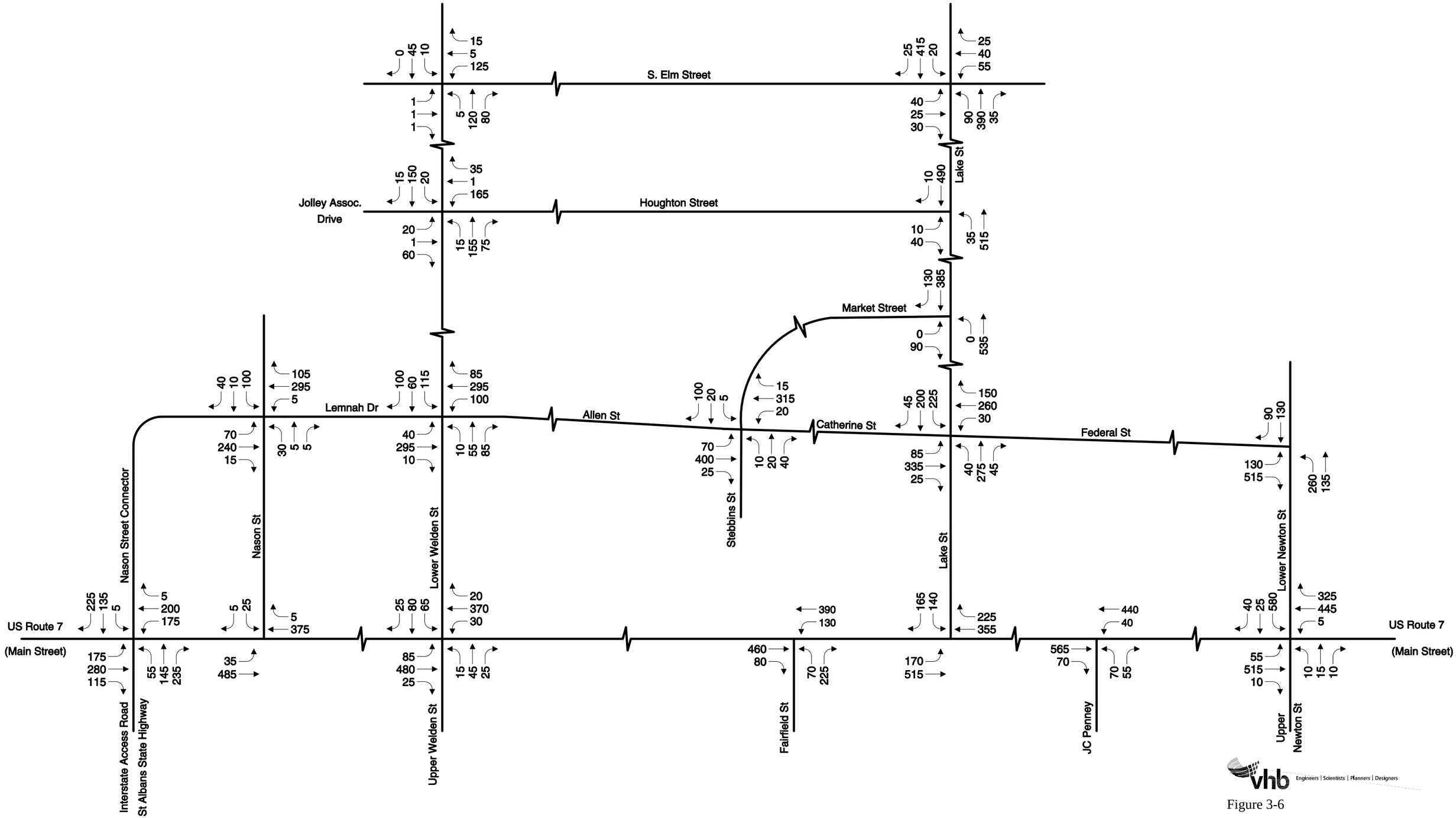


Figure 3-6

2010 PM Peak Hour Volumes
Updated Proposed Action
EA Reevaluation

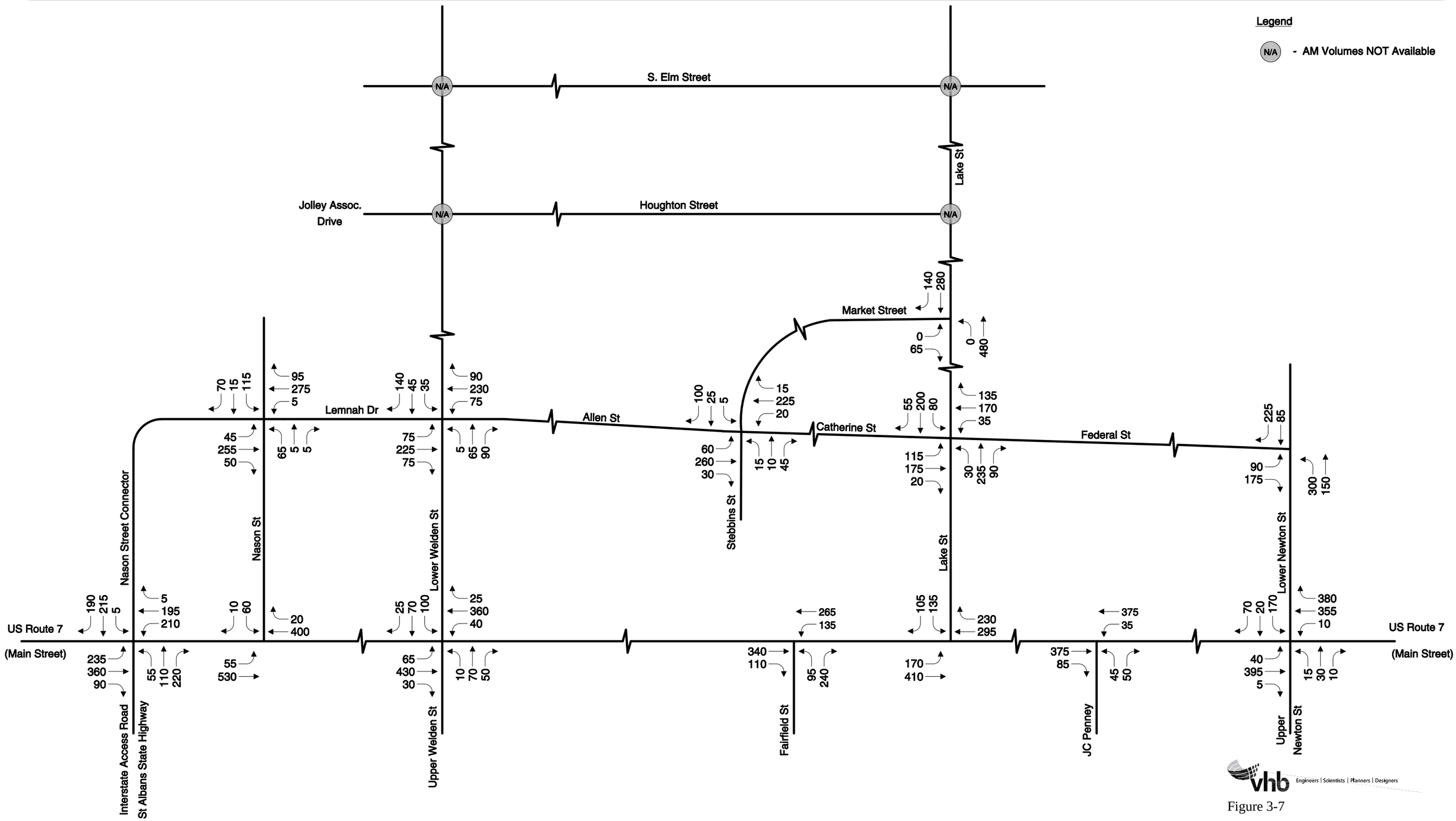


Figure 3-7

2030 AM Peak Hour Volumes
Updated Proposed Action
EA Reevaluation

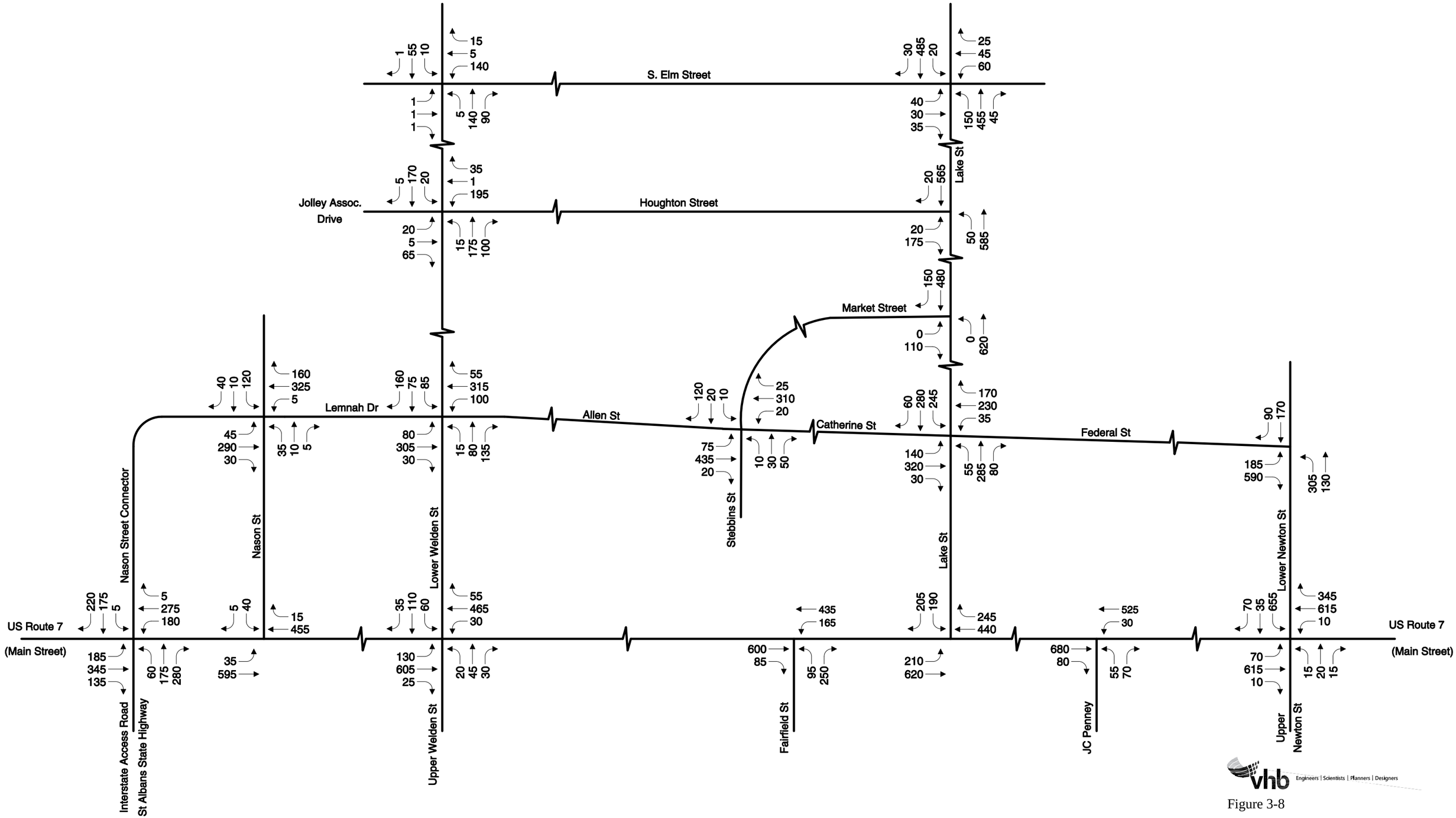
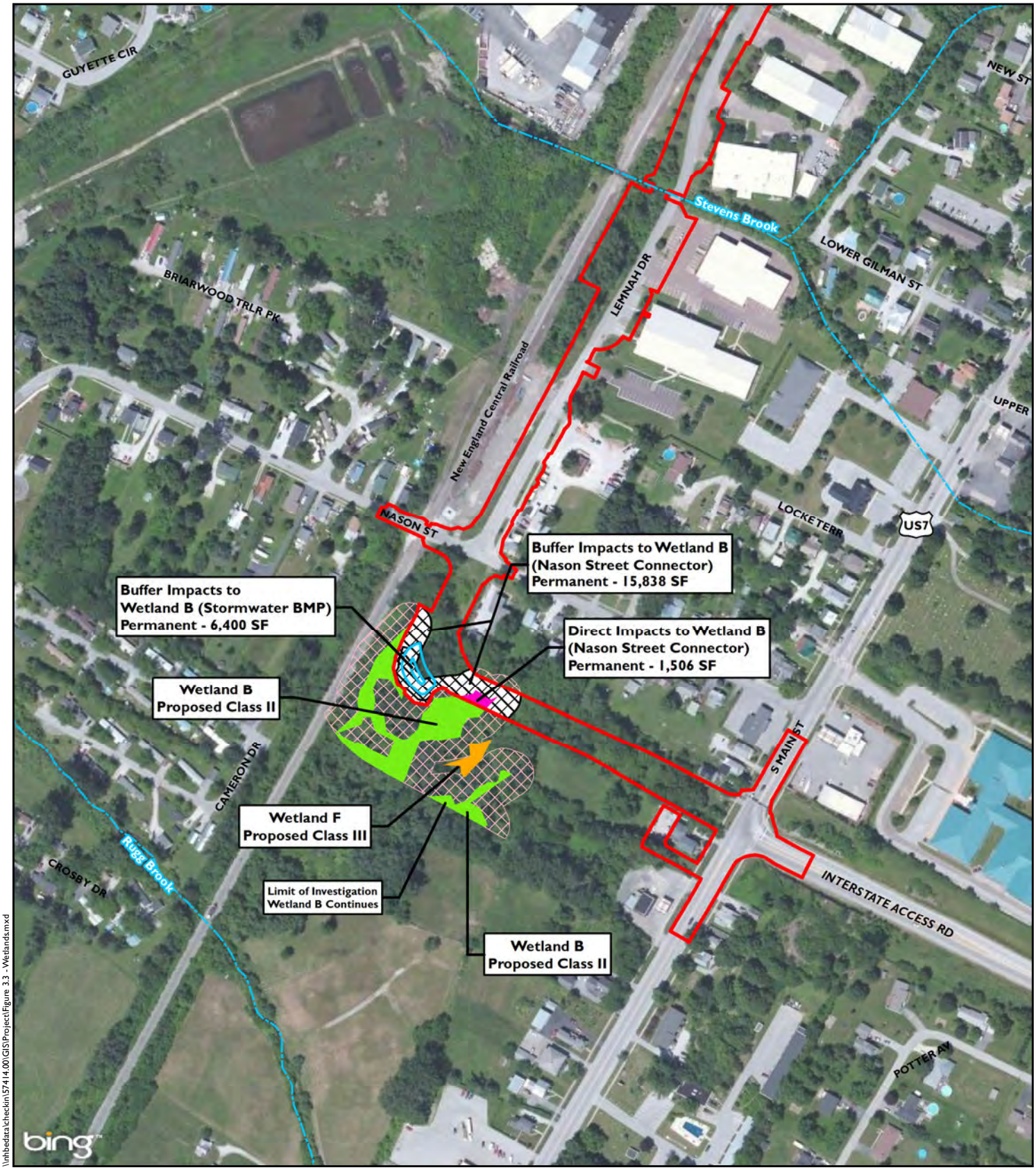


Figure 3-8

2030 PM Peak Hour Volumes
Updated Proposed Action
EA Reevaluation

Not to Scale



\\hbdata\checkin\57414.00\GIS\Project\Figure 3.3 - Wetlands.mxd

Legend

- Proposed Action Project Footprint
- Proposed Stormwater BMP
- Delineated Wetland (VHB)
- Proposed Class II (VHB)
- Proposed Class III (VHB)
- Stream (VHD)
- Wetland Impact Area
- Wetland Buffer Impact
- Class II Wetland Buffer

0 300 600Feet

VHB Vanasse Hangen Brustlin, Inc.

Figure #3.3-1 - Wetlands Map
Federal Street Multimodal Connector
City of St. Albans, Vermont

LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- CENTRAL VERMONT RAILROAD HEADQUARTERS HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

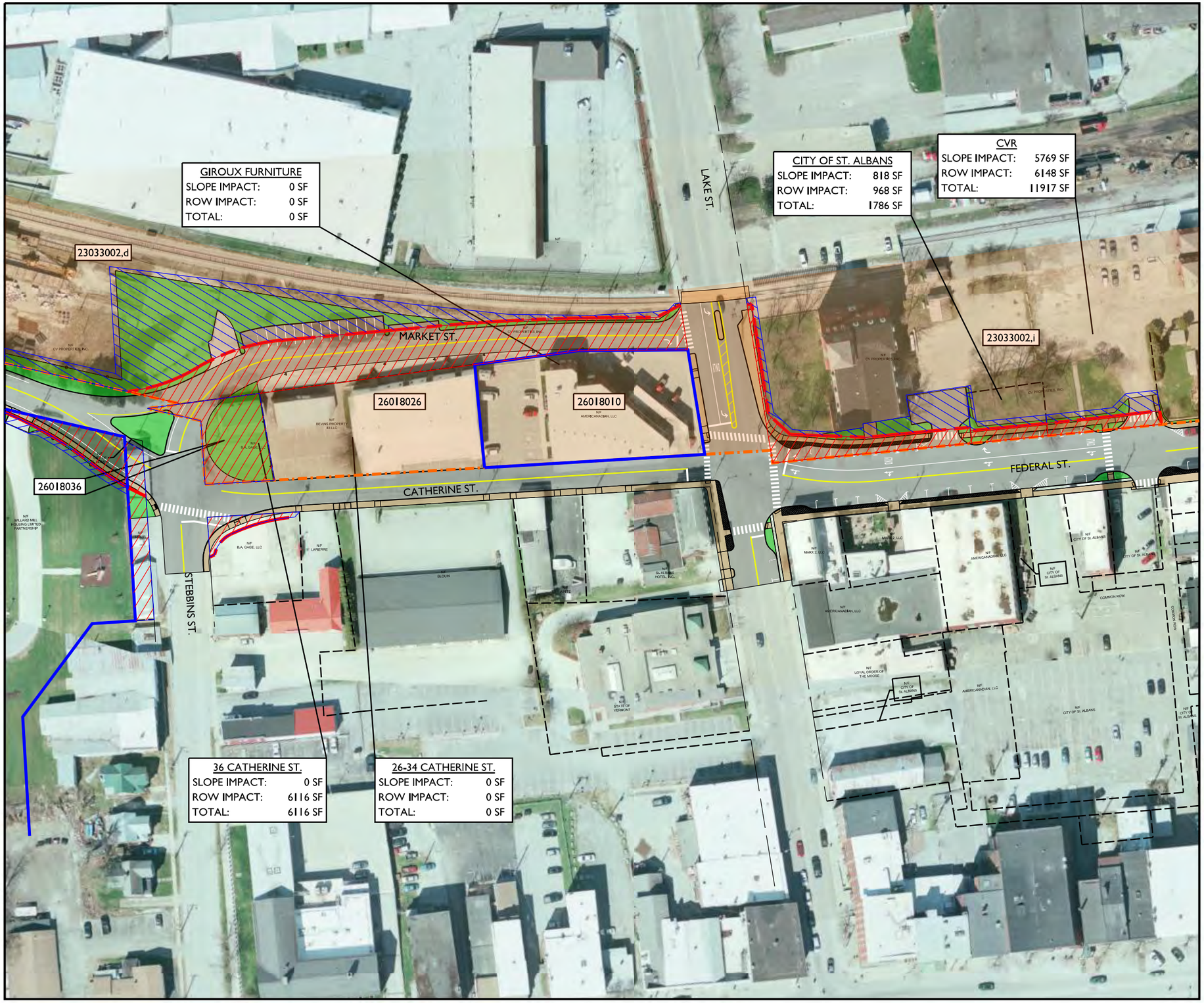
N
VT STATE PLANE GRID

0 100 200 Feet

VHB *Vanasse Hangen Brustlin, Inc.*

Figure #4.4-1
Section 4(f) Impacts
Federal Street Multimodal Connector
Central Vermont Railroad Headquarters Historic District
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.



LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- CENTRAL VERMONT RAILROAD HEADQUARTERS HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

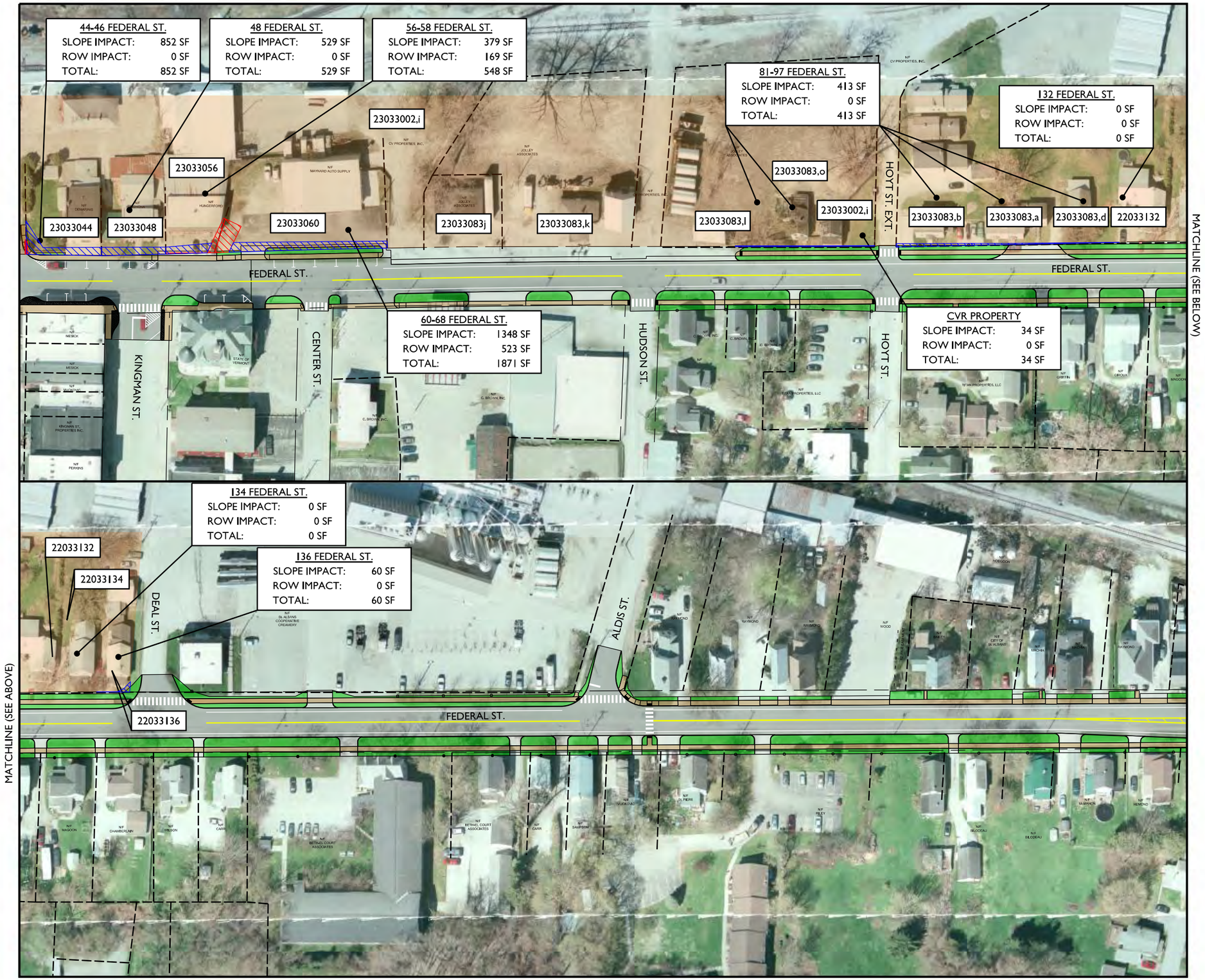
N
VT STATE PLANE GRID

0 100 200 Feet

VHB Vanasse Hangen Brustlin, Inc.

Figure #4.4-2
Section 4(f) Impacts
Federal Street Multimodal Connector
Central Vermont Railroad Headquarters Historic District
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.



LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- CENTRAL VERMONT RAILROAD HEADQUARTERS HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

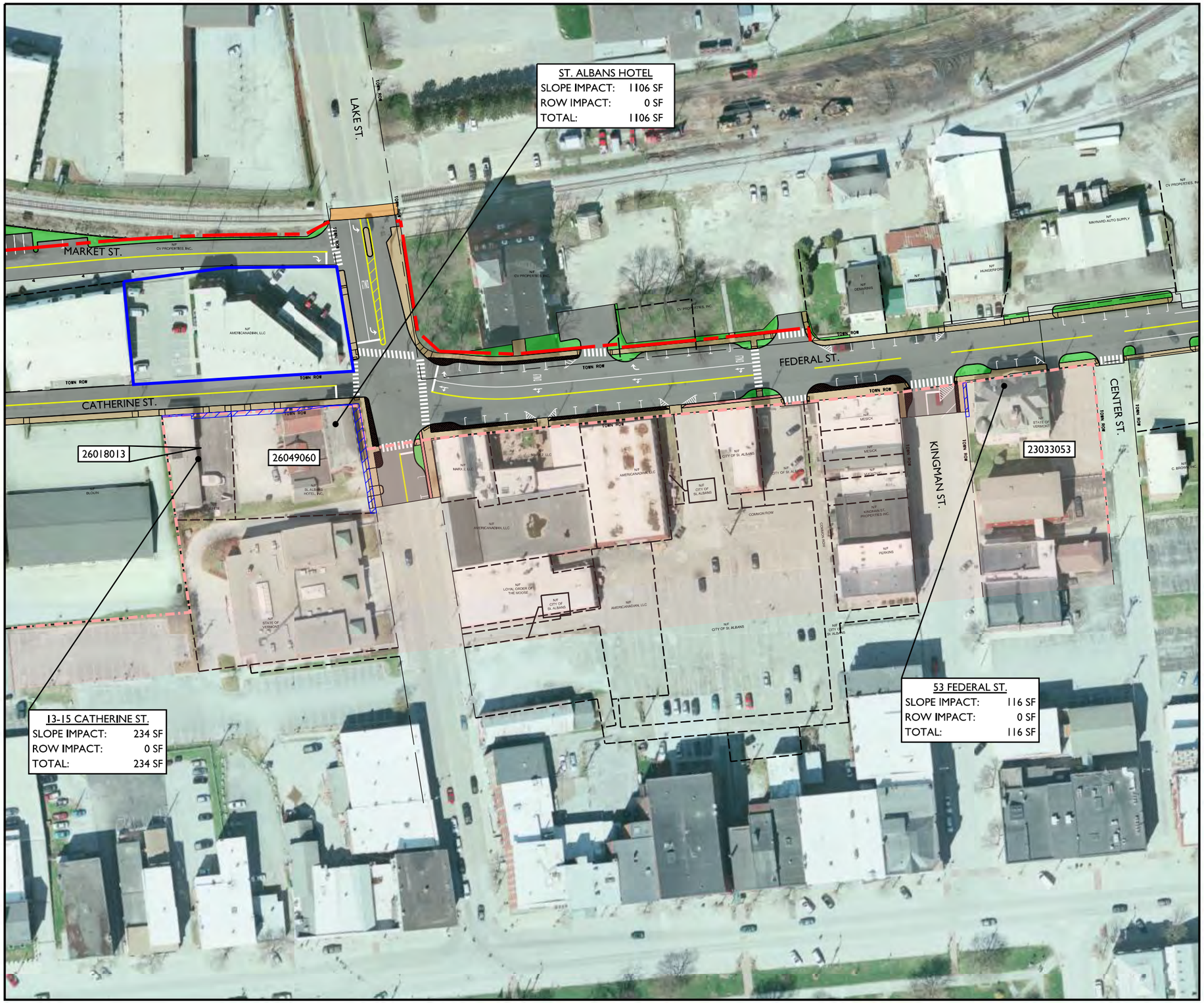
N
VT STATE PLANE GRID

0 100 200 Feet

VHB *Vanasse Hangen Brustlin, Inc.*

Figure #4.4-3
Section 4(f) Impacts
Federal Street Multimodal Connector
Central Vermont Railroad Headquarters Historic District
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.



LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- SAINT ALBANS HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

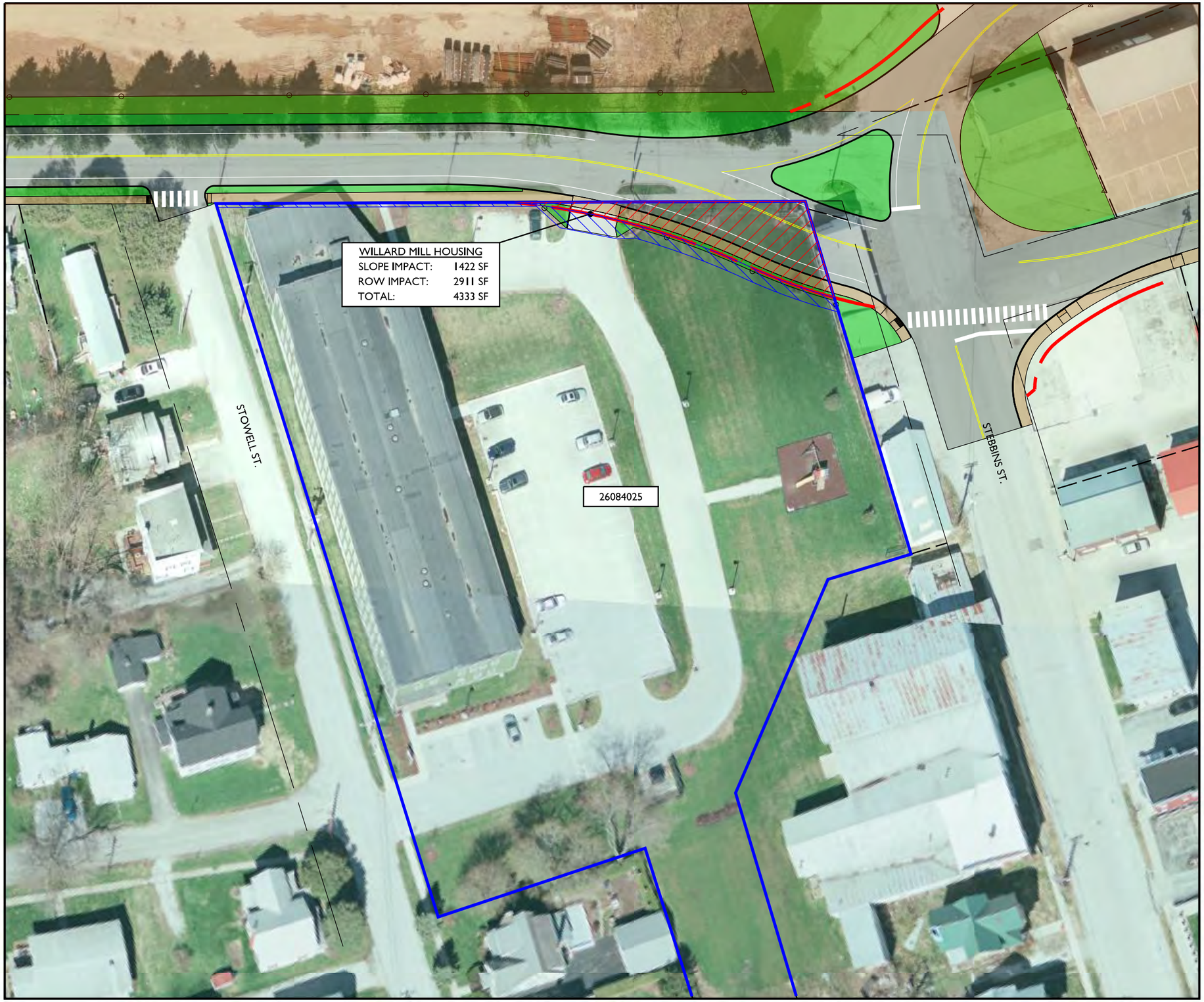
N
VT STATE PLANE GRID

0 100 200 Feet

VHB Vanasse Hangen Brustlin, Inc.

Figure #4.4-4
Section 4(f) Impacts
Federal Street Multimodal Connector
Saint Albans Historic District
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.



LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- CENTRAL VERMONT HEADQUARTERS RAILROAD HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

N

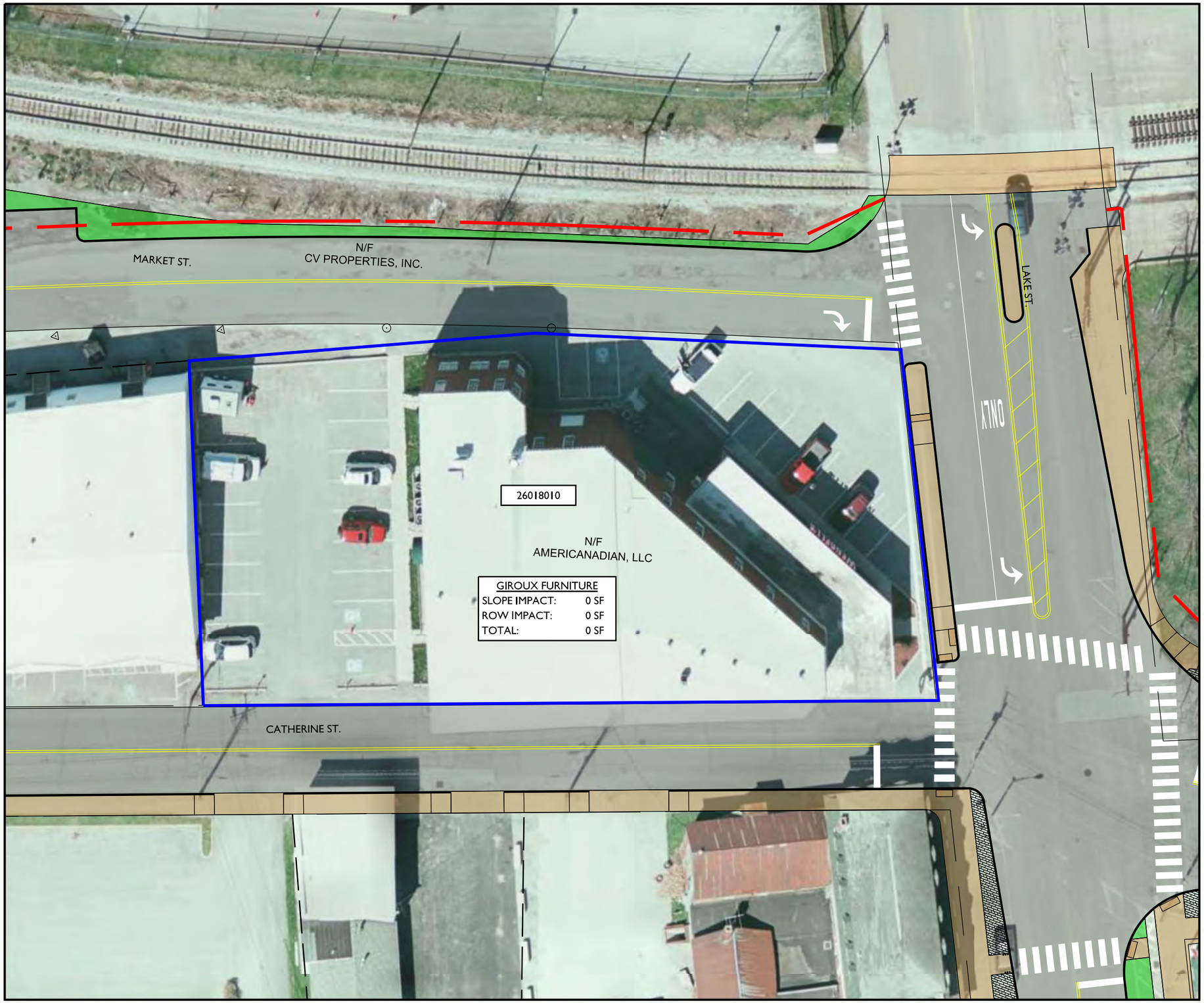
VT STATE PLANE GRID

0 50 100 Feet

VHB Vanasse Hangen Brustlin, Inc.

Figure #4.4-5
Section 4(f) Impacts
Federal Street Multimodal Connector
Willard Manufacturing Company Building
25 Stowell Street (Property ID: 26084025)
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.



LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- CENTRAL VERMONT HEADQUARTERS RAILROAD HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

N

VT STATE PLANE GRID

0 30 60 Feet

VHB Vanasse Hangen Brustlin, Inc.

Figure #4.4-6
Section 4(f) Impacts
Federal Street Multimodal Connector
Giroux Furniture Company Building
10-18 Catherine Street (Property ID: 26018010)
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.

LEGEND

- EXISTING PROPERTY LINES
- EXISTING R.O.W.
- INDIVIDUAL HISTORIC PROPERTY (LISTED OR ELIGIBLE FOR LISTING)
- FEDERAL / LAKE / CATHERINE STREETS INTERSECTION HISTORIC DISTRICT BOUNDARY
- PROPOSED R.O.W.
- SLOPE IMPACTS
- ROW IMPACTS
- ### PROPERTY ID #
- PROPOSED SLOPE WORK
- PROPOSED PAVEMENT
- PROPOSED SIDEWALK
- PROPOSED PAVED DRIVEWAY
- PROPOSED BUILDING DEMOLITION

N

VT STATE PLANE GRID

0 50 100 Feet

VHB *Vanasse Hangen Brustlin, Inc.*

Figure #4.4-7
Section 4(f) Impacts
Federal Street Multimodal Connector
Federal / Lake / Catherine Streets Intersection Historic District
City of St. Albans, VT

NOTE: BASE MAP PHOTOGRAPHY IS NOT ORTHOCORRECTED AND IS THEREFORE SUBJECT TO DISTORTION AND NOT A TRUE REPRESENTATION OF HORIZONTAL POSITION. IT IS INCLUDED TO PROVIDE ADDITIONAL INFORMATION FOR THE REVIEWER.

Tables

3.2-1 Signalized Intersection Capacity Analysis Summary
3.2-2 Unsignalized Intersection Capacity Analysis Summary
3.2-3 Roundabout Capacity Analysis Summary - Lower Welden Street at Lemnah Drive / Allen Street

Table 3.2-1
Signalized Intersection Capacity Analysis Summary

		2010 Build			2030 Build		
		v/c*	Delay**	LOS***	v/c	Delay	LOS
Lower Welden St at Lemnah Dr / Allen St (w/o left-turn lanes)	AM Peak	0.54	32	C	0.69	41	D
	PM Peak	0.75	39	D	0.83	51	D
Lower Welden St at Lemnah Dr / Allen St (with left-turn lanes)	*AM Peak*	*0.38*	*29*	*C*	*0.47*	*30*	*C*
	PM Peak	*0.47*	*31*	*C*	*0.53*	*30*	*C*
Lake St at Federal St & Catherine St	AM Peak	0.66	45	D	0.68	59	E
	PM Peak	0.74	39	D	0.91	61	E
Lower Newton St at Federal St	AM Peak	0.32	30	C	0.34	30	C
	PM Peak	0.46	25	C	0.53	28	C
US Route 7 at Upper Newton St / Lower Newton St	AM Peak	0.40	21	C	0.47	22	C
	PM Peak	0.86	63	E	0.98	79	E
US Route 7 at Lake St	AM Peak	0.35	26	C	0.41	32	C
	PM Peak	0.47	27	C	0.56	33	C
US Route 7 at Fairfield St	AM Peak	0.28	26	C	0.33	27	C
	PM Peak	0.34	23	C	0.44	25	C

* Volume to capacity ratio.

** Average delay per vehicle in seconds.

*** Intersection level of service.

Lower Welden St at Lemnah Dr / Allen St - Evaluated with single multiuse lanes on all approaches.

Lower Welden St at Lemnah Dr / Allen St - Evaluated with auxiliary lanes (NB SB & EB left-turn lanes).

Note – A detailed signal warrant evaluation at the intersection of Lower Welden St at Lemnah Dr / Allen St has NOT been conducted. Traffic signal installation should only be pursued if signal warrants are met.

Table 3.2-2
Unsignalized Capacity Analyses Summary

	2010 Build Alternative					
	Weekday Morning			Weekday Evening		
Location / Movement	Demand*	Delay**	LOS***	Demand	Delay	LOS
Nason St Connector / Lemnah Dr at Nason St						
NB left turn from Nason St Connector	45	8	A	70	9	A
SB left turn from Lemnah Dr	5	8	A	5	8	A
WB movements from Nason St	55	19	C	40	22	C
EB movements from Nason St	170	33	D	150	33	D
Lemnah Dr / Allen St at Lower Welden St *(4-Way)*						
NB movements from Lemnah Dr	330	22	C	345	23	C
SB movements from Allen St	385	18	C	480	29	D
WB movements from L Welden St	125	13	B	150	16	C
EB movements from L Welden St	180	12	B	275	15	B
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr	50	8	A	40	8	A
SB left turns from Allen St	60	8	A	100	8	A
WB movements from Lower Welden St *(STOP)*	125	22	C	150	33	D
EB left turns from L Welden St *(STOP)*	45	57	F	115	310	F
EB shared through/right from L Welden St *(STOP)*	135	16	C	160	27	D
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr *(STOP)*	50	28	D	40	344	F
NB through/right from Lemnah Dr *(STOP)*	280	28	D	305	67	F
SB left turns from Allen St *(STOP)*	60	35	E	100	574	F
SB through/right from Lemnah Dr *(STOP)*	390	20	C	380	89	F
WB movements from Lower Welden St	125	1	A	150	1	A
EB movements from Lower Welden St	180	1	A	275	4	A
Allen St/Catherine St at Stebbins St/Market St						
NB movements from Allen St	380	1	A	495	2	A
SB movements from Catherine St	250	1	A	350	1	A
WB movements from Stebbins St	45	16	C	70	22	C
EB movements from Market St	115	13	B	125	15	C

* Demand expressed in vehicles per hour.

** Delay expressed in seconds per vehicle.

*** Level of service.

Table 3.2-2 - Continued
Unsignalized Capacity Analyses Summary

	2030 Build Alternative					
	Weekday Morning			Weekday Evening		
Location / Movement	Demand	Delay	LOS	Demand	Delay	LOS
Nason St Connector / Lemnah Dr at Nason St						
NB left turn from Nason St Connector	45	9	A	45	9	A
SB left turn from Lemnah Dr	5	8	A	5	8	A
WB movements from Nason St	75	38	E	50	25	D
EB movements from Nason St	200	46	E	170	55	F
Lemnah Dr / Allen St at Lower Welden St *(4-Way)*						
NB movements from Lemnah Dr	375	32	D	415	39	E
SB movements from Allen St	395	22	C	470	48	E
WB movements from Lower Welden St	160	16	C	230	26	D
EB movements from Lower Welden St	220	16	C	320	25	D
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr	75	8	A	80	8	A
SB left turns from Allen St	75	8	A	100	8	A
WB movements from Lower Welden St *(STOP)*	160	42	E	230	175	F
EB left turns from L Welden St *(STOP)*	35	93	F	85	694	F
EB shared through/right from L Welden St *(STOP)*	185	26	D	235	61	F
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr *(STOP)*	75	41	E	80	#	F
NB through/right from Lemnah Dr *(STOP)*	300	31	D	335	107	F
SB left turns from Allen St *(STOP)*	75	52	F	100	#	F
SB through/right from Lemnah Dr *(STOP)*	230	23	C	370	142	F
WB movements from Lower Welden St	160	1	A	230	1	A
EB movements from Lower Welden St	220	2	A	320	3	A
Allen St/Catherine St at Stebbins St/Market St						
NB movements from Allen St	350	2	A	530	2	A
SB movements from Catherine St	260	1	A	355	1	A
WB movements from Stebbins St	70	16	C	95	30	C
EB movements from Market St	130	13	B	150	18	C

* Demand expressed in vehicles per hour.

** Delay expressed in seconds per vehicle.

*** Level of service.

Delay from synchro analysis too long to calculate.

Table 3.2-3
Roundabout Capacity Analysis Summary - Lower Welden St at Lemnah Dr / Allen St

		2010 Build Alternative					
	Peak	*Synchro 8* ^			NCHRP ~		
Approach	Period	*Delay**	*Queue***	*LOS****	Delay	Queue	LOS
NB movements from Lemnah Dr	AM	*11*	*3*	*B*	7	3	A
SB movements from Allen St		*9*	*2*	*A*	6	2	A
WB movements from Lower Welden St		*8*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*6*	*0*	*A*	5	0	A
Overall					7		A
NB movements from Lemnah Dr	PM	*11*	*3*	*B*	8	3	A
SB movements from Allen St		*11*	*3*	*B*	7	3	A
WB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
Overall					8		A

		2030 Build Alternative					
	Peak	*Synchro 8* ^			NCHRP ~		
Approach	Period	*Delay*	*Queue*	*LOS*	Delay	Queue	LOS
NB movements from Lemnah Dr	AM	*13*	*4*	*B*	9	4	A
SB movements from Allen St		*10*	*3*	*A*	7	2	A
WB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*7*	*0*	*A*	5	0	A
Overall					8		A
NB movements from Lemnah Dr	PM	*13*	*4*	*B*	10	4	A
SB movements from Allen St		*12*	*4*	*B*	9	4	A
WB movements from Lower Welden St		*12*	*2*	*B*	9	2	A
EB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
Overall					9		A

^ *Output from Synchro 8 with HCM 2010 methodology.*

~ NCHRP methodology - spreadsheet.

* Delay expressed in seconds per vehicle.

** 95th percentile queue expressed in vehicles.

*** Level of service.

Appendix

Traffic Report Update for Federal Street Multimodal Connector by VHB, dated July 7, 2015

Memorandum

To: Mr. Dominic Cloud, City Manager
City of Saint Albans
100 North Main Street
Saint Albans, VT 05478

Date: July 7, 2015

Project #: 57414.00

From: Nick Sanders, PE
Senior Traffic Engineer

Re: Traffic Report Update
Federal Street Multimodal Connector Environmental Assessment

VHB prepared the Federal Street Multimodal Connector Environmental Assessment (EA) dated May 2012 for the City of Saint Albans. Since the completion of the EA, the City has reconsidered some of the proposed intersection improvements and seeks to find alternative solutions that lessen the impacts on the surrounding environment. In addition, there have been several new developments in the study area that have altered the traffic volume demands, requiring reassessment of the previously prepared EA traffic analyses. Specifically, these developments include:

- The new State office building, hotel, and parking garage development on Lake and Federal Street as documented in VHB's August 2013 memorandum, which is provided in the Appendix.
- The closure of Houghton Street and the reoccupation of the State office building on Houghton Street by Mylan Technologies as documented in the Cross Consulting Engineers, PC August 2013 letter, which is provided in the Appendix.

The purpose of this memorandum is to document the findings of the updated traffic analyses and to evaluate alternative design scenarios for the intersections of:

- Nason Street Connector / Lemnah Drive at Nason Street
- Lemnah Drive/Allen Street at Lower Welden Street
- Allen Street/Catherine Street at Stebbins Street/Market Street
- Catherine Street/Federal Street/ Market Street at Lake Street

Traffic Network Development

The traffic volumes increases and diversions associated with the proposed State office building development project and the Houghton Street closure project were distributed throughout the study area based on existing flow patterns. The traffic volume networks for this assessment include all intersections shown in the EA's Proposed Action, as well as the additional intersections included in the Houghton Street closure project (Lake Street at: Houghton Street and South Elm Street and Lower Welden Street at: Houghton Street and South Elm Street). It should be noted that the Houghton Street closure project did not include an evaluation of the weekday morning peak hour condition. Therefore the weekday morning peak hour adjustments associated with the Houghton Street closure were estimated based on a comparison between the weekday morning and weekday evening peak hour volumes. **Figures 1** through **4** show the net difference in traffic volumes at each intersection from the original EA Proposed action to the updated scenario.

The 2010 and 2030 Updated Proposed Action weekday morning and weekday evening peak hour traffic volume networks were developed by adding the net difference in traffic volumes (associated with the proposed State office building development project and the Houghton Street closure project) to the originally developed Proposed Action

2 Bedford Farms Drive
Suite 200
Bedford, NH 03110-6532
P 603.391.3900

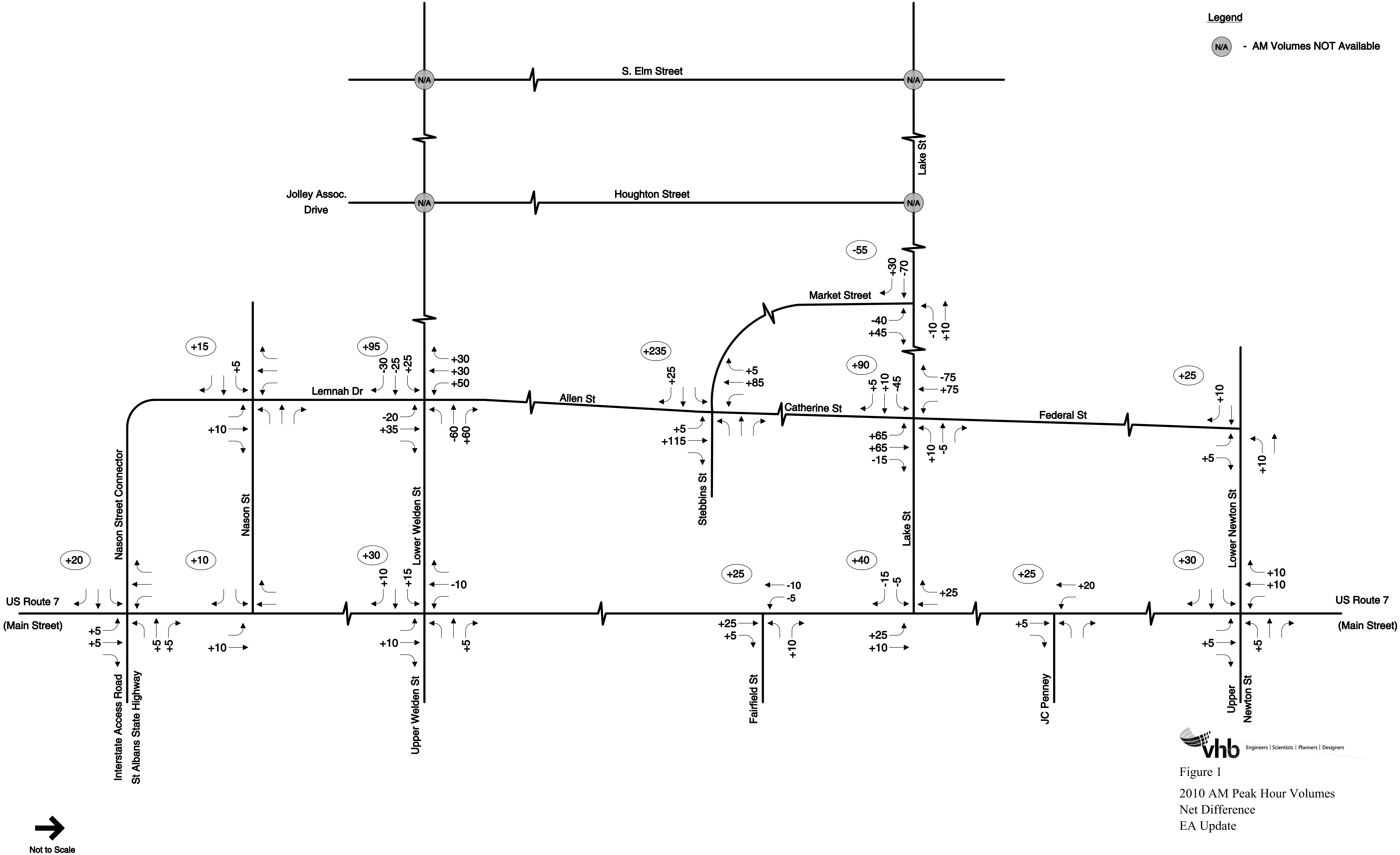


Figure 1

2010 AM Peak Hour Volumes
Net Difference
EA Update

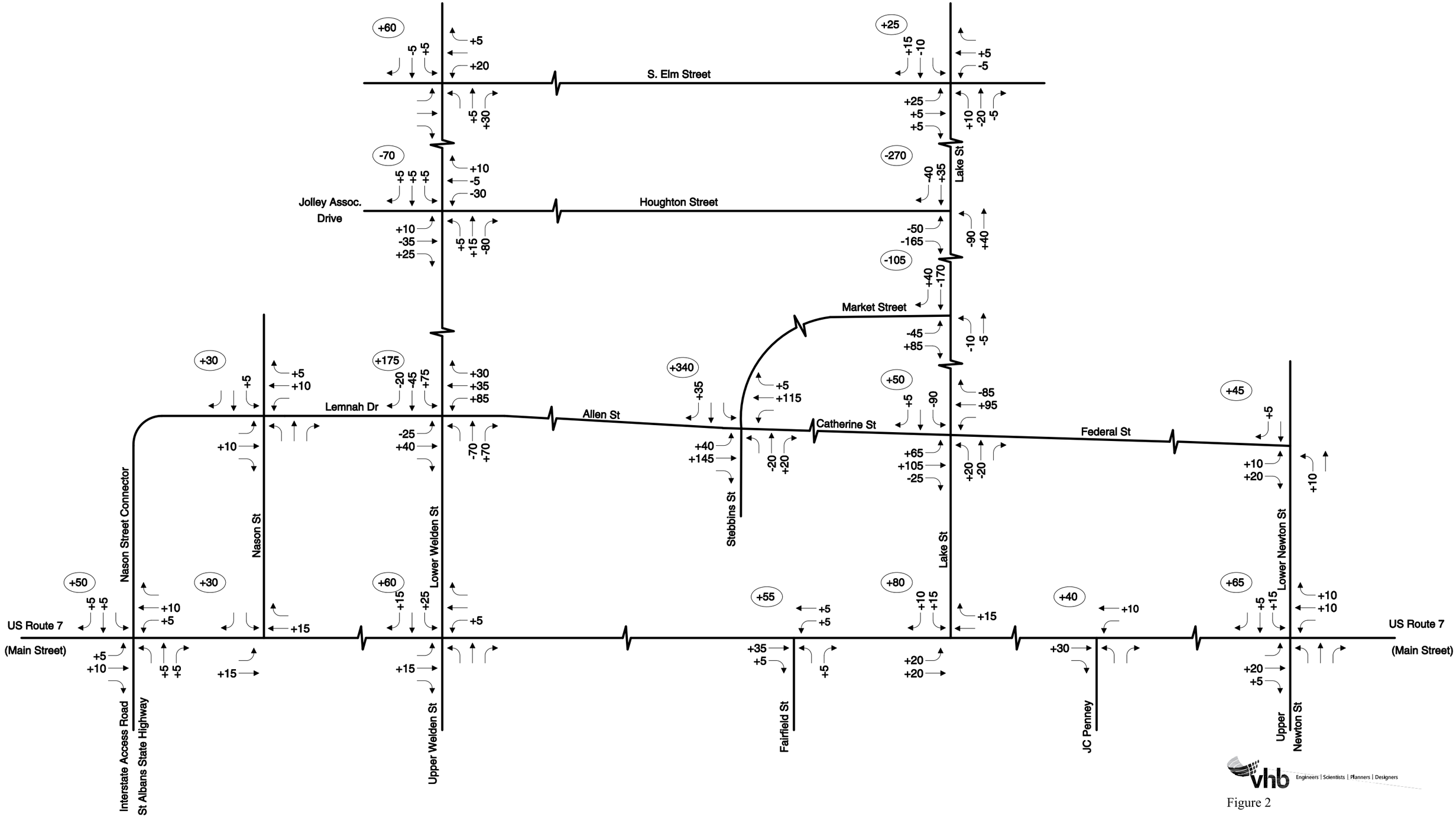


Figure 2

2010 PM Peak Hour Volumes
Net Difference
EA Update

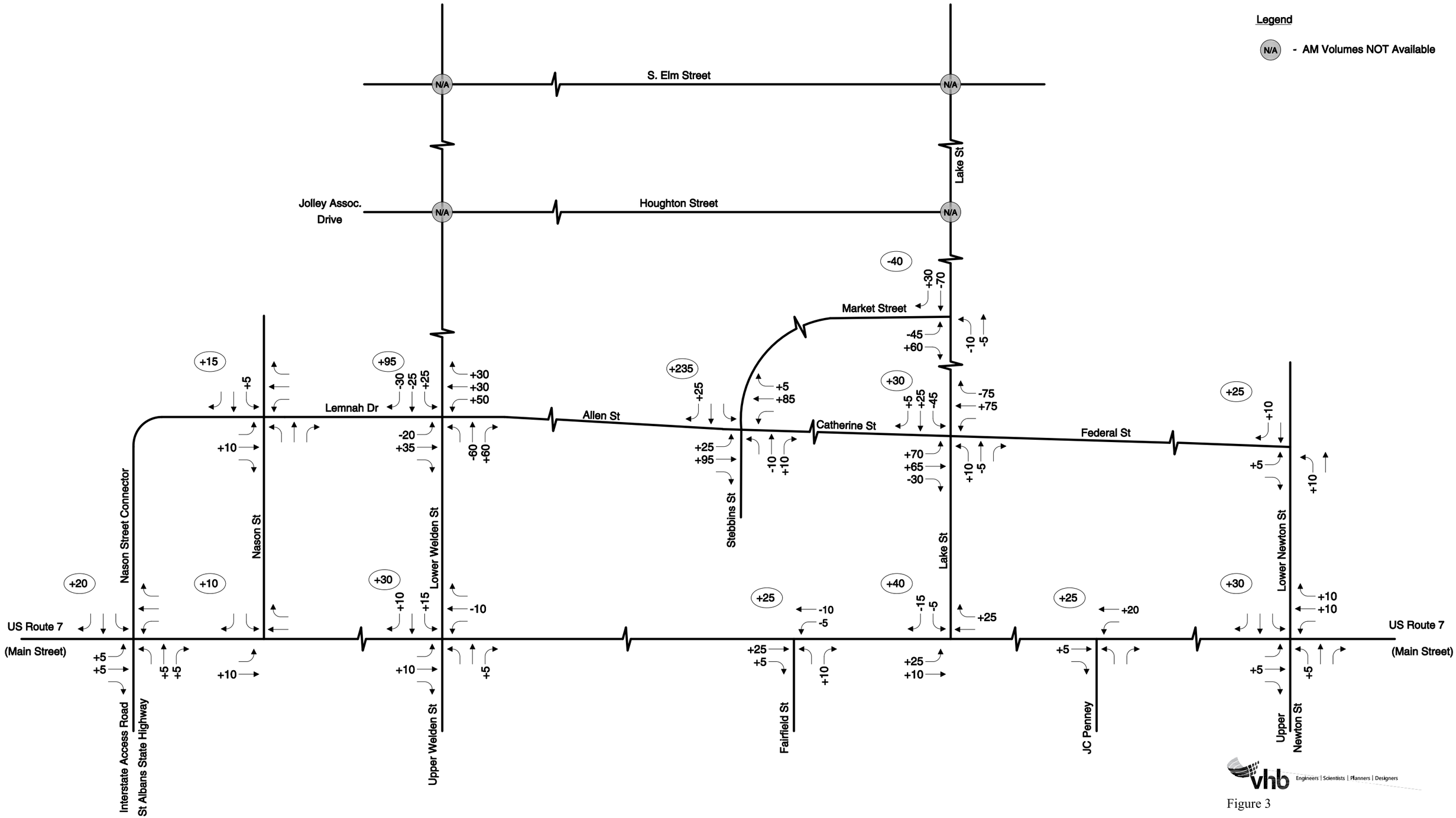


Figure 3

2030 AM Peak Hour Volumes
Net Difference
EA Update

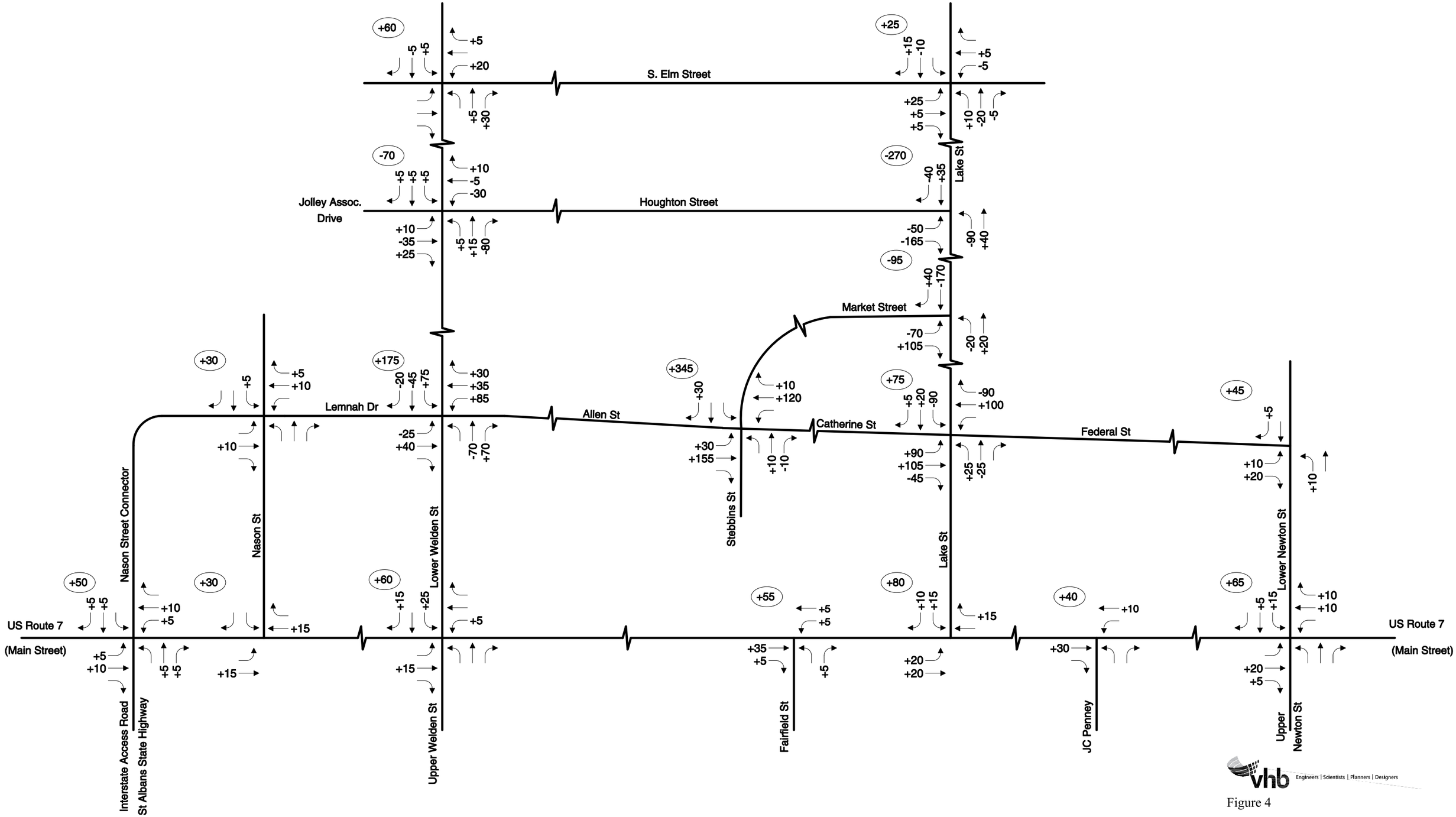


Figure 4

2030 PM Peak Hour Volumes
Net Difference
EA Update

traffic volume networks. **Figures 5** through **8** show the 2010 and 2030 Updated Proposed Action weekday morning and weekday evening peak hour traffic volume networks.

Due to the diversions associated with the Houghton Street closure, the most substantial traffic volume increases generally occurred along Lemnah Drive, Allen Street, and Catherine Street. During the 2010 weekday evening peak hour, volumes at the Lemnah Drive/Lower Welden Street intersection are projected to increase by 175 vehicles and volumes at the Catherine Street/Market Street/Stebbins Street intersection are projected to increase by 340 vehicles under this scenario. The most substantial decreases in volume generally occurred along Lake Street north of Houghton Street with a reduction of 270 vehicles anticipated during the 2010 weekday evening peak hour. Volume adjustments along other study area streets, particularly along Main Street, are substantially smaller in nature.

Traffic Operational Analyses

To assess the quality of traffic flow, capacity analyses were conducted to determine how well the study area intersections will serve the forecasted traffic demands placed upon them. The traffic performance measures and the evaluation criteria used in the operational analyses are based on the methodology presented in the 2000 Highway Capacity Manual.[1] Proposed roundabouts were evaluated using two analysis tools: Synchro version 8 and the National Cooperative Highway Research Program (NCHRP) 572 Roundabout Analysis worksheet.

A primary result of capacity analysis is the assignment of level of service (LOS), which is a qualitative measure describing operational conditions at a given facility under specific traffic volume demands. Six levels of service are defined ranging in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustifiable. LOS E reflects a condition of longer delay, but can be considered acceptable in a congested area, particularly in cases where traffic control devices and other measures are taken to improve safety or physical/geometric improvements are not considered to avoid environmental, historical, or property impacts.

The operational analysis for this updated evaluation was limited to study area intersections that experience traffic volume increases of approximately 75 peak hour trips[2] or more compared to the previous analysis presented in the EA (as shown in Figures 1 through 4) and/or where geometric or traffic control modifications (from those assumed in the EA) are being considered. The following study area intersections were evaluated with alternative design scenarios:

- Nason Street Connector and Lemnah Drive at Nason Street
    - EA Design Assumption – Stop control on Nason Street approaches with left-turn lanes provided on all approaches except Nason Street westbound
    - Modified Design Assumption - Two-way stop with single lane approaches on both Nason Street approaches

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[1] 2000 Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C.

[2] The VTrans Traffic Impact Study Guideline identify 75 additional peak hour trips at an intersection as the threshold for determining the geographic scope of the evaluation.

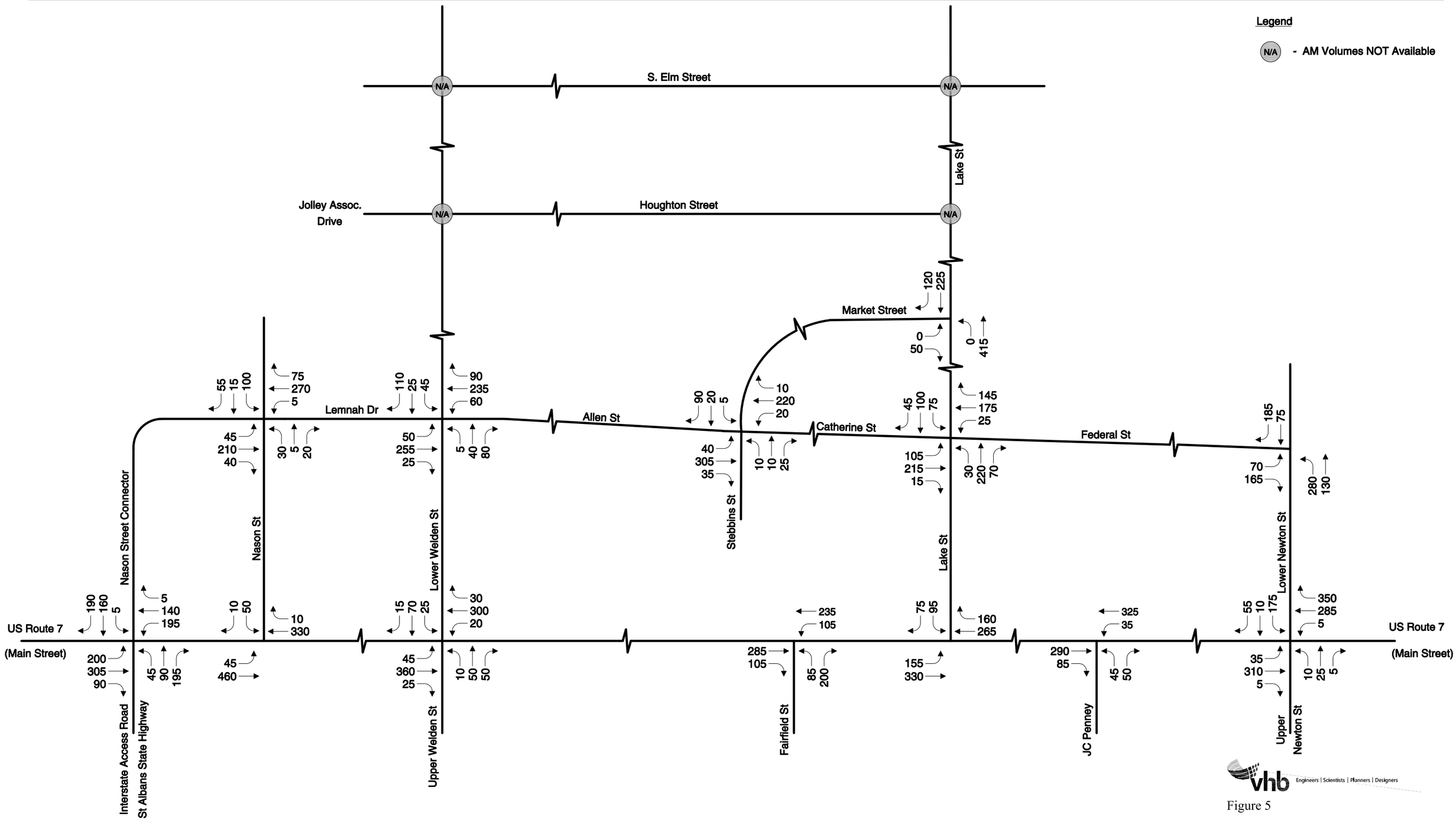

Figure 5

2010 AM Peak Hour Volumes
Updated Proposed Action

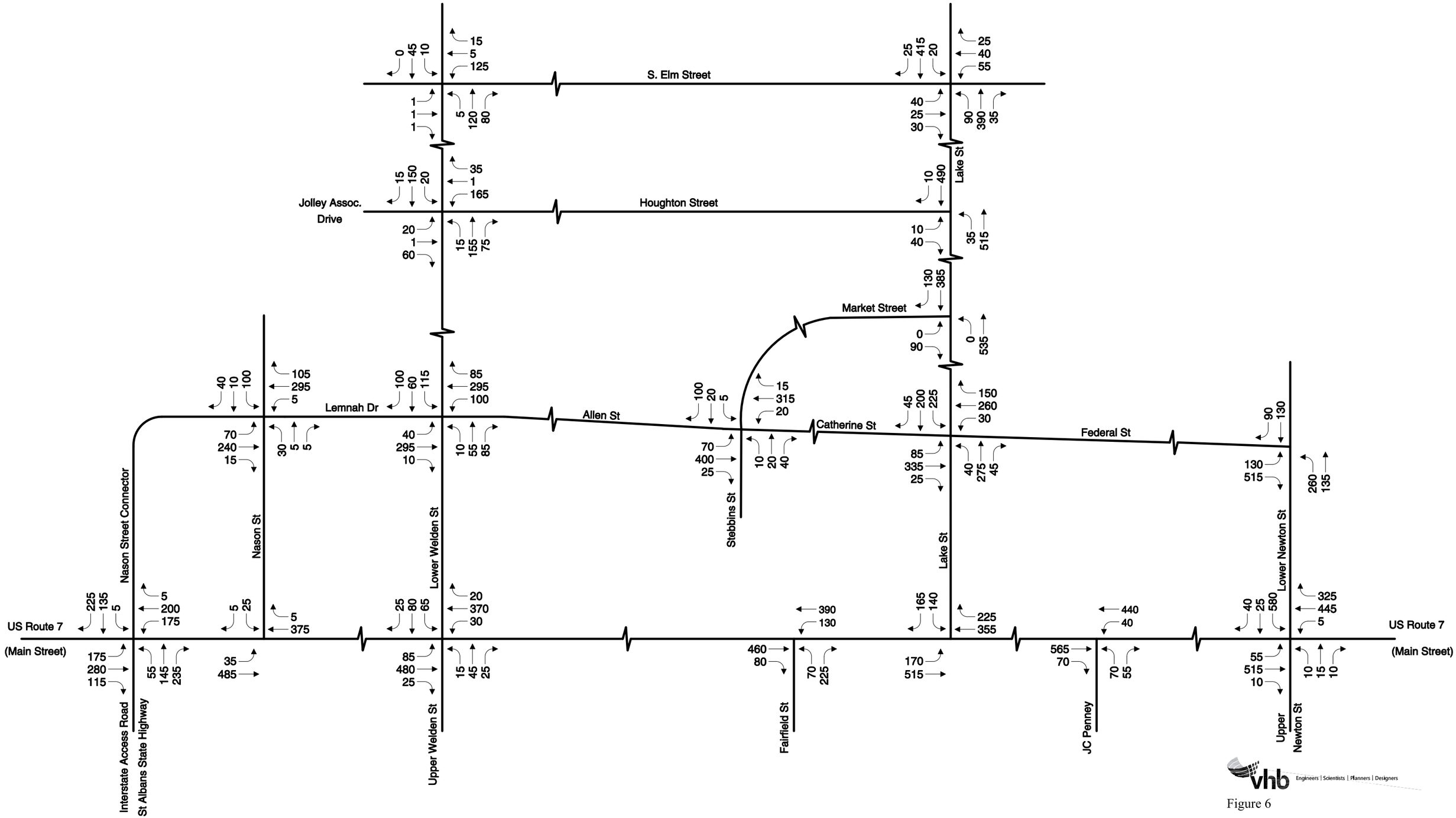

Figure 6

2010 PM Peak Hour Volumes
Updated Proposed Action

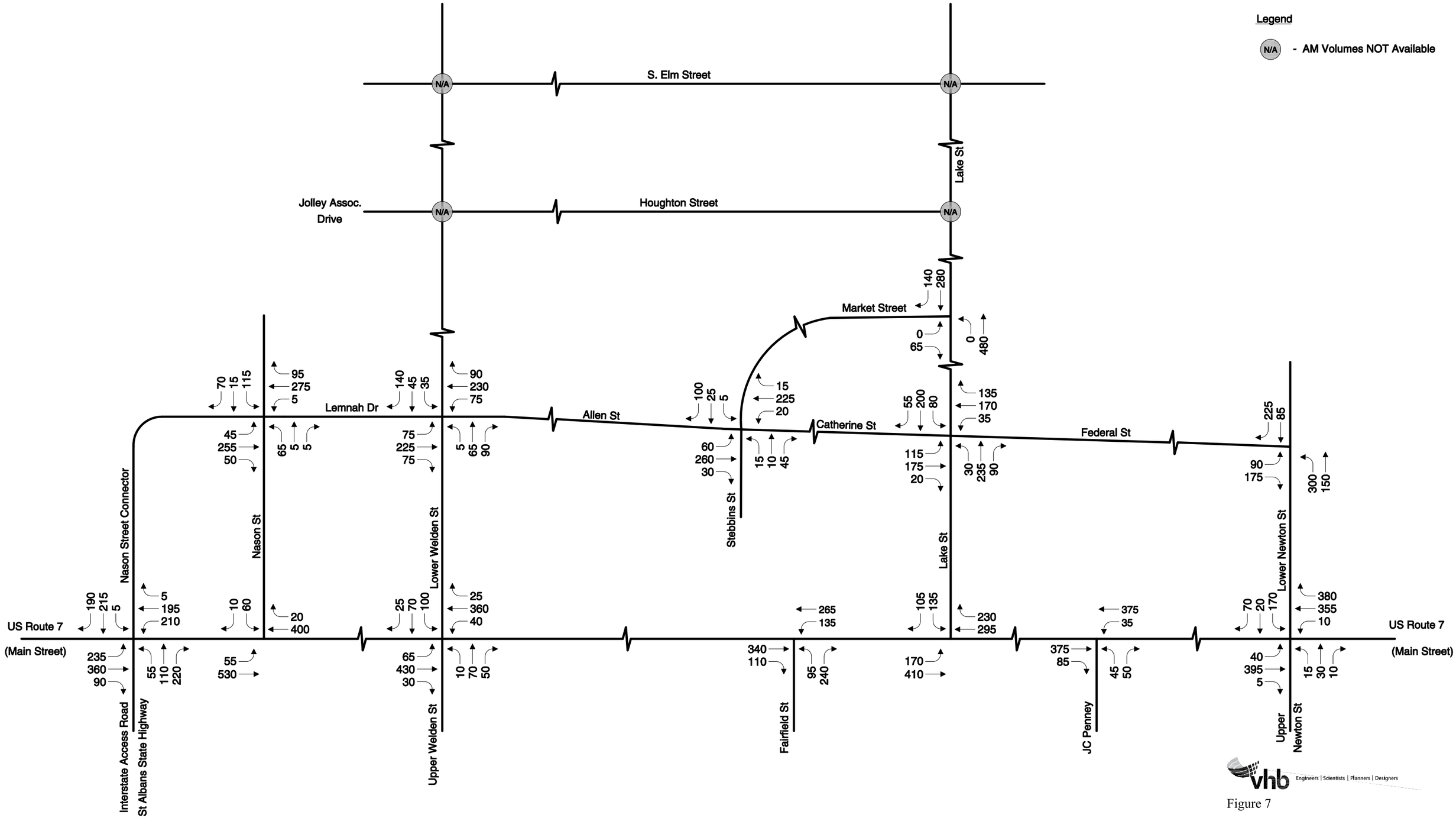

Figure 7

2030 AM Peak Hour Volumes
Updated Proposed Action

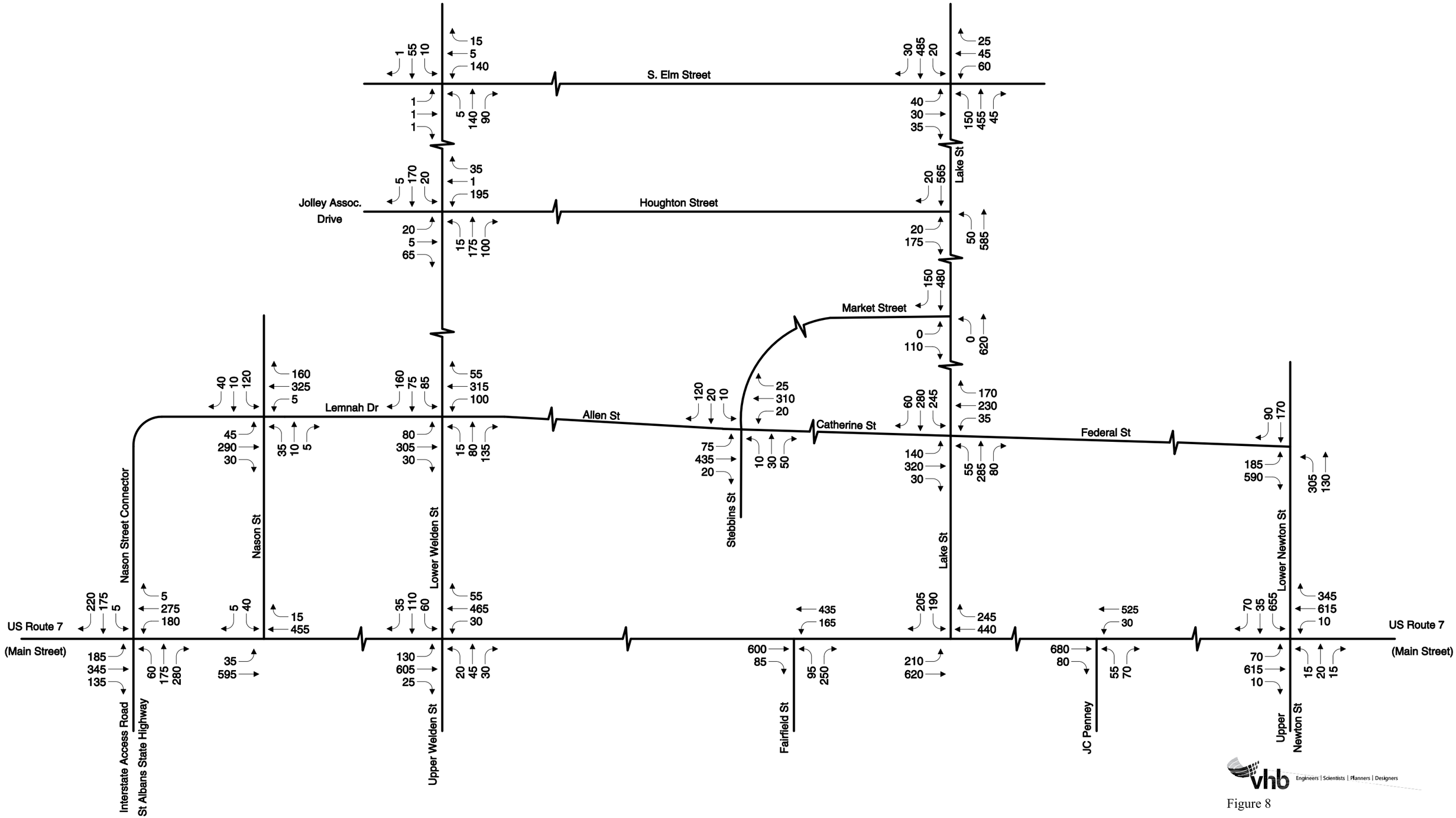

Figure 8

2030 PM Peak Hour Volumes
Updated Proposed Action

- Lemnah Drive and Allen Street at Lower Welden
    - EA Design Assumption – Single lane roundabout with right-turn slip lane on Lower Welden Street eastbound approach (reanalyzed for updated traffic volumes)
    - Modified Design Assumption -
        - Signal with and without left-turn lanes on the Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound approaches
        - Four-way stop control intersection with left-turn lanes on Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound
        - Two-way stop control on Lower Welden Street with left-turn lanes on Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound
- Allen Street and Catherine Street at Stebbins Street and Market Street
    - EA Design Assumption – One-way circulation northbound on Allen Street/Catherine Street with single lane approaches under stop control on Stebbins Street (two way traffic flow) and Market Street (one way traffic flow southbound)
    - Modified Design Assumption – Two way traffic flow and single multiuse lanes on all approaches with stop control on Stebbins Street and Market Street
- Catherine Street, Federal Street, and Market Street at Lake Street
    - EA Design Assumption – Signal control with single lane approaches on both Lake Street approaches; separate left, through, and right-turn lanes on Federal Street southbound approach; left and through/right-turn lanes on Catherine Street northbound approach (one-way); and one-way traffic flow southbound on Market Street
    - Modified Design Assumption – Signal control with single lane approaches on Catherine Street northbound, Market Street northbound, and Lake Street westbound; left/through and right-turn lanes on Federal Street southbound approach; left-turn and through/right-turn lanes; an exclusive pedestrian phase and signal phasing to accommodate the railroad crossing

The results of the updated 2010 and 2030 signalized, unsignalized, and roundabout operational analyses are summarized in **Tables 1**, **2**, and **3** respectively. A comparison between the results of this updated analysis and the original EA Proposed Action revealed similar operations at most intersections. Specifically, most intersections are expected to operate at the same LOS. Copies of the updated operational analyses are provided in the Appendix.

The proposed signalized intersection of Catherine Street, Federal Street, and Market Street at Lake Street is expected to operate at LOS D in 2010, but drop to LOS E by the 2030 forecast year. Although the overall intersection is expected to operate below capacity through the 2030 forecast year, long queues are expected by the forecast year along Catherine Street northbound (300 to 625 feet for the 50th and 95th percentile queues respectively) and Lake Street westbound (375 to 775 feet for the 50th and 95th percentile queues respectively) during the critical weekday evening peak hour. These queues are a result of the single lane approaches, which are necessary to avoid property impacts, the exclusive pedestrian phase, and the modified signal timings necessary to accommodate preemption with the railroad.

The Catherine Street northbound and Lake Street westbound 95th percentile queues are approximately 250 feet longer in comparison to the results from the EA Design.

The signalized intersections of Lower Newton Street at Federal Street, US Route 7 at Lake Street and US Route 7 at Fairfield Street are all expected to operate at LOS C through the 2030 forecast year. The operations are consistent with the findings of the original EA because there are no design modifications and the changes in peak hour traffic volumes was relatively small at these three intersections.

The signalized intersection of US Route 7 at Upper Newton Street and Lower Newton Street is expected to operate at LOS C during the weekday morning peak hour and just below capacity (v/c ratio of 0.98) at LOS E during the weekday evening peak hour in the 2030 forecast year. As discussed in the original EA traffic evaluation, these operations are partially attributed to incorporating safety measures and exclusive pedestrian phases into the intersection's operation.

The intersection of Lower Welden Street at Lemnah Drive and Allen Street was evaluated as a roundabout, a signal, and a stop control intersection (both two-way and four-way). The Proposed Action from the original EA provided a single lane roundabout with a right-turn lane on the eastbound Lower Welden Street approach. The updated evaluation with the modified traffic volumes revealed that all approaches at a roundabout are expected to operate at LOS B or better based on the Synchro analysis and LOS A based on the NCHRP methodology through the 2030 forecast year during both the weekday morning and weekday evening peak hours. It is should be noted that the critical eastbound approach on Lower Welden Street, which crosses the railroad tracks, is projected to have a 95th percentile queue of approximately 25 feet or one vehicle (staying clear of the railroad crossing).

Alternatively, a four-way stop controlled intersection with left turn lanes on the Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound approaches is expected to provide LOS D on the northbound movement from Lemnah Drive and LOS C on the other approaches through the 2030 forecast year during the weekday morning peak hour. During the weekday evening peak hour, the northbound approach from Lemnah Drive and the southbound approach from Allen Street are expected to operate at LOS E while the eastbound and westbound Lower Welden Street approaches are expected to operate at LOS D through the 2030 forecast year. However, the 95th percentile queues on the critical eastbound approach are expected to extend beyond the railroad crossing on Lower Welden Street. A review of peak hour volumes with consideration of the 12-hour temporal distribution experienced at the Lake Street, Catherine Street and Federal Street intersection indicates that the intersection of Lower Welden Street at Lemnah Drive and Allen Street likely meets the minimum volumes identified for multi-way stop sign installation in the Manual on Uniform Traffic Control Devices[3] (MUTCD). A more detailed multi-way stop warrant evaluation with detailed crash data and daily counts at the intersection of Lower Welden Street at Lemnah Drive and Allen Street should be conducted if four-way stop control is perused.

Two-way stop control was evaluated at the intersection of Lower Welden Street at Lemnah Drive and Allen Street under two conditions: one, with the stop control on the eastbound and westbound approaches on Lower Welden Street and two, with the stop control on the northbound and southbound approaches of Lemnah Drive and Allen Street. Stop control on the eastbound and westbound Lower Weldon Street approaches is expected to provide LOS F operations on these minor street approaches with long delays and queues. Specifically, during the 2030 future year weekday evening peak hour the westbound approach from Lower Welden Street is expected to operate at LOS F with

[3] Manual on Uniform Traffic Control Devises (MUTCD) 2009 Edition.

a delay of 175 seconds and a 95th percentile queue of 325 feet and the eastbound left-turn is expected to operate at LOS F with a delay of over 500 seconds and a 95th percentile queue of 700 feet. This eastbound queue extends well beyond the railroad crossing on Lower Welden Street. Conversely, with stop control on the northbound and southbound approaches it is the Lemnah Drive and Allen Street minor street approaches that are expected to provide LOS F with long delays and queues. In 2010 delays are expected to exceed 300 seconds on the stop controlled approaches of Lemnah Drive and Allen Street, the 95th percentile queues on the northbound Lemnah Drive approach are expected to be 125 feet for the left-turn lane and 250 feet for the shared through/right lane and the 95th percentile queue on the southbound Allen Street approach are expected to be 275 feet for the left-turn lane and 350 feet for the shared through/right lane during the weekday evening peak hour. The delays and queues on the minor street approaches of Lemnah Drive and Allen Street will be even longer by the forecast year of 2030.

Finally, a signal was evaluated with and without left-turn lanes on the same three approaches (Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound). Although the operational analysis indicates that a signal would operate at acceptable levels of service (LOS D without left-turn lanes and LOS C with left-turn lanes), an inspection of the peak hour volumes indicates that the Warrant 3 (Peak Hour) from the MUTCD is not satisfied. Installing a traffic signal at intersection of Lower Welden Street at Lemnah Drive and Allen Street should not be pursued without first determining if a signal is warranted by conducting a detailed signal warrant evaluation.

The minor street approaches of Nason Street at the proposed unsignalized intersection with Nason Street Connector and Lemnah Drive are expected to operate at LOS C and LOS D in 2010. By the 2030 forecast year, the minor street operations on Nason Street are expected to drop to LOS E during the weekday morning peak hour and LOS D (westbound) and F (eastbound) during the weekday evening peak hour. This critical eastbound approach is expected to experience delays of 55 seconds or less and a 95th percentile queue of 175 feet in the 2030 forecast year peak hour conditions. The minor street approaches of Stebbins Street (westbound) and Market Street (eastbound) at the unsignalized intersection of Allen Street and Catherine Street are expected to operate at LOS C or better through the forecast year of 2030.

Table 1
Signalized Intersection Capacity Analysis Summary

		2010 Build			2030 Build		
		v/c*	Delay**	LOS***	v/c	Delay	LOS
Lower Welden St at Lemnah Dr / Allen St (w/o left-turn lanes)	AM Peak	0.54	32	C	0.69	41	D
	PM Peak	0.75	39	D	0.83	51	D
Lower Welden St at Lemnah Dr / Allen St (with left-turn lanes)	*AM Peak*	*0.38*	*29*	*C*	*0.47*	*30*	*C*
	PM Peak	*0.47*	*31*	*C*	*0.53*	*30*	*C*
Lake St at Federal St & Catherine St	AM Peak	0.66	45	D	0.68	59	E
	PM Peak	0.74	39	D	0.91	61	E
Lower Newton St at Federal St	AM Peak	0.32	30	C	0.34	30	C
	PM Peak	0.46	25	C	0.53	28	C
US Route 7 at Upper Newton St / Lower Newton St	AM Peak	0.40	21	C	0.47	22	C
	PM Peak	0.86	63	E	0.98	79	E
US Route 7 at Lake St	AM Peak	0.35	26	C	0.41	32	C
	PM Peak	0.47	27	C	0.56	33	C
US Route 7 at Fairfield St	AM Peak	0.28	26	C	0.33	27	C
	PM Peak	0.34	23	C	0.44	25	C

* Volume to capacity ratio.

** Average delay per vehicle in seconds.

*** Intersection level of service.

Lower Welden St at Lemnah Dr / Allen St - Evaluated with single multiuse lanes on all approaches.

Lower Welden St at Lemnah Dr / Allen St - Evaluated with auxiliary lanes (NB SB & EB left-turn lanes).

Note – A detailed signal warrant evaluation at the intersection of Lower Welden St at Lemnah Dr / Allen St has NOT been conducted. Traffic signal installation should only be pursued if signal warrants are met.

Table 2
Unsignalized Capacity Analyses Summary

	2010 Build Alternative					
	Weekday Morning			Weekday Evening		
Location / Movement	Demand*	Delay**	LOS***	Demand	Delay	LOS
Nason St Connector / Lemnah Dr at Nason St						
NB left turn from Nason St Connector	45	8	A	70	9	A
SB left turn from Lemnah Dr	5	8	A	5	8	A
WB movements from Nason St	55	19	C	40	22	C
EB movements from Nason St	170	33	D	150	33	D
Lemnah Dr / Allen St at Lower Welden St *(4-Way)*						
NB movements from Lemnah Dr	330	22	C	345	23	C
SB movements from Allen St	385	18	C	480	29	D
WB movements from L Welden St	125	13	B	150	16	C
EB movements from L Welden St	180	12	B	275	15	B
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr	50	8	A	40	8	A
SB left turns from Allen St	60	8	A	100	8	A
WB movements from Lower Welden St *(STOP)*	125	22	C	150	33	D
EB left turns from L Welden St *(STOP)*	45	57	F	115	310	F
EB shared through/right from L Welden St *(STOP)*	135	16	C	160	27	D
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr *(STOP)*	50	28	D	40	344	F
NB through/right from Lemnah Dr *(STOP)*	280	28	D	305	67	F
SB left turns from Allen St *(STOP)*	60	35	E	100	574	F
SB through/right from Lemnah Dr *(STOP)*	390	20	C	380	89	F
WB movements from Lower Welden St	125	1	A	150	1	A
EB movements from Lower Welden St	180	1	A	275	4	A
Allen St/Catherine St at Stebbins St/Market St						
NB movements from Allen St	380	1	A	495	2	A
SB movements from Catherine St	250	1	A	350	1	A
WB movements from Stebbins St	45	16	C	70	22	C
EB movements from Market St	115	13	B	125	15	C

* Demand expressed in vehicles per hour.

** Delay expressed in seconds per vehicle.

*** Level of service.

Table 2 - Continued
Unsignalized Capacity Analyses Summary

	2030 Build Alternative					
	Weekday Morning			Weekday Evening		
Location / Movement	Demand	Delay	LOS	Demand	Delay	LOS
Nason St Connector / Lemnah Dr at Nason St						
NB left turn from Nason St Connector	45	9	A	45	9	A
SB left turn from Lemnah Dr	5	8	A	5	8	A
WB movements from Nason St	75	38	E	50	25	D
EB movements from Nason St	200	46	E	170	55	F
Lemnah Dr / Allen St at Lower Welden St *(4-Way)*						
NB movements from Lemnah Dr	375	32	D	415	39	E
SB movements from Allen St	395	22	C	470	48	E
WB movements from Lower Welden St	160	16	C	230	26	D
EB movements from Lower Welden St	220	16	C	320	25	D
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr	75	8	A	80	8	A
SB left turns from Allen St	75	8	A	100	8	A
WB movements from Lower Welden St *(STOP)*	160	42	E	230	175	F
EB left turns from L Welden St *(STOP)*	35	93	F	85	694	F
EB shared through/right from L Welden St *(STOP)*	185	26	D	235	61	F
Lemnah Dr / Allen St at Lower Welden St *(2-Way)*						
NB left turns from Lemnah Dr *(STOP)*	75	41	E	80	#	F
NB through/right from Lemnah Dr *(STOP)*	300	31	D	335	107	F
SB left turns from Allen St *(STOP)*	75	52	F	100	#	F
SB through/right from Lemnah Dr *(STOP)*	230	23	C	370	142	F
WB movements from Lower Welden St	160	1	A	230	1	A
EB movements from Lower Welden St	220	2	A	320	3	A
Allen St/Catherine St at Stebbins St/Market St						
NB movements from Allen St	350	2	A	530	2	A
SB movements from Catherine St	260	1	A	355	1	A
WB movements from Stebbins St	70	16	C	95	30	C
EB movements from Market St	130	13	B	150	18	C

* Demand expressed in vehicles per hour.

** Delay expressed in seconds per vehicle.

*** Level of service.

Delay from synchro analysis too long to calculate.

Table 3
Roundabout Capacity Analysis Summary - Lower Welden St at Lemnah Dr / Allen St

		2010 Build Alternative					
	Peak	*Synchro 8 ^*			NCHRP ~		
Approach	Period	*Delay**	*Queue***	*LOS****	Delay	Queue	LOS
NB movements from Lemnah Dr	AM	*11*	*3*	*B*	7	3	A
SB movements from Allen St		*9*	*2*	*A*	6	2	A
WB movements from Lower Welden St		*8*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*6*	*0*	*A*	5	0	A
Overall					7		A
NB movements from Lemnah Dr	PM	*11*	*3*	*B*	8	3	A
SB movements from Allen St		*11*	*3*	*B*	7	3	A
WB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
Overall					8		A

		2030 Build Alternative					
	Peak	*Synchro 8 ^*			NCHRP ~		
Approach	Period	*Delay*	*Queue*	*LOS*	Delay	Queue	LOS
NB movements from Lemnah Dr	AM	*13*	*4*	*B*	9	4	A
SB movements from Allen St		*10*	*3*	*A*	7	2	A
WB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
EB movements from Lower Welden St		*7*	*0*	*A*	5	0	A
Overall					8		A
NB movements from Lemnah Dr	PM	*13*	*4*	*B*	10	4	A
SB movements from Allen St		*12*	*4*	*B*	9	4	A
WB movements from Lower Welden St		*12*	*2*	*B*	9	2	A
EB movements from Lower Welden St		*9*	*1*	*A*	7	1	A
Overall					9		A

^ *Output from Synchro 8 with HCM 2010 methodology.*

~ NCHRP methodology - spreadsheet.

* Delay expressed in seconds per vehicle.

** 95th percentile queue expressed in vehicles.

*** Level of service.

Recommendations and Conclusions

This updated EA traffic evaluation, which accounts for traffic volume changes associated with the proposed State office building development project and the Houghton Street closure project as well as design changes at several study area intersections revealed comparable traffic operations at most study area intersections as compared to the original EA traffic evaluation. Given the updated traffic volumes, the City could further evaluate and consideration of the following design modifications:

- Nason Street Connector / Lemnah Drive at Nason Street: A four-way unsignalized intersection with left-turn lanes on Nason Street Connector (northbound) and Lemnah Drive (southbound) and single lane approaches under stop control on Nason Street. This configuration is expected to provide acceptable operations (LOS D or better) in 2010. By the 2030 forecast year the Nason Street eastbound approach is anticipate to drop to LOS F, but with manageable delays of no greater than 55 seconds and a 95th percentile queue of 175 feet. An eastbound bypass shoulder on Nason Street has been included in the design due the railroad crossing on approximately 80 west of the intersection. Additionally the City should consider the installation of a "Do Not Stop on Tracks" (R8-8) sign on the eastbound Nason Street approach to the railroad tracks.

- Lemnah Drive/Allen Street at Lower Welden Street: Although a traffic signal is expected to provide acceptable operations (LOS D or better) through the 2030 forecast year, an inspection of the peak hour volumes indicates that the Warrant 3 (Peak Hour) from the MUTCD is not met. A more detailed signal warrant evaluation would need to be conducted to determine if signalization (which would require modified signal timings necessary to accommodate preemption with the railroad) could be pursued at this location.

  A review of peak hour volumes indicates that the intersection of Lower Welden Street at Lemnah Drive and Allen Street likely meets the minimum volumes identified in the MUTCD for multi-way stop sign installation. A four-way stop controlled intersection with left-turn lanes on the Lemnah Drive northbound, Allen Street southbound, and Lower Welden Street eastbound is expected to operate at LOS E and D with manageable delays ranging between 25 and 48 seconds during the critical weekday evening peak hour in the 2030 forecast year. However, it should be noted that the 2030 forecast year peak hour eastbound 95th percentile queues on Lower Welden Street of 175 feet extend beyond the railroad crossing. As such, the City should consider the installation of a "Do Not Stop on Tracks" (R8-8) sign on the eastbound Lower Welden Street approach to the railroad tracks if a four-way stop control instillation is perused at this location.

  A single lane roundabout with an eastbound right-turn lane on Lower Welden Street, which was the Proposed Action from the original EA assessment, provides the best traffic operations (LOS B and LOS A) with short approach delays of 13 seconds or less and 95th percentile queues of one vehicle or less through the 2030 forecast year.

- Allen Street/Catherine Street at Stebbins Street/Market Street: A four-way unsignalized intersection with single lane approaches and stop control on Stebbins Street and Market Street is expected to provide good operations (LOS C or better) through the 2030 forecast year.

- Catherine Street/Federal Street/ Market Street at Lake Street: A signal with single lane approaches on Catherine Street northbound, Market Street northbound, and Lake Street westbound, an exclusive pedestrian phase, and signal phasing to accommodate the railroad crossing is expected to operate at LOS C during the weekday morning and LOS E (below capacity with a v/c of 0.91) during the weekday evening peak hour

through the 2030 forecast year. Although the overall intersection is expected to operate below capacity through the 2030 forecast year, long queues are expected by the forecast year along Catherine Street northbound (300 to 625 feet for the 50th and 95th percentile queues respectively) and Lake Street westbound (375 to 775 feet for the 50th and 95th percentile queues respectively) during the critical weekday evening peak hour. These queues are a result of the single lane approaches, which are necessary to avoid property impacts, the exclusive pedestrian phase, and the modified signal timings necessary to accommodate preemption with the railroad.

Technical Appendix

- Traffic Circulation and Site Access Assessment – Proposed Parking Garage on Lake / Federal Street - VHB August 2013
- Houghton Street Closure - Cross Consulting Engineers, PC August 2013
- Signalized Intersection Capacity Analysis
- Unsignalized Intersection Capacity Analyses
- Roundabout Capacity Analysis
- MUTCD Warrant Evaluation

Traffic Circulation and Site Access Assessment – Proposed Parking Garage on Lake / Federal Street

VHB August 2013

Transportation
Land Development
Environmental
Services

Vanasse Hangen Brustlin, Inc.

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Bedford, New Hampshire 03110-6532
603 644-0888
FAX 603 644-2385

Memorandum

To: Mr. Dominic Cloud, City Manager
City of St. Albans
100 North Main Street
St. Albans, VT 05478

Date: August 5, 2013

Project No.: 52400.00

From: Nick Sanders, P.E.
Senior Project Engineer

Re: Traffic Circulation and
Site Access Assessment
Proposed Parking Garage
Lake/Federal Street, St. Albans, VT

Vanasse Hangen Brustlin, Inc. (VHB) has completed a traffic circulation and site access assessment for the proposed parking garage and State office building to be located on the northeast quadrant of the intersection of Federal Street and Lake Street in St. Albans, VT. The proposed development calls for constructing a new 370 space parking garage and a State office building that will have approximately 150 employees. The scope of work for this evaluation is generally limited to the intersections of Lake Street with Federal Street/Catherine Street and Lake Street with North Main Street as well as the site driveways along Lake Street and Federal Street. This memorandum includes the following:

- A description of site access;
- A trip generation estimate for the proposed use;
- A description of the traffic volume development;
- An evaluation of traffic operations within the study area with and without the development program; and
- Conclusions.

SITE ACCESS

Access and egress to and from the site is proposed via two full access site driveways: one on Lake Street 170 feet west of North Main Street and the other on Federal Street 360 feet north of Lake Street. A third driveway, just north of 11 Federal Street will be one way inbound (eastbound) and will primarily serve 11 Federal Street. Therefore, for the purpose of this assessment all site generated traffic is assumed to use the two primary full access driveways. It should be noted that typical urban characteristics such as buildings adjacent to the sidewalks and parked vehicles along the street may limit the sight lines for vehicles exiting the site driveways. However, Lake Street and Federal Street provide clear lines of sight approaching the site driveways due to their straight alignment (no vertical or horizontal curves).

TRIP GENERATION

Trip generation estimates for the proposed development were calculated using rates published by the Institute of Transportation Engineers (ITE) Trip Generation[1] and parking garage data collected by VHB[2].

[1] Trip Generation 8th Edition, Institute of Transportation Engineers, Washington D.C., 2008.

The ITE General office Building Land Use Code 710 was used to estimate the trips for the proposed State office building, which will utilize 170 of the parking spaces in the garage. The trip generation estimate for the remaining 200 parking spaces was based on parking garage data collected by VHB. These rates suggest that the proposed development will generate approximately 130 trips (115 entering and 15 exiting) during the weekday morning peak hour and 220 trips (80 entering and 140 exiting) during the weekday evening peak hour. Calculations supporting the proposed trip generation estimate for the project are provided in the Appendix. Table 1 summarizes the trip generation estimates for the proposed development program.

TABLE 1
TRIP GENERATION SUMMARY

	Site Generated Trips (370 Space Parking Garage)		
Period	Public (200 Spaces)	State Office Building (170 Spaces/150 Emp.)	Total Trips
Weekday Morning Peak Hour (vph)*			
Enter	30	85	115
Exit	5	10	15
Total	35	95	130
Weekday Evening Peak Hour (vph)*			
Enter	60	20	80
Exit	45	95	140
Total	105	115	220

* vph = vehicles per hour.

It is important to note that a 100-space surface parking lot currently exists on the site. This evaluation relied upon traffic volume networks previously established in the Federal Street Multi-Modal Connector Road Environmental Assessment (EA), which did not specifically identify trips associated with the existing lot. For analysis purposes, the trip generation cited above was considered to be 100% new traffic to roadway network, which presents a conservative approach for evaluation purposes.

TRAFFIC VOLUMES

The 2010 Existing and Proposed Action weekday morning and weekday evening peak hour traffic volumes from the Federal Street Multi-Modal Connector Road Environmental Assessment (EA) were used as the basis for this assessment. Because these volumes were adjusted to represent a Design Hour Volume (DHV) condition as part of the Federal Street EA, no further seasonal adjustment was required. For informational purposes, the EA Proposed Action for the Lake Street intersection with Catherine Street/Federal Street includes the installation of a traffic signal and conversion of Catherine Street (northbound) and Market Street (southbound) to one-way legs of the intersection. The signalized improvements also include pedestrian accommodations.

The directional distribution of site-generated traffic was approximated based on a review of the existing travel patterns within the study area. Based on the distribution, the trips expected to be generated by the proposed development were added to the 2010 Existing and Proposed Action peak hour traffic volumes to establish the 2010 Build volumes under both the Existing and Proposed Action conditions from the Federal Street Connector Road EA.

[2] Parking garage data based on a municipal 525 space parking garage in Portsmouth, NH (August 2005).

TRAFFIC ANALYSES

Intersection capacity analyses were performed for the study area intersections. Levels of service (LOS) were calculated based on the criteria published in the 2000 Highway Capacity Manual[3]. Level of service is the term that defines the conditions that may occur on a given roadway or at an intersection when accommodating various traffic volume loads. Levels of service range from A to F with LOS A representing the best operating conditions and LOS F representing the worst. Copies of the level of service calculations have been provided in the Appendix.

It should be noted that capacity analysis was conducted for both the Existing and Proposed Action conditions from the Federal Street Connector Road EA. The signalized intersection of Lake Street at North Main Street is expected to operate at LOS C with or without the proposed development under both the Existing and the Proposed Action conditions. Under the Proposed Action the signalized intersection of Lake Street at Federal Street/Catherine Street is projected to operate at LOS D during the weekday morning peak hour and LOS E during the weekday evening peak hour with or without the proposed development program. It should be pointed out that the Proposed Action LOS E operations projected for the intersection of Lake Street at Federal Street/Catherine Street is a result of the goals associated with the EA to enhance the multi-modal nature of the downtown area and promote pedestrian activity. The lower LOS can be in part attributed toward the use of an exclusive pedestrian phase at the intersection to assist in accomplishing the EA goals. Traffic operations will be better than reported under conditions where the pedestrian phase is not activated.

The capacity analysis reported small changes in vehicle delays and volume to capacity ratios as a result of the traffic volumes associated with the proposed development program. There will be no noticeable change in overall operations to motorists as a result of the proposed development program. Table 2 summarizes the level of service results for the signalized intersections with and without the proposed development program under both the Existing and the Proposed Action conditions.

TABLE 2

SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

		2010 - Existing Conditions					
	Peak	No Build			Build		
Location	Period	v/c*	Delay**	LOS***	v/c	Delay	LOS
Lake St at	AM	0.51	24	C	0.52	26	C
North Main St	PM	0.79	28	C	0.82	30	C
		2010 - Proposed Action (Federal St EA)					
	Peak	No Build			Build		
Location	Period	v/c*	Delay**	LOS***	v/c	Delay	LOS
Lake St at	AM	0.36	21	C	0.39	23	C
North Main St	PM	0.57	29	C	0.60	26	C
Lake St at	AM	0.61	43	D	0.65	45	D
Catherine St/Federal St	PM	0.80	69	E	0.84	59	E

* Volume to capacity ratio.

** Delay expressed in seconds per vehicle.

*** Level of service.

Table 3 and 4 summarizes the level of service results for the unsignalized study area intersections (Lake Street at Catherine Street/Federal Street, Lake Street at the site driveway, and Federal Street at the site

[3] Highway Capacity Manual, Federal Highway Administration, Transportation Research Board, 2000.

driveway). The minor street approaches of Catherine Street and Federal Street at the intersection of Lake Street operate at LOS D and C respectively during the weekday morning peak hour and at LOS F during the weekday evening peak hour under the Existing condition with or without the proposed development program. All movements at both unsignalized site driveways are expected to operate acceptably (LOS C or better) under both the Existing and the Proposed Action conditions.

TABLE 3

UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2010 Weekday Morning - Existing Conditions					
	No Build			Build		
Location / Movement	Demand*	Delay^	LOS+	Demand	Delay	LOS
Lake St at Catherine St/Federal St						
EB movements from Lake St	335	4	A	365	4	A
WB movements from Lake St	250	1	A	255	1	A
NB movements from Catherine St	65	29	D	70	32	D
SB movements from Federal St	325	20	C	325	22	C
Lake St at site driveway						
SB movements from site driveway	-	-	-	15	12	B
EB shared left/through from Lake St	-	-	-	235	1	A
Federal St at site driveway						
SB shared left/through from Federal St	-	-	-	345	1	A
WB movements from site driveway	-	-	-	1	12	B

	2010 Weekday Evening - Existing Conditions					
	No Build			Build		
Location / Movement	Demand	Delay	LOS	Demand	Delay	LOS
Lake St at Catherine St/Federal St						
EB movements from Lake St	620	6	A	640	6	A
WB movements from Lake St	315	1	A	355	1	A
NB movements from Catherine St	100	>180	F	105	>180	F
SB movements from Federal St	355	>180	F	360	>180	F
Lake St at site driveway						
SB movements from site driveway	-	-	-	115	17	C
EB shared left/through from Lake St	-	-	-	380	1	A
Federal St at site driveway						
SB shared left/through from Federal St	-	-	-	365	1	A
WB movements from site driveway	-	-	-	25	13	B

* Demand in vehicles per hour.

^ Delay in seconds per vehicle.

\+ Level of service.

TABLE 4

UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2010 - Proposed Action (Federal St EA)					
	Build Weekday Morning			Build Weekday Evening		
Location / Movement	Demand*	Delay^	LOS+	Demand	Delay	LOS
Lake St at site driveway						
SB movements from site driveway	10	12	B	95	16	C
EB shared left/through from Lake St	210	1	A	295	1	A
Federal St at site driveway						
SB shared left/through from Federal St	370	1	A	445	1	A
WB movements from site driveway	5	12	B	45	16	C

* Demand in vehicles per hour.

^ Delay in seconds per vehicle.

\+ Level of service.

As noted previously, the operational results should be considered conservative as they do not take credit for trips currently being generated by the existing 100-space surface parking lot located on the site.

Queues

The maximum queues on all approaches at both site driveways are expected to be approximately 50 feet or less under the Existing condition and 25 feet or less under the Proposed Action.

Under the Existing condition the maximum southbound queues on Federal Street approaching the unsignalized intersection of Lake Street and Catherine Street are calculated to reach 100 feet during the weekday morning peak hour and over 700 feet during the weekday evening peak hour with or without the proposed development program. As a result, this weekday evening peak hour queue will extend beyond the proposed site driveway on Federal Street (360 north of Lake Street) under the Existing condition. Being an urban environment, this type of condition is not unusual or unexpected for a busy corridor under peak hour conditions. With the Proposed Action from the Federal Street Connector Road EA in place, the maximum southbound queues on Federal Street approaching the signalized intersection of Lake Street and Catherine Street will be much shorter at 125 feet and 225 during the weekday morning and weekday evening peak hours respectively and queues will no longer block the Federal Street site driveway. Therefore, under the Existing condition the City may want to be prepared to provide signage that restricts exiting movements at the Federal Street site driveway to right-turn only as a temporary measure, if the condition becomes problematic once constructed.

Under the Existing condition the mainline approaches on Lake Street at the unsignalized intersection of Catherine Street and Federal Street are calculated to have queues of 50 feet or less during the weekday morning and weekday evening peak hours. However, both the average and the maximum westbound queues on Lake Street approaching the intersection of Federal Street and Catherine Street are expected to block the proposed site driveway on Lake Street during the weekday evening peak hour under the Proposed Action condition. Additionally, the eastbound maximum queue on Lake Street approaching the intersection of North Main Street is expected to block the proposed site driveway on Lake Street during the weekday evening peak hour condition under both the Existing and Proposed Action conditions. As a result of queues potentially blocking the driveway in both directions, the City should be prepared to provide signage that restricts movements at the Lake Street site driveway to right-turns only under the Proposed Action if traffic operations become problematic under this condition.

It is our understanding that site constraints would prohibit the construction of channelized right-turn driveways that would force right-turn movements. Traffic volume data is not available for other times

periods throughout the day (such as noontime) or on Saturday. If volumes during other periods are less than the weekday evening peak hour, the City could consider only restricting movements during the weekday evening peak period (example: 3:00 PM to 6:00 PM), and allowing full movements during the less congested time periods. However, as stated above, the implementation of restrictions may not be necessary if actual traffic operations in the field are better than estimated in the conservative analysis.

CONCLUSIONS

The proposed development calls for constructing a new 370 space parking garage and a State office building that will have approximately 150 employees. Trip generation estimates indicate that the project will generate approximately 130 trips (115 entering and 15 exiting) during the weekday morning peak hour and 220 trips (80 entering and 140 exiting) during the weekday evening peak hour; noting that these estimates include trips currently being generated by the existing 100-space surface parking lot located on the site.

Traffic operations are expected to remain at the same LOS with or without the proposed development and motorists will experience no noticeable change in delay as a result of the project. Specifically, the signalized intersection of Lake Street at North Main Street is expected to operate at LOS C with or without the proposed development. Under the Existing condition the southbound minor street approach of Federal Street at the unsignalized intersection of Catherine Street and Lake Street will operate at LOS F during the weekday evening peak hour with or without the proposed development program. However under the Proposed Action condition the signalized intersection of Lake Street at Federal Street/Catherine Street is projected to operate at LOS D under the weekday morning peak hour and LOS E under the weekday evening peak hour with or without the proposed development program. All movements at both unsignalized site driveways are expected to operate acceptably (LOS C or better).

Access and egress to and from the site is proposed via two full access site driveways: one on Lake Street 170 feet west of North Main Street and the other on Federal Street 360 feet north of Lake Street. Lake Street and Federal Street provide clear lines of sight approaching the site driveways due to their straight alignment. However the southbound queue on Federal Street approaching the unsignalized intersection of Catherine Street and Lake Street will block the site driveway on Federal Street under the Existing condition. Additionally, queues along Lake Street from the adjacent signals at Federal Street and North Main Street will block the site driveway on Lake Street under the Proposed Action condition. Therefore, the City may want to consider and plan for limiting exiting movements at the Federal Street driveway to right-turn only under the Existing condition as a temporary measure if the left-turns exiting become difficult and limiting entering and exiting movements to right-turn only at the Lake Street driveway in the future under the Proposed Action condition during specific times of the day or all day. However, the implementation of restrictions may not be necessary if actual traffic operations in the field are better than estimated in the conservative analysis.

Appendix

- Trip Generation
- Signalized Intersection Capacity Analyses
- Unsignalized Intersection Capacity Analyses

Trip Generation

St Albans 370 space parking lot

Total Spaces = 370
State Office Spaces = 170
Other Spaces (Public/Hotel) = 200

	Peak Month Trips*	Trip Rate**	Public/Hotel (200 Spaces) Projected Trips***	Public/Hotel (200 Spaces) **Projected Trips**	**State Office Building (170 Spaces / 150 Emps.)**	**Total**
Weekday Morning						
Entering	79	0.15	30	**30**	**85**	**115**
Exiting	4	0.01	2	**5**	**10**	**15**
Total	83	0.16	32	**35**	**95**	**130**
Weekday Evening						
Entering	157	0.30	60	**60**	**20**	**80**
Exiting	119	0.23	45	**45**	**95**	**140**
Total	276	0.53	105	**105**	**115**	**220**

*Based on data provided by existing Portsmouth, NH municipal garage for August 2005 (peak month).
**Based on 525 existing transient spaces.
Data from the High-Hanover Parking Garage from VAI March 2007 TIAS Westin Hotel
***Based on 200 additinoal spaces (Public/Hotel).

General Office Building
(710)

Average Vehicle Trip Ends vs: Employees
On a: Weekday,
A.M. Peak Hour

Number of Studies: 163
Avg. Number of Employees: 695
Directional Distribution: 88% entering, 12% exiting

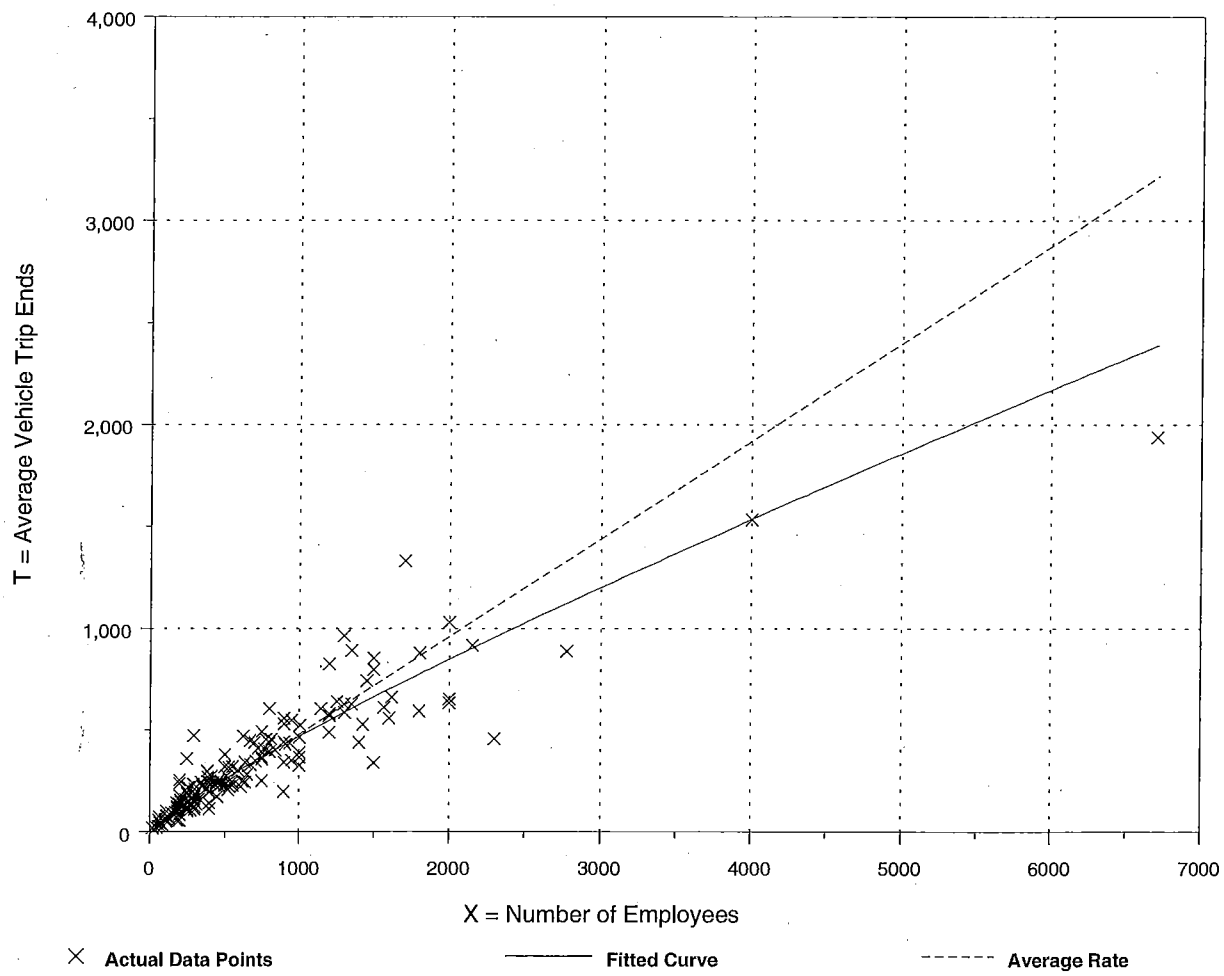
Trip Generation per Employee

Average Rate	Range of Rates	Standard Deviation
0.48 x 150	0.20 - 1.62	0.71

= 72

USE 95 (85 IN, 10 OUT)

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.86 Ln(X) + 0.24 $R^2 = 0.88$

@ 150 = 95

General Office Building
(710)

Average Vehicle Trip Ends vs: Employees
On a: Weekday,
P.M. Peak Hour

Number of Studies: 173
Avg. Number of Employees: 688
Directional Distribution: 17% entering, 83% exiting

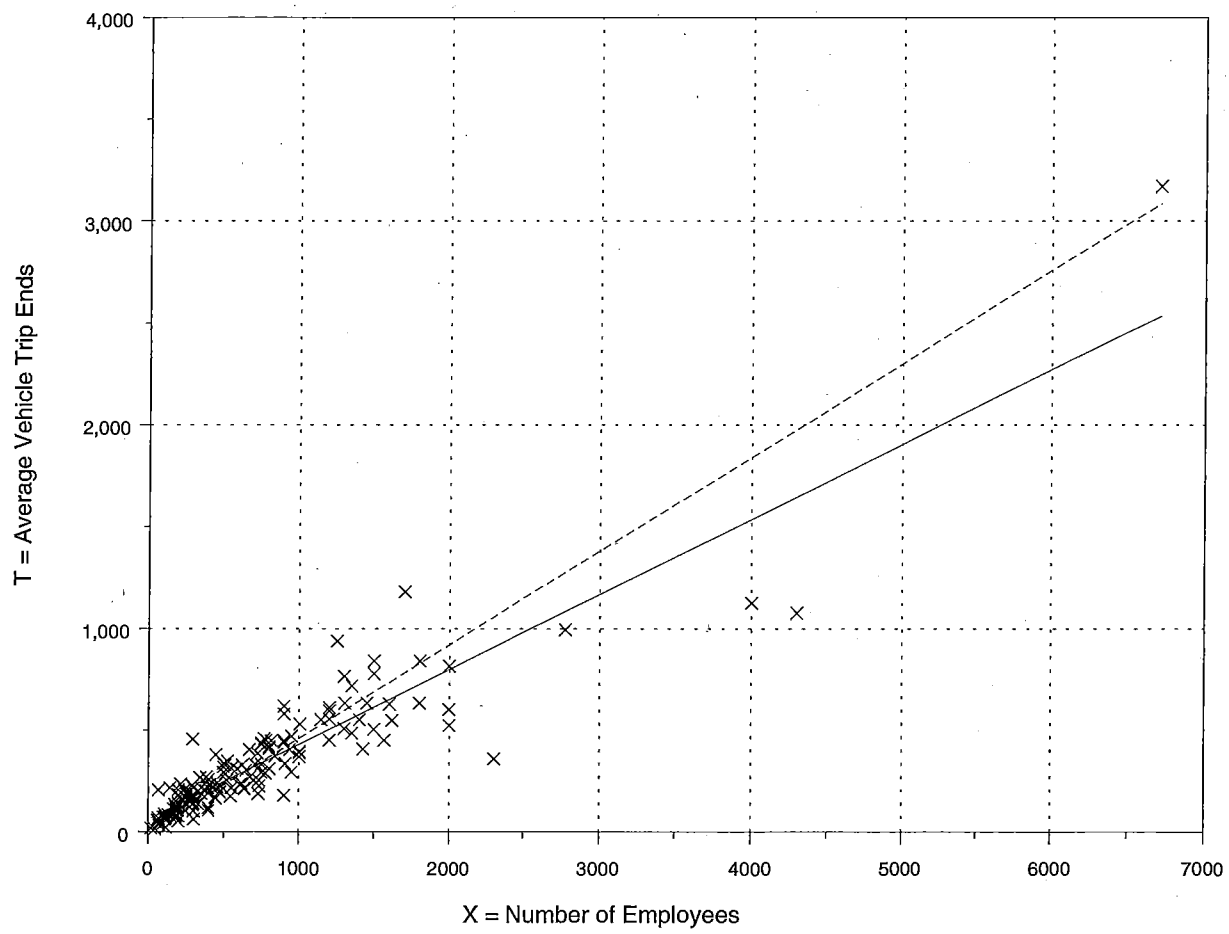
Trip Generation per Employee

Average Rate	Range of Rates	Standard Deviation
0.46 × 150	0.16 - 3.12	0.70

= 69

USE 115 (20 IN, 95 OUT)

Data Plot and Equation



× Actual Data Points ——— Fitted Curve ------ Average Rate

Fitted Curve Equation: T = 0.37(X) + 60.08 **R^2 = 0.84**

@ 150 = 116

Signalized Intersection Capacity Analysis

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	95	120	135	395	305	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1719	1538	1736	1827	3471	1553
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1719	1538	1736	1827	3471	1553
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	103	130	147	429	332	125
RTOR Reduction (vph)	0	108	0	0	0	99
Lane Group Flow (vph)	103	22	147	429	332	26
Heavy Vehicles (%)	5%	5%	4%	4%	4%	4%
Turn Type		Over	Prot			Perm
Protected Phases	4	5	5	2 5	6	
Permitted Phases						6
Actuated Green, G (s)	14.0	15.0	15.0	38.0	19.0	19.0
Effective Green, g (s)	14.0	15.0	15.0	38.0	19.0	19.0
Actuated g/C Ratio	0.16	0.17	0.17	0.42	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0		4.0	4.0
Lane Grp Cap (vph)	267	256	289	771	733	328
v/s Ratio Prot	c0.06	0.01	0.08	c0.23	0.10	
v/s Ratio Perm						0.02
v/c Ratio	0.39	0.08	0.51	0.56	0.45	0.08
Uniform Delay, d1	34.1	31.7	34.1	19.6	31.0	28.5
Progression Factor	1.00	1.00	0.63	0.35	1.00	1.00
Incremental Delay, d2	4.2	0.6	5.2	2.4	2.0	0.5
Delay (s)	38.3	32.3	26.5	9.2	33.0	29.0
Level of Service	D	C	C	A	C	C
Approach Delay (s)	35.0			13.6	31.9	
Approach LOS	C			B	C	

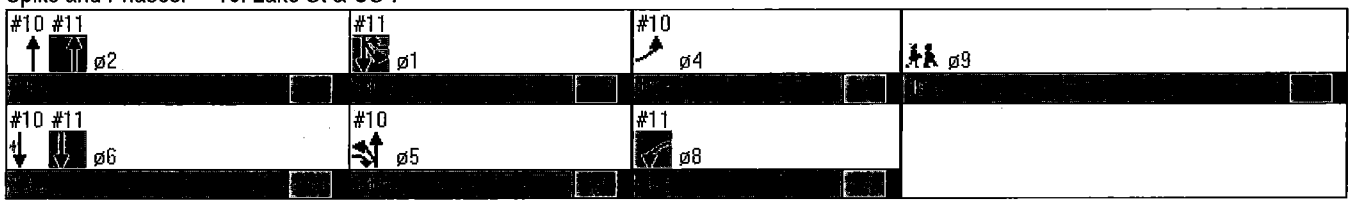
Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	38.0
Intersection Capacity Utilization	32.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	95	120	135	395	305	115				
Lane Group Flow (vph)	103	130	147	429	332	125				
Turn Type		Over	Prot			Perm				
Protected Phases	4	5	5	2 5	6		1	2	8	9
Permitted Phases						6				
Minimum Split (s)	10.0	10.0	10.0		10.0	10.0	10.0	10.0	10.0	30.0
Total Split (s)	18.0	19.0	19.0	42.0	23.0	23.0	19.0	23.0	18.0	30.0
Total Split (%)	20.0%	21.1%	21.1%	46.7%	25.6%	25.6%	21%	26%	20%	33%
Yellow Time (s)	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag		Lag	Lag		Lead	Lead	Lag	Lead		
Lead-Lag Optimize?										
v/c Ratio	0.39	0.36	0.51	0.56	0.45	0.29				
Control Delay	39.0	9.3	27.0	9.3	33.3	7.8				
Queue Delay	0.0	0.1	23.4	1.2	0.4	0.0				
Total Delay	39.0	9.5	50.3	10.5	33.7	7.8				
Queue Length 50th (ft)	53	0	86	61	87	0				
Queue Length 95th (ft)	103	48	m125	56	129	44				
Internal Link Dist (ft)	525			79	1579					
Turn Bay Length (ft)		275				100				
Base Capacity (vph)	267	365	289	771	733	426				
Starvation Cap Reductn	0	0	131	161	0	0				
Spillback Cap Reductn	0	23	0	0	113	0				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.39	0.38	0.93	0.70	0.54	0.29				

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green
Natural Cycle: 60
Control Type: Pretimed
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: Lake St & US 7



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	160	210	175	600	420	155
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1736	1827	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	1736	1827	3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	174	228	190	652	457	168
RTOR Reduction (vph)	0	190	0	0	0	133
Lane Group Flow (vph)	174	38	190	652	457	35
Heavy Vehicles (%)	2%	2%	4%	4%	2%	2%
Turn Type		Over	Prot			Perm
Protected Phases	4	5	5	2 5	6	
Permitted Phases						6
Actuated Green, G (s)	14.0	15.0	15.0	38.0	19.0	19.0
Effective Green, g (s)	14.0	15.0	15.0	38.0	19.0	19.0
Actuated g/C Ratio	0.16	0.17	0.17	0.42	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0		4.0	4.0
Lane Grp Cap (vph)	275	264	289	771	747	334
v/s Ratio Prot	c0.10	0.02	0.11	c0.36	0.13	
v/s Ratio Perm						0.02
v/c Ratio	0.63	0.14	0.66	0.85	0.61	0.11
Uniform Delay, d1	35.6	32.0	35.1	23.4	32.2	28.6
Progression Factor	1.00	1.00	0.56	0.35	1.00	1.00
Incremental Delay, d2	10.6	1.1	6.5	6.7	3.7	0.6
Delay (s)	46.2	33.2	26.3	14.8	35.9	29.3
Level of Service	D	C	C	B	D	C
Approach Delay (s)	38.8			17.4	34.1	
Approach LOS	D			B	C	

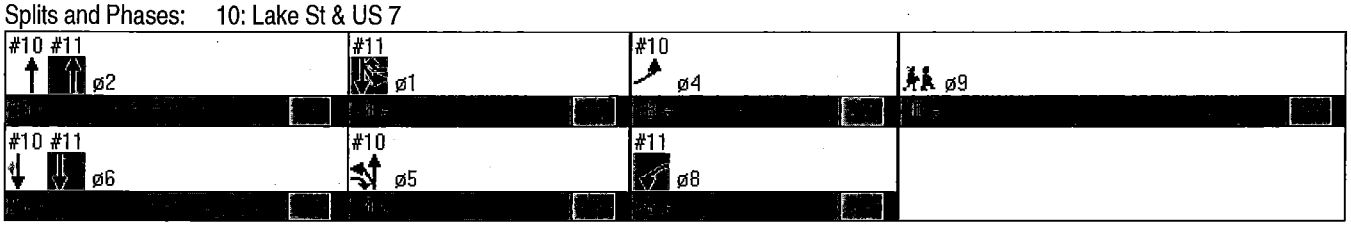
Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	38.0
Intersection Capacity Utilization	47.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	160	210	175	600	420	155				
Lane Group Flow (vph)	174	228	190	652	457	168				
Turn Type		Over	Prot			Perm				
Protected Phases	4	5	5	2 5	6		1	2	8	9
Permitted Phases						6				
Minimum Split (s)	10.0	10.0	10.0		10.0	10.0	10.0	10.0	10.0	30.0
Total Split (s)	18.0	19.0	19.0	42.0	23.0	23.0	19.0	23.0	18.0	30.0
Total Split (%)	20.0%	21.1%	21.1%	46.7%	25.6%	25.6%	21%	26%	20%	33%
Yellow Time (s)	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag		Lag	Lag		Lead	Lead	Lag	Lead		
Lead-Lag Optimize?										
v/c Ratio	0.63	0.50	0.66	0.85	0.61	0.36				
Control Delay	47.0	9.0	27.1	16.2	36.2	7.4				
Queue Delay	0.0	0.3	114.4	30.8	3.5	0.0				
Total Delay	47.0	9.3	141.5	47.0	39.7	7.4				
Queue Length 50th (ft)	94	0	114	390	124	0				
Queue Length 95th (ft)	#165	62	m131	m410	175	51				
Internal Link Dist (ft)	525			79	1579					
Turn Bay Length (ft)		275				100				
Base Capacity (vph)	275	454	289	771	747	467				
Starvation Cap Reductn	0	0	134	150	0	0				
Spillback Cap Reductn	0	33	0	0	199	0				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.63	0.54	1.23	1.05	0.83	0.36				

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green
Natural Cycle: 80
Control Type: Pretimed
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: Lake St & US 7



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	100	125	170	395	305	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1719	1538	1736	1827	3471	1553
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1719	1538	1736	1827	3471	1553
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	136	185	429	332	152
RTOR Reduction (vph)	0	113	0	0	0	120
Lane Group Flow (vph)	109	23	185	429	332	32
Heavy Vehicles (%)	5%	5%	4%	4%	4%	4%
Turn Type		Over	Prot			Perm
Protected Phases	4	5	5	2 5	6	
Permitted Phases						6
Actuated Green, G (s)	14.0	15.0	15.0	38.0	19.0	19.0
Effective Green, g (s)	14.0	15.0	15.0	38.0	19.0	19.0
Actuated g/C Ratio	0.16	0.17	0.17	0.42	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0		4.0	4.0
Lane Grp Cap (vph)	267	256	289	771	733	328
v/s Ratio Prot	c0.06	0.01	0.11	c0.23	0.10	
v/s Ratio Perm						0.02
v/c Ratio	0.41	0.09	0.64	0.56	0.45	0.10
Uniform Delay, d1	34.3	31.7	35.0	19.6	31.0	28.6
Progression Factor	1.00	1.00	0.66	0.38	1.00	1.00
Incremental Delay, d2	4.6	0.7	8.9	2.5	2.0	0.6
Delay (s)	38.8	32.4	32.1	10.0	33.0	29.2
Level of Service	D	C	C	B	C	C
Approach Delay (s)	35.3			16.7	31.8	
Approach LOS	D			B	C	

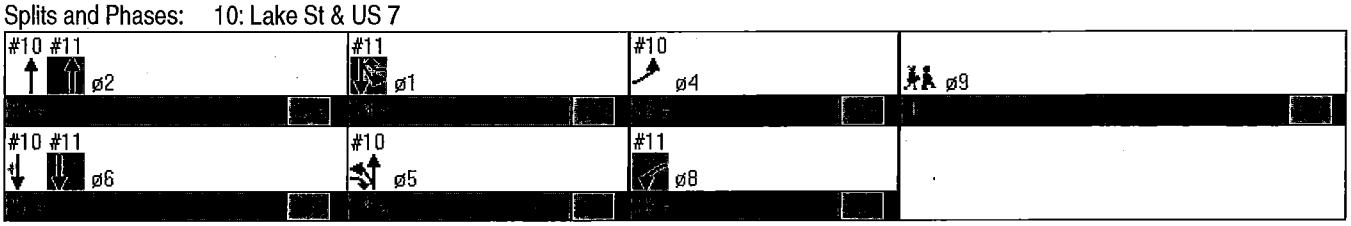
Intersection Summary			
HCM Average Control Delay	25.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	38.0
Intersection Capacity Utilization	33.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	100	125	170	395	305	140				
Lane Group Flow (vph)	109	136	185	429	332	152				
Turn Type		Over	Prot			Perm				
Protected Phases	4	5	5	2 5	6		1	2	8	9
Permitted Phases						6				
Minimum Split (s)	10.0	10.0	10.0		10.0	10.0	10.0	10.0	10.0	30.0
Total Split (s)	18.0	19.0	19.0	42.0	23.0	23.0	19.0	23.0	18.0	30.0
Total Split (%)	20.0%	21.1%	21.1%	46.7%	25.6%	25.6%	21%	26%	20%	33%
Yellow Time (s)	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag		Lag	Lag		Lead	Lead	Lag	Lead		
Lead-Lag Optimize?										
v/c Ratio	0.41	0.37	0.64	0.56	0.45	0.34				
Control Delay	39.5	9.3	32.8	10.2	33.3	7.6				
Queue Delay	0.0	0.2	70.4	1.2	0.4	0.0				
Total Delay	39.5	9.5	103.2	11.5	33.7	7.6				
Queue Length 50th (ft)	57	0	108	68	87	0				
Queue Length 95th (ft)	107	49	m#170	66	129	48				
Internal Link Dist (ft)	277			79	1579					
Turn Bay Length (ft)		275				100				
Base Capacity (vph)	267	370	289	771	733	448				
Starvation Cap Reductn	0	0	123	164	0	0				
Spillback Cap Reductn	0	23	0	0	110	0				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.41	0.39	1.11	0.71	0.53	0.34				

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green
Natural Cycle: 60
Control Type: Pretimed
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: Lake St & US 7



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	195	250	200	600	420	175
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1736	1827	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	1736	1827	3539	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	212	272	217	652	457	190
RTOR Reduction (vph)	0	227	0	0	0	150
Lane Group Flow (vph)	212	45	217	652	457	40
Heavy Vehicles (%)	2%	2%	4%	4%	2%	2%
Turn Type		Over	Prot			Perm
Protected Phases	4	5	5	2 5	6	
Permitted Phases						6
Actuated Green, G (s)	14.0	15.0	15.0	38.0	19.0	19.0
Effective Green, g (s)	14.0	15.0	15.0	38.0	19.0	19.0
Actuated g/C Ratio	0.16	0.17	0.17	0.42	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0		4.0	4.0
Lane Grp Cap (vph)	275	264	289	771	747	334
v/s Ratio Prot	c0.12	0.03	0.13	c0.36	0.13	
v/s Ratio Perm						0.03
v/c Ratio	0.77	0.17	0.75	0.85	0.61	0.12
Uniform Delay, d1	36.5	32.2	35.7	23.4	32.2	28.7
Progression Factor	1.00	1.00	0.58	0.37	1.00	1.00
Incremental Delay, d2	18.7	1.4	10.4	7.0	3.7	0.7
Delay (s)	55.1	33.6	31.3	15.6	35.9	29.5
Level of Service	E	C	C	B	D	C
Approach Delay (s)	43.0			19.5	34.0	
Approach LOS	D			B	C	

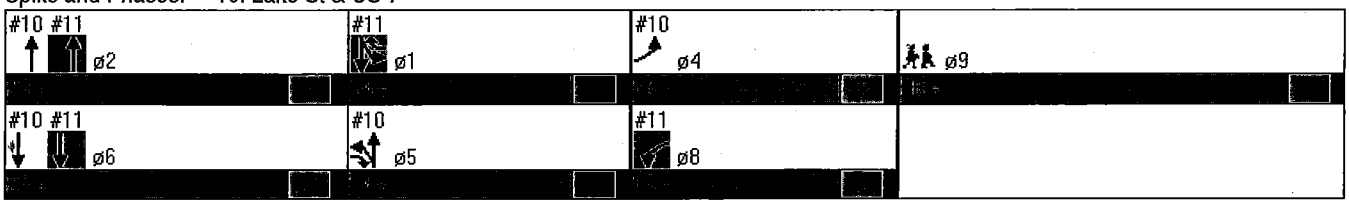
Intersection Summary			
HCM Average Control Delay	29.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	38.0
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	195	250	200	600	420	175				
Lane Group Flow (vph)	212	272	217	652	457	190				
Turn Type		Over	Prot			Perm				
Protected Phases	4	5	5	2 5	6		1	2	8	9
Permitted Phases						6				
Minimum Split (s)	10.0	10.0	10.0		10.0	10.0	10.0	10.0	10.0	30.0
Total Split (s)	18.0	19.0	19.0	42.0	23.0	23.0	19.0	23.0	18.0	30.0
Total Split (%)	20.0%	21.1%	21.1%	46.7%	25.6%	25.6%	21%	26%	20%	33%
Yellow Time (s)	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag		Lag	Lag		Lead	Lead	Lag	Lead		
Lead-Lag Optimize?										
v/c Ratio	0.77	0.55	0.75	0.85	0.61	0.39				
Control Delay	56.6	9.2	33.2	17.1	36.2	7.4				
Queue Delay	0.0	0.4	166.9	31.4	3.6	0.0				
Total Delay	56.6	9.6	200.1	48.4	39.8	7.4				
Queue Length 50th (ft)	117	0	131	388	124	0				
Queue Length 95th (ft)	#226	67	m153	m412	175	53				
Internal Link Dist (ft)	267			79	1579					
Turn Bay Length (ft)		275				100				
Base Capacity (vph)	275	491	289	771	747	484				
Starvation Cap Reductn	0	0	129	151	0	0				
Spillback Cap Reductn	0	37	0	0	200	0				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.77	0.60	1.36	1.05	0.84	0.39				

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green
Natural Cycle: 90
Control Type: Pretimed
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: Lake St & US 7



Movement	EBL	EBR	EBR2	NBL	NBT	NBR	SBL	SBT	NWL2	NWT	NWR
Lane Configurations											
Volume (vph)	75	150	30	50	145	70	120	135	25	80	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	12	12	12	12	14	14	12	12	12
Total Lost time (s)	4.0	4.0			5.0			3.0	4.0	5.0	4.0
Lane Util. Factor	1.00	1.00			1.00			1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00			0.99			1.00	1.00	1.00	0.97
Flpb, ped/bikes	0.99	1.00			1.00			1.00	0.99	1.00	1.00
Frt	1.00	0.85			0.96			1.00	1.00	0.95	0.85
Flt Protected	0.95	1.00			0.99			0.98	0.95	1.00	1.00
Satd. Flow (prot)	1636	1524			1689			1886	1702	1719	1485
Flt Permitted	0.95	1.00			0.99			0.98	0.95	1.00	1.00
Satd. Flow (perm)	1636	1524			1689			1886	1702	1719	1485
Peak-hour factor, PHF	0.72	0.72	0.72	0.80	0.80	0.80	0.86	0.86	0.84	0.84	0.84
Adj. Flow (vph)	104	208	42	62	181	88	140	157	30	95	286
RTOR Reduction (vph)	0	7	0	0	12	0	0	0	0	0	257
Lane Group Flow (vph)	104	243	0	0	319	0	0	297	30	95	29
Confl. Peds. (#/hr)	3		2			14	14		2		3
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	5%	5%	5%	5%	5%
Turn Type		custom		Split			Split		Perm		Perm
Protected Phases	5	2		4	4		3	3		6	
Permitted Phases	2								6		6
Actuated Green, G (s)	25.7	25.7			24.2			36.7	10.0	10.0	10.0
Effective Green, g (s)	26.7	26.7			25.2			39.7	11.0	10.0	11.0
Actuated g/C Ratio	0.24	0.24			0.23			0.36	0.10	0.09	0.10
Clearance Time (s)	5.0	5.0			6.0			6.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	397	370			387			681	170	156	149
v/s Ratio Prot	0.03	c0.16			c0.19			c0.16		0.06	
v/s Ratio Perm	0.04								0.02		0.02
v/c Ratio	0.26	0.66			0.82			0.44	0.18	0.61	0.19
Uniform Delay, d1	33.7	37.5			40.3			26.7	45.4	48.1	45.4
Progression Factor	1.00	1.00			1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	4.2			13.2			2.0	0.5	6.6	0.6
Delay (s)	34.0	41.7			53.5			28.7	45.8	54.7	46.1
Level of Service	C	D			D			C	D	D	D
Approach Delay (s)	39.5				53.5			28.7		48.0	
Approach LOS	D				D			C		D	

Intersection Summary			
HCM Average Control Delay	43.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.4
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

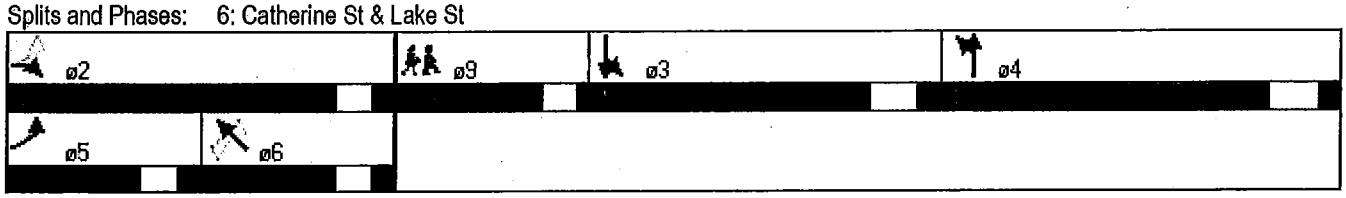
c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT	NWL2	NWT	NWR	ø9
Lane Configurations								
Volume (vph)	75	150	145	135	25	80	240	
Lane Group Flow (vph)	104	250	331	297	30	95	286	
Turn Type		custom			Perm		Perm	
Protected Phases	5	2	4	3		6		9
Permitted Phases	2				6		6	
Detector Phase	5	2	4	3	6	6	6	
Switch Phase								
Minimum Initial (s)	10.0	10.0	5.0	5.0	4.0	4.0	4.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Total Split (s)	16.0	32.0	33.0	29.0	16.0	16.0	16.0	16.0
Total Split (%)	14.5%	29.1%	30.0%	26.4%	14.5%	14.5%	14.5%	15%
Yellow Time (s)	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-3.0	-1.0	0.0	-1.0	
Total Lost Time (s)	4.0	4.0	5.0	3.0	4.0	5.0	4.0	
Lead/Lag	Lead			Lag	Lag	Lag	Lag	Lead
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Min	None	None	None	None
v/c Ratio	0.26	0.66	0.83	0.40	0.18	0.61	0.70	
Control Delay	35.2	45.5	55.9	29.4	47.3	64.6	15.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	35.2	45.5	55.9	29.4	47.3	64.6	15.7	
Queue Length 50th (ft)	58	150	209	151	19	65	0	
Queue Length 95th (ft)	83	180	266	271	46	112	60	
Internal Link Dist (ft)	486		514	140		468		
Turn Bay Length (ft)	300				50		370	
Base Capacity (vph)	398	397	445	736	187	173	418	
Starvation Cap Reductn	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.26	0.63	0.74	0.40	0.16	0.55	0.68	

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 3:SBTL, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 6: Catherine St & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	130	320	265	135	100	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3471	1553	1719	1538
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3471	1553	1719	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	141	348	288	147	109	98
RTOR Reduction (vph)	0	0	0	83	0	75
Lane Group Flow (vph)	141	348	288	64	109	23
Heavy Vehicles (%)	4%	4%	4%	4%	5%	5%
Turn Type	Prot			Perm		Over
Protected Phases	5	2 5	6		4	5
Permitted Phases				6		
Actuated Green, G (s)	27.3	61.8	51.2	51.2	12.9	27.3
Effective Green, g (s)	28.3	62.8	52.2	52.2	13.9	28.3
Actuated g/C Ratio	0.24	0.52	0.44	0.44	0.12	0.24
Clearance Time (s)	5.0		5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	409	956	1510	676	199	363
v/s Ratio Prot	0.08	c0.19	c0.08		c0.06	0.02
v/s Ratio Perm				0.04		
v/c Ratio	0.34	0.36	0.19	0.09	0.55	0.06
Uniform Delay, d1	38.1	16.8	20.9	20.0	50.1	35.6
Progression Factor	0.67	0.51	0.80	0.78	1.00	1.00
Incremental Delay, d2	0.5	0.2	0.3	0.3	3.1	0.1
Delay (s)	26.0	8.8	17.0	15.9	53.1	35.6
Level of Service	C	A	B	B	D	D
Approach Delay (s)		13.8	16.7		44.9	
Approach LOS		B	B		D	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	25.6
Intersection Capacity Utilization	31.1%	ICU Level of Service	A
Analysis Period (min)	15		

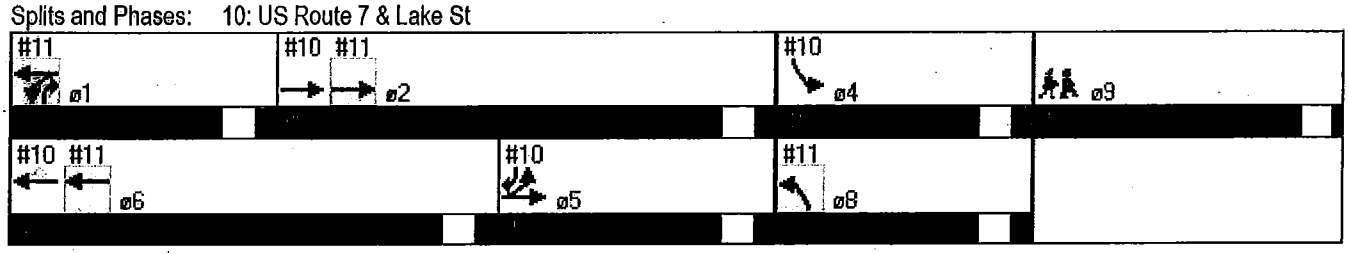
c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBR	SBL	SBR	ø1	ø2	ø6	ø9
Lane Configurations										
Volume (vph)	130	320	265	135	100	90				
Lane Group Flow (vph)	141	348	288	147	109	98				
Turn Type	Prot			Perm		Over				
Protected Phases	5	2 5	6		4	5	1	2	8	9
Permitted Phases				6						
Detector Phase	5	2 5	6	6	4	5				
Switch Phase										
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	5.0	10.0	5.0	4.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	16.0	28.0
Total Split (s)	25.0	70.0	44.0	44.0	23.0	25.0	24.0	45.0	23.0	28.0
Total Split (%)	20.8%	58.3%	36.7%	36.7%	19.2%	20.8%	20%	38%	19%	23%
Yellow Time (s)	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag	Lag		Lead	Lead		Lag	Lead	Lag		
Lead-Lag Optimize?							Yes	Yes		
Recall Mode	None		C-Min	C-Min	None	None	None	C-Min	None	None
v/c Ratio	0.34	0.35	0.18	0.19	0.55	0.22				
Control Delay	27.0	12.3	20.5	5.1	59.9	7.8				
Queue Delay	101.4	1.6	0.0	0.0	0.0	0.1				
Total Delay	128.4	13.9	20.5	5.1	59.9	7.9				
Queue Length 50th (ft)	76	51	68	9	81	0				
Queue Length 95th (ft)	94	219	78	9	135	42				
Internal Link Dist (ft)		60	1628		514					
Turn Bay Length (ft)				100		275				
Base Capacity (vph)	412	1014	1701	836	272	440				
Starvation Cap Reductn	292	484	0	0	0	0				
Spillback Cap Reductn	0	0	13	0	0	57				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	1.18	0.66	0.17	0.18	0.40	0.26				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: US Route 7 & Lake St



Movement	EBL	EBR	EBR2	NBL	NBT	NBR	SBL	SBT	NWL2	NWL	NWR
Lane Configurations											
Volume (vph)	60	230	50	40	275	45	315	200	30	155	245
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	12	12	12	12	14	14	12	12	12
Total Lost time (s)	4.0	4.0			5.0			3.0	4.0	5.0	4.0
Lane Util. Factor	1.00	1.00			1.00			1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00			0.99			1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00			1.00			1.00	0.99	1.00	1.00
Frt	1.00	0.85			0.98			1.00	1.00	0.95	0.85
Flt Protected	0.95	1.00			0.99			0.97	0.95	1.00	1.00
Satd. Flow (prot)	1708	1583			1792			1947	1746	1770	1547
Flt Permitted	0.95	1.00			0.99			0.97	0.95	1.00	1.00
Satd. Flow (perm)	1708	1583			1792			1947	1746	1770	1547
Peak-hour factor, PHF	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.92	0.92	0.92
Adj. Flow (vph)	65	250	54	43	296	48	328	208	33	168	266
RTOR Reduction (vph)	0	7	0	0	4	0	0	0	0	0	226
Lane Group Flow (vph)	65	297	0	0	383	0	0	536	33	168	40
Confl. Peds. (#/hr)	1		4			15	15		4		1
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	1%	1%	2%	2%	2%
Turn Type		custom		Split			Split		Perm		Perm
Protected Phases	5	2		4	4		3	3		6	
Permitted Phases	2								6		6
Actuated Green, G (s)	30.5	30.5			25.0			40.7	17.2	17.2	17.2
Effective Green, g (s)	31.5	31.5			26.0			43.7	18.2	17.2	18.2
Actuated g/C Ratio	0.26	0.26			0.22			0.36	0.15	0.14	0.15
Clearance Time (s)	5.0	5.0			6.0			6.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	448	416			388			709	265	254	235
v/s Ratio Prot	0.01	c0.19			c0.21			c0.28		0.09	
v/s Ratio Perm	0.03								0.02		0.03
v/c Ratio	0.15	0.71			0.99			0.76	0.12	0.66	0.17
Uniform Delay, d1	33.9	40.2			46.8			33.5	44.0	48.6	44.3
Progression Factor	1.00	1.00			1.00			1.00	1.20	1.23	3.04
Incremental Delay, d2	0.1	5.8			41.2			7.4	0.2	6.0	0.3
Delay (s)	34.1	45.9			87.8			40.8	53.1	65.8	135.0
Level of Service	C	D			F			D	D	E	F
Approach Delay (s)	43.8				87.8			40.8		104.3	
Approach LOS	D				F			D		F	

Intersection Summary			
HCM Average Control Delay	68.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.8
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

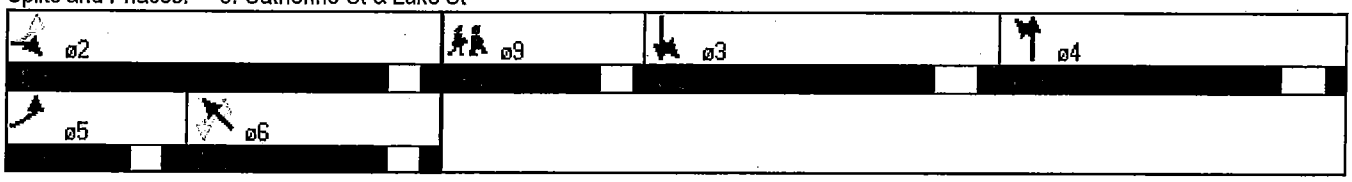
c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT	NWL2	NWT	NWR	ø9
Lane Configurations								
Volume (vph)	60	230	275	200	30	155	245	
Lane Group Flow (vph)	65	304	387	536	33	168	266	
Turn Type		custom			Perm		Perm	
Protected Phases	5	2	4	3		6		9
Permitted Phases	2				6		6	
Detector Phase	5	2	4	3	6	6	6	
Switch Phase								
Minimum Initial (s)	10.0	10.0	5.0	5.0	4.0	4.0	4.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	18.0
Total Split (s)	16.0	39.0	31.0	32.0	23.0	23.0	23.0	18.0
Total Split (%)	13.3%	32.5%	25.8%	26.7%	19.2%	19.2%	19.2%	15%
Yellow Time (s)	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-3.0	-1.0	0.0	-1.0	
Total Lost Time (s)	4.0	4.0	5.0	3.0	4.0	5.0	4.0	
Lead/Lag	Lead			Lag	Lag	Lag	Lag	Lead
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Min	None	None	None	None
v/c Ratio	0.15	0.74	0.99	0.69	0.12	0.66	0.58	
Control Delay	33.6	51.0	88.2	37.9	54.0	72.7	21.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	33.6	51.0	88.2	37.9	54.0	72.7	21.9	
Queue Length 50th (ft)	38	206	308	332	19	103	12	
Queue Length 95th (ft)	73	301	#511	#703	m52	209	161	
Internal Link Dist (ft)	486		514	140		468		
Turn Bay Length (ft)	300				50		370	
Base Capacity (vph)	434	468	392	777	281	270	472	
Starvation Cap Reductn	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.15	0.65	0.99	0.69	0.12	0.62	0.56	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 26 (22%), Referenced to phase 3:SBTL, Start of Yellow
Natural Cycle: 105
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Catherine St & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	150	495	355	210	125	155
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3539	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3539	1583	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	163	538	386	228	136	168
RTOR Reduction (vph)	0	0	0	150	0	113
Lane Group Flow (vph)	163	538	386	78	136	55
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	Prot			Perm		Over
Protected Phases	5	2 5	6		4	5
Permitted Phases				6		
Actuated Green, G (s)	38.0	52.9	39.9	39.9	13.5	38.0
Effective Green, g (s)	39.0	53.9	40.9	40.9	14.5	39.0
Actuated g/C Ratio	0.32	0.45	0.34	0.34	0.12	0.32
Clearance Time (s)	5.0		5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	564	821	1206	540	214	514
v/s Ratio Prot	0.09	c0.29	c0.11		c0.08	0.03
v/s Ratio Perm				0.05		
v/c Ratio	0.29	0.66	0.32	0.14	0.64	0.11
Uniform Delay, d1	30.2	25.8	29.3	27.4	50.2	28.3
Progression Factor	0.51	0.45	0.88	2.54	0.66	1.06
Incremental Delay, d2	0.3	1.8	0.7	0.5	4.9	0.1
Delay (s)	15.7	13.4	26.5	70.1	38.3	30.2
Level of Service	B	B	C	E	D	C
Approach Delay (s)		14.0	42.7		33.8	
Approach LOS		B	D		C	

Intersection Summary			
HCM Average Control Delay	28.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	25.6
Intersection Capacity Utilization	39.6%	ICU Level of Service	A
Analysis Period (min)	15		

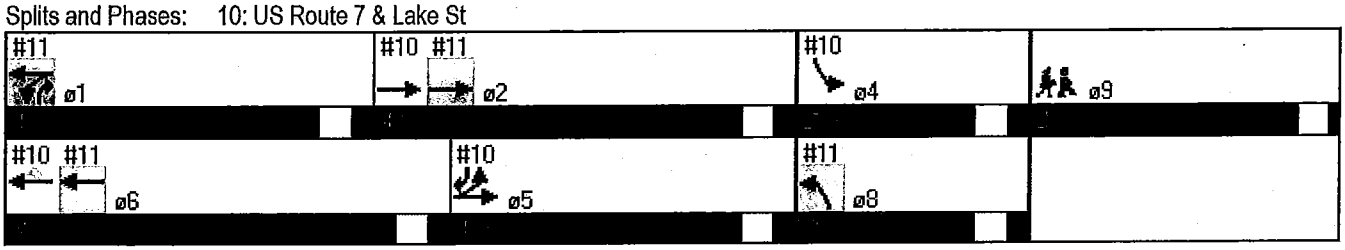
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø1	ø2	ø8	ø9
Lane Configurations	↰	↑	↑↑	↱	↰	↱				
Volume (vph)	150	495	355	210	125	155				
Lane Group Flow (vph)	163	538	386	228	136	168				
Turn Type	Prot			Perm		Over				
Protected Phases	5	2 5	6		4	5	1	2	8	9
Permitted Phases				6						
Detector Phase	5	2 5	6	6	4	5				
Switch Phase										
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	5.0	10.0	5.0	4.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	16.0	28.0
Total Split (s)	31.0	69.0	40.0	40.0	21.0	31.0	33.0	38.0	21.0	28.0
Total Split (%)	25.8%	57.5%	33.3%	33.3%	17.5%	25.8%	28%	32%	18%	23%
Yellow Time (s)	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag	Lag		Lead	Lead		Lag	Lead	Lag		
Lead-Lag Optimize?							Yes	Yes		
Recall Mode	None		C-Min	C-Min	None	None	None	C-Min	None	None
v/c Ratio	0.29	0.63	0.30	0.32	0.63	0.27				
Control Delay	18.5	20.2	26.2	11.6	44.1	7.0				
Queue Delay	8.5	0.8	0.0	0.0	0.0	0.3				
Total Delay	26.9	21.0	26.3	11.6	44.1	7.3				
Queue Length 50th (ft)	96	314	138	58	107	0				
Queue Length 95th (ft)	109	#660	211	161	m141	m59				
Internal Link Dist (ft)		60	1628		514					
Turn Bay Length (ft)				100		275				
Base Capacity (vph)	564	856	1276	717	251	628				
Starvation Cap Reductn	357	112	0	0	0	0				
Spillback Cap Reductn	0	0	49	0	0	145				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.79	0.72	0.31	0.32	0.54	0.35				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 115 (96%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: US Route 7 & Lake St



Movement	EBL	EBR	EBR2	NBL	NBT	NBR	SBL	SBT	NWL2	NWT	NWR
Lane Configurations											
Volume (vph)	75	160	35	50	150	70	130	150	25	80	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	12	12	12	12	14	14	12	12	12
Total Lost time (s)	4.0	4.0			5.0			3.0	4.0	5.0	4.0
Lane Util. Factor	1.00	1.00			1.00			1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00			0.99			1.00	1.00	1.00	0.97
Flpb, ped/bikes	0.99	1.00			1.00			1.00	0.99	1.00	1.00
Frt	1.00	0.85			0.96			1.00	1.00	0.95	0.85
Flt Protected	0.95	1.00			0.99			0.98	0.95	1.00	1.00
Satd. Flow (prot)	1636	1524			1692			1886	1702	1719	1485
Flt Permitted	0.95	1.00			0.99			0.98	0.95	1.00	1.00
Satd. Flow (perm)	1636	1524			1692			1886	1702	1719	1485
Peak-hour factor, PHF	0.72	0.72	0.72	0.80	0.80	0.80	0.86	0.86	0.84	0.84	0.84
Adj. Flow (vph)	104	222	49	62	188	88	151	174	30	95	286
RTOR Reduction (vph)	0	8	0	0	12	0	0	0	0	0	257
Lane Group Flow (vph)	104	263	0	0	326	0	0	325	30	95	29
Confl. Peds. (#/hr)	3		2			14	14		2		3
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	5%	5%	5%	5%	5%
Turn Type		custom		Split			Split		Perm		Perm
Protected Phases	5	2		4	4		3	3		6	
Permitted Phases	2								6		6
Actuated Green, G (s)	25.6	25.6			24.4			36.6	10.0	10.0	10.0
Effective Green, g (s)	26.6	26.6			25.4			39.6	11.0	10.0	11.0
Actuated g/C Ratio	0.24	0.24			0.23			0.36	0.10	0.09	0.10
Clearance Time (s)	5.0	5.0			6.0			6.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	396	369			391			679	170	156	149
v/s Ratio Prot	0.03	c0.17			c0.19			c0.17		0.06	
v/s Ratio Perm	0.04								0.02		0.02
v/c Ratio	0.26	0.71			0.83			0.48	0.18	0.61	0.19
Uniform Delay, d1	33.8	38.2			40.3			27.2	45.4	48.1	45.4
Progression Factor	1.12	1.12			1.00			1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	6.3			14.2			2.4	0.5	6.6	0.6
Delay (s)	38.2	49.0			54.5			29.6	45.8	54.7	46.1
Level of Service	D	D			D			C	D	D	D
Approach Delay (s)	46.0				54.5			29.6		48.0	
Approach LOS	D				D			C		D	

Intersection Summary			
HCM Average Control Delay	44.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	18.4
Intersection Capacity Utilization	57.7%	ICU Level of Service	B
Analysis Period (min)	15		

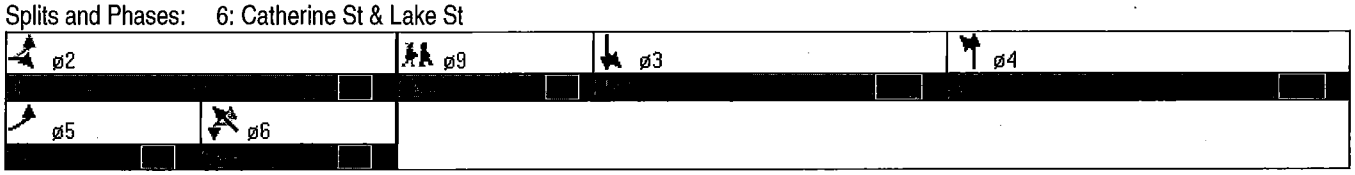
c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT	NWL2	NWT	NWR	ø9
Lane Configurations								
Volume (vph)	75	160	150	150	25	80	240	
Lane Group Flow (vph)	104	271	338	325	30	95	286	
Turn Type		custom			Perm		Perm	
Protected Phases	5	2	4	3		6		9
Permitted Phases	2				6		6	
Detector Phase	5	2	4	3	6	6	6	
Switch Phase								
Minimum Initial (s)	10.0	10.0	5.0	5.0	4.0	4.0	4.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Total Split (s)	16.0	32.0	33.0	29.0	16.0	16.0	16.0	16.0
Total Split (%)	14.5%	29.1%	30.0%	26.4%	14.5%	14.5%	14.5%	15%
Yellow Time (s)	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-3.0	-1.0	0.0	-1.0	
Total Lost Time (s)	4.0	4.0	5.0	3.0	4.0	5.0	4.0	
Lead/Lag	Lead			Lag	Lag	Lag	Lag	Lead
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Min	None	None	None	None
v/c Ratio	0.26	0.72	0.84	0.44	0.18	0.61	0.70	
Control Delay	39.2	52.6	57.3	30.2	47.3	64.6	15.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	39.2	52.6	57.3	30.2	47.3	64.6	15.7	
Queue Length 50th (ft)	60	161	213	170	19	65	0	
Queue Length 95th (ft)	m86	194	273	298	46	112	60	
Internal Link Dist (ft)	486		164	140		468		
Turn Bay Length (ft)	300				50		370	
Base Capacity (vph)	397	397	442	734	187	173	418	
Starvation Cap Reductn	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.26	0.68	0.76	0.44	0.16	0.55	0.68	

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 3:SBTL, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Catherine St & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	155	320	265	160	105	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3471	1553	1719	1538
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3471	1553	1719	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	168	348	288	174	114	98
RTOR Reduction (vph)	0	0	0	97	0	76
Lane Group Flow (vph)	168	348	288	77	114	22
Heavy Vehicles (%)	4%	4%	4%	4%	5%	5%
Turn Type	Prot			Perm		Over
Protected Phases	5	2 5	6		4	5
Permitted Phases				6		
Actuated Green, G (s)	26.4	61.5	51.8	51.8	13.2	26.4
Effective Green, g (s)	27.4	62.5	52.8	52.8	14.2	27.4
Actuated g/C Ratio	0.23	0.52	0.44	0.44	0.12	0.23
Clearance Time (s)	5.0		5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	396	952	1527	683	203	351
v/s Ratio Prot	c0.10	c0.19	c0.08		c0.07	0.01
v/s Ratio Perm				0.05		
v/c Ratio	0.42	0.37	0.19	0.11	0.56	0.06
Uniform Delay, d1	39.6	17.0	20.5	19.8	50.0	36.3
Progression Factor	0.73	0.56	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	0.2	0.3	0.3	3.5	0.1
Delay (s)	29.6	9.8	20.8	20.1	53.5	36.3
Level of Service	C	A	C	C	D	D
Approach Delay (s)		16.3	20.5		45.6	
Approach LOS		B	C		D	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	29.6
Intersection Capacity Utilization	32.7%	ICU Level of Service	A
Analysis Period (min)	15		

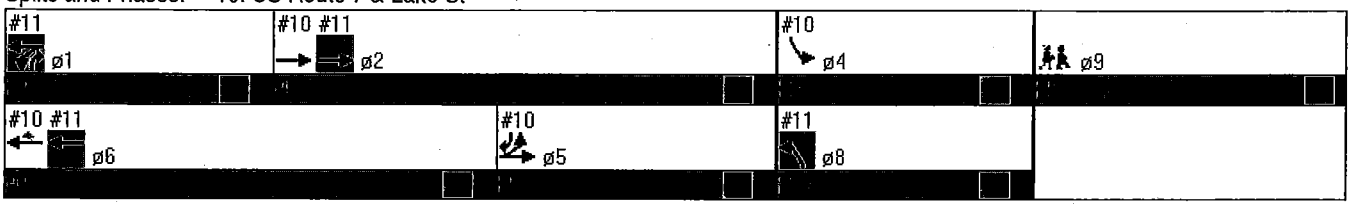
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	155	320	265	160	105	90				
Lane Group Flow (vph)	168	348	288	174	114	98				
Turn Type	Prot			Perm		Over				
Protected Phases	5	2 5	6		4	5	1	2	8	9
Permitted Phases				6						
Detector Phase	5	2 5	6	6	4	5				
Switch Phase										
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	5.0	10.0	5.0	4.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	16.0	28.0
Total Split (s)	25.0	70.0	44.0	44.0	23.0	25.0	24.0	45.0	23.0	28.0
Total Split (%)	20.8%	58.3%	36.7%	36.7%	19.2%	20.8%	20%	38%	19%	23%
Yellow Time (s)	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag	Lag		Lead	Lead		Lag	Lead	Lag		
Lead-Lag Optimize?							Yes	Yes		
Recall Mode	None		C-Min	C-Min	None	None	None	C-Min	None	None
v/c Ratio	0.42	0.35	0.18	0.22	0.56	0.23				
Control Delay	31.8	13.6	24.7	5.8	59.9	8.3				
Queue Delay	126.6	1.8	0.0	0.0	0.0	0.0				
Total Delay	158.4	15.4	24.7	5.8	59.9	8.4				
Queue Length 50th (ft)	108	55	57	0	85	0				
Queue Length 95th (ft)	186	337	133	54	140	44				
Internal Link Dist (ft)		60	1628		271					
Turn Bay Length (ft)				100		275				
Base Capacity (vph)	400	1012	1697	848	273	430				
Starvation Cap Reductn	265	492	0	0	0	0				
Spillback Cap Reductn	0	0	13	0	0	18				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	1.24	0.67	0.17	0.21	0.42	0.24				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: US Route 7 & Lake St



Movement	EBL	EBR	EBR2	NBL	NBT	NBR	SBL	SBT	NWL2	NWT	NWR
Lane Configurations											
Volume (vph)	60	235	55	40	305	45	325	210	30	155	255
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	12	12	12	12	14	14	12	12	12
Total Lost time (s)	4.0	4.0			5.0			3.0	4.0	5.0	4.0
Lane Util. Factor	1.00	1.00			1.00			1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00			0.99			1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00			1.00			1.00	0.99	1.00	1.00
Frt	1.00	0.85			0.98			1.00	1.00	0.95	0.85
Flt Protected	0.95	1.00			0.99			0.97	0.95	1.00	1.00
Satd. Flow (prot)	1708	1583			1796			1947	1746	1770	1547
Flt Permitted	0.95	1.00			0.99			0.97	0.95	1.00	1.00
Satd. Flow (perm)	1708	1583			1796			1947	1746	1770	1547
Peak-hour factor, PHF	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.92	0.92	0.92
Adj. Flow (vph)	65	255	60	43	328	48	339	219	33	168	277
RTOR Reduction (vph)	0	7	0	0	4	0	0	0	0	0	235
Lane Group Flow (vph)	65	308	0	0	415	0	0	558	33	168	42
Confl. Peds. (#/hr)	1		4			15	15		4		1
Heavy Vehicles (%)	2%	2%	2%	3%	3%	3%	1%	1%	2%	2%	2%
Turn Type		custom		Split			Split		Perm		Perm
Protected Phases	5	2		4	4		3	3		6	
Permitted Phases	2								6		6
Actuated Green, G (s)	30.5	30.5			25.0			40.7	17.3	17.3	17.3
Effective Green, g (s)	31.5	31.5			26.0			43.7	18.3	17.3	18.3
Actuated g/C Ratio	0.26	0.26			0.22			0.36	0.15	0.14	0.15
Clearance Time (s)	5.0	5.0			6.0			6.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	448	416			389			709	266	255	236
v/s Ratio Prot	0.01	c0.19			c0.23			c0.29		0.09	
v/s Ratio Perm	0.03								0.02		0.03
v/c Ratio	0.15	0.74			1.07			0.79	0.12	0.66	0.18
Uniform Delay, d1	33.9	40.5			47.0			34.0	43.9	48.6	44.3
Progression Factor	1.00	1.00			0.85			1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	6.8			63.8			8.6	0.2	6.0	0.4
Delay (s)	34.1	47.3			103.8			42.6	44.1	54.6	44.7
Level of Service	C	D			F			D	D	D	D
Approach Delay (s)	45.0				103.8			42.6		48.1	
Approach LOS	D				F			D		D	

Intersection Summary			
HCM Average Control Delay	58.5	HCM Level of Service	E
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.8
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

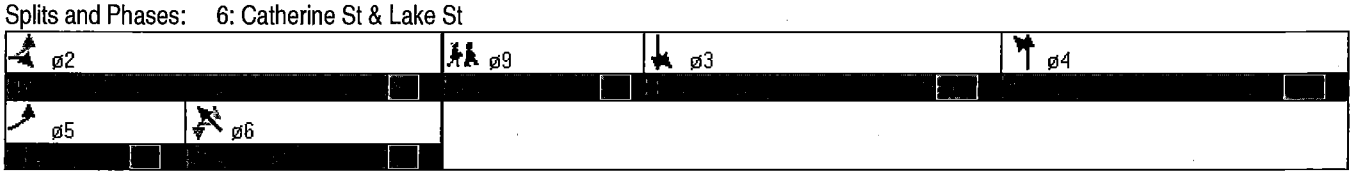
c Critical Lane Group

Lane Group	EBL	EBR	NBT	SBT	NWWL2	NWWT	NWWR	ø9
Lane Configurations								
Volume (vph)	60	235	305	210	30	155	255	
Lane Group Flow (vph)	65	315	419	558	33	168	277	
Turn Type		custom			Perm		Perm	
Protected Phases	5	2	4	3		6		9
Permitted Phases	2				6		6	
Detector Phase	5	2	4	3	6	6	6	
Switch Phase								
Minimum Initial (s)	10.0	10.0	5.0	5.0	4.0	4.0	4.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	18.0
Total Split (s)	16.0	39.0	31.0	32.0	23.0	23.0	23.0	18.0
Total Split (%)	13.3%	32.5%	25.8%	26.7%	19.2%	19.2%	19.2%	15%
Yellow Time (s)	3.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-3.0	-1.0	0.0	-1.0	
Total Lost Time (s)	4.0	4.0	5.0	3.0	4.0	5.0	4.0	
Lead/Lag	Lead			Lag	Lag	Lag	Lag	Lead
Lead-Lag Optimize?								
Recall Mode	None	None	None	C-Min	None	None	None	None
v/c Ratio	0.15	0.77	1.07	0.72	0.12	0.66	0.59	
Control Delay	33.6	52.4	102.3	38.9	45.1	61.7	10.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	33.6	52.4	102.3	38.9	45.1	61.7	10.8	
Queue Length 50th (ft)	38	215	~361	351	23	126	0	
Queue Length 95th (ft)	73	314	#566	#739	53	201	78	
Internal Link Dist (ft)	486		161	140		468		
Turn Bay Length (ft)	300				50		370	
Base Capacity (vph)	435	469	393	777	282	271	482	
Starvation Cap Reductn	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.15	0.67	1.07	0.72	0.12	0.62	0.57	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 26 (22%), Referenced to phase 3:SBTL, Start of Yellow
Natural Cycle: 115
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Catherine St & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	170	495	355	225	160	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3539	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3539	1583	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	538	386	245	174	201
RTOR Reduction (vph)	0	0	0	164	0	136
Lane Group Flow (vph)	185	538	386	81	174	65
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	Prot			Perm		Over
Protected Phases	5	2 5	6		4	5
Permitted Phases				6		
Actuated Green, G (s)	38.0	51.3	38.6	38.6	14.8	38.0
Effective Green, g (s)	39.0	52.3	39.6	39.6	15.8	39.0
Actuated g/C Ratio	0.32	0.44	0.33	0.33	0.13	0.32
Clearance Time (s)	5.0		5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	564	796	1168	522	233	514
v/s Ratio Prot	0.11	c0.29	c0.11		c0.10	0.04
v/s Ratio Perm				0.05		
v/c Ratio	0.33	0.68	0.33	0.15	0.75	0.13
Uniform Delay, d1	30.6	27.1	30.2	28.4	50.2	28.5
Progression Factor	0.50	0.45	1.00	1.00	0.75	1.04
Incremental Delay, d2	0.3	2.2	0.8	0.6	10.8	0.1
Delay (s)	15.7	14.5	31.0	29.0	48.3	29.8
Level of Service	B	B	C	C	D	C
Approach Delay (s)		14.8	30.2		38.4	
Approach LOS		B	C		D	

Intersection Summary			
HCM Average Control Delay	25.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	25.6
Intersection Capacity Utilization	41.6%	ICU Level of Service	A
Analysis Period (min)	15		

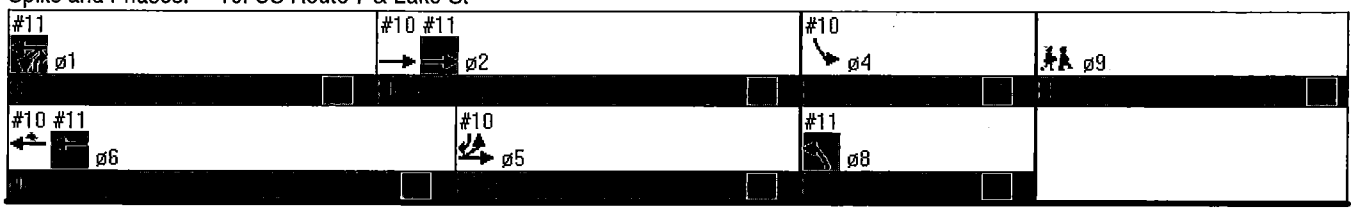
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø1	ø2	ø8	ø9
Lane Configurations										
Volume (vph)	170	495	355	225	160	185				
Lane Group Flow (vph)	185	538	386	245	174	201				
Turn Type	Prot			Perm		Over				
Protected Phases	5	2 5	6		4	5	1	2	8	9
Permitted Phases				6						
Detector Phase	5	2 5	6	6	4	5				
Switch Phase										
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	5.0	10.0	5.0	4.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	16.0	28.0
Total Split (s)	31.0	69.0	40.0	40.0	21.0	31.0	33.0	38.0	21.0	28.0
Total Split (%)	25.8%	57.5%	33.3%	33.3%	17.5%	25.8%	28%	32%	18%	23%
Yellow Time (s)	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0				
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0				
Lead/Lag	Lag		Lead	Lead		Lag	Lead	Lag		
Lead-Lag Optimize?							Yes	Yes		
Recall Mode	None		C-Min	C-Min	None	None	None	C-Min	None	None
v/c Ratio	0.33	0.65	0.31	0.34	0.75	0.31				
Control Delay	18.7	20.9	30.4	5.3	55.3	6.7				
Queue Delay	8.9	0.9	0.0	0.0	0.0	0.4				
Total Delay	27.6	21.8	30.4	5.3	55.3	7.0				
Queue Length 50th (ft)	98	276	109	0	137	0				
Queue Length 95th (ft)	128	#669	168	59	m197	m55				
Internal Link Dist (ft)		60	1628		273					
Turn Bay Length (ft)				100		275				
Base Capacity (vph)	564	834	1240	714	251	650				
Starvation Cap Reductn	337	107	0	0	0	0				
Spillback Cap Reductn	0	0	42	0	0	153				
Storage Cap Reductn	0	0	0	0	0	0				
Reduced v/c Ratio	0.81	0.74	0.32	0.34	0.69	0.40				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 115 (96%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 10: US Route 7 & Lake St



Unsignalized Intersection Capacity Analysis

HCM Unsignalized Intersection Capacity Analysis
6: Lake St & Federal St

8/5/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	135	175	25	5	185	60	5	50	10	30	70	225
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.86	0.86	0.86	0.80	0.80	0.80	0.72	0.72	0.72	0.84	0.84	0.84
Hourly flow rate (vph)	157	203	29	6	231	75	7	69	14	36	83	268
Pedestrians		3			2			6			14	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												5
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					605							
pX, platoon unblocked												
vC, conflicting volume	320			239			998	871	226	878	848	286
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	320			239			998	871	226	878	848	286
tC, single (s)	4.1			4.2			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	87			100			92	71	98	80	67	64
cM capacity (veh/h)	1209			1299			92	243	798	179	251	736

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	390	312	90	387
Volume Left	157	6	7	36
Volume Right	29	75	14	268
cSH	1209	1299	238	746
Volume to Capacity	0.13	0.00	0.38	0.52
Queue Length 95th (ft)	11	0	42	76
Control Delay (s)	4.2	0.2	29.1	20.0
Lane LOS	A	A	D	C
Approach Delay (s)	4.2	0.2	29.1	20.0
Approach LOS			D	C

Intersection Summary			
Average Delay	10.2		
Intersection Capacity Utilization	54.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Lake St & Federal St

8/5/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	290	30	10	235	70	10	55	35	45	35	275
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.96	0.96	0.96	0.93	0.93	0.93	0.59	0.59	0.59	0.86	0.86	0.86
Hourly flow rate (vph)	312	302	31	11	253	75	17	93	59	52	41	320
Pedestrians		1			4			15			15	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												5
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					605							
pX, platoon unblocked												
vC, conflicting volume	343			348			1451	1322	337	1379	1300	306
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	343			348			1451	1322	337	1379	1300	306
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	74			99			51	17	92	0	65	56
cM capacity (veh/h)	1206			1190			35	113	699	28	115	724

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	646	339	169	413
Volume Left	312	11	17	52
Volume Right	31	75	59	320
cSH	1206	1190	121	224
Volume to Capacity	0.26	0.01	1.40	1.84
Queue Length 95th (ft)	26	1	288	724
Control Delay (s)	5.9	0.3	287.1	433.1
Lane LOS	A	A	F	F
Approach Delay (s)	5.9	0.3	287.1	433.1
Approach LOS			F	F

Intersection Summary			
Average Delay	147.7		
Intersection Capacity Utilization	73.8%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Lake St & Federal St

8/5/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	150	190	25	5	190	60	5	50	15	30	70	225
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.86	0.86	0.86	0.80	0.80	0.80	0.72	0.72	0.72	0.84	0.84	0.84
Hourly flow rate (vph)	174	221	29	6	238	75	7	69	21	36	83	268
Pedestrians		3			2			6			14	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												5
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					604							
pX, platoon unblocked												
vC, conflicting volume	326			256			1056	929	243	943	906	292
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	326			256			1056	929	243	943	906	292
tC, single (s)	4.1			4.2			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	85			100			91	68	97	77	63	63
cM capacity (veh/h)	1202			1279			79	220	780	153	228	730

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	424	319	97	387
Volume Left	174	6	7	36
Volume Right	29	75	21	268
cSH	1202	1279	226	668
Volume to Capacity	0.15	0.00	0.43	0.58
Queue Length 95th (ft)	13	0	50	93
Control Delay (s)	4.3	0.2	32.4	22.4
Lane LOS	A	A	D	C
Approach Delay (s)	4.3	0.2	32.4	22.4
Approach LOS			D	C

Intersection Summary			
Average Delay	11.2		
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
28: Lake St & site driveway

8/5/2013

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	20	215	250	60	10	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	24	253	294	71	12	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			357			
pX, platoon unblocked						
vC, conflicting volume	365				629	329
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	365				629	329
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	99
cM capacity (veh/h)	1194				437	712

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	276	365	18
Volume Left	24	0	12
Volume Right	0	71	6
cSH	1194	1700	502
Volume to Capacity	0.02	0.21	0.04
Queue Length 95th (ft)	2	0	3
Control Delay (s)	0.9	0.0	12.4
Lane LOS	A		B
Approach Delay (s)	0.9	0.0	12.4
Approach LOS			B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
18: site driveway & Federal St

8/5/2013

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	1	1	245	15	20	325
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	1	1	288	18	24	382
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	726	297			306	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	726	297			306	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			98	
cM capacity (veh/h)	384	742			1255	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	306	406
Volume Left	1	0	24
Volume Right	1	18	0
cSH	506	1700	1255
Volume to Capacity	0.00	0.18	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	12.1	0.0	0.6
Lane LOS	B		A
Approach Delay (s)	12.1	0.0	0.6
Approach LOS	B		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Lake St & Federal St

8/5/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	310	300	30	20	265	70	10	60	35	45	35	280
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.96	0.96	0.96	0.93	0.93	0.93	0.59	0.59	0.59	0.86	0.86	0.86
Hourly flow rate (vph)	323	312	31	22	285	75	17	102	59	52	41	326
Pedestrians		1			4			15			15	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			1			1	
Right turn flare (veh)												5
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					604							
pX, platoon unblocked												
vC, conflicting volume	375			359			1539	1407	347	1469	1385	339
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	375			359			1539	1407	347	1469	1385	339
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	72			98			36	0	91	0	59	53
cM capacity (veh/h)	1174			1179			27	97	689	0	99	694

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	667	382	178	419
Volume Left	323	22	17	52
Volume Right	31	75	59	326
cSH	1174	1179	101	49
Volume to Capacity	0.28	0.02	1.77	8.56
Queue Length 95th (ft)	28	1	358	Err
Control Delay (s)	6.1	0.6	456.1	Err
Lane LOS	A	A	F	F
Approach Delay (s)	6.1	0.6	456.1	Err
Approach LOS			F	F

Intersection Summary			
Average Delay	2596.5		
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
28: Lake St & site driveway

8/5/2013

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	10	370	315	45	75	40
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	402	342	49	82	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			347			
pX, platoon unblocked						
vC, conflicting volume	391				791	367
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	391				791	367
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				77	94
cM capacity (veh/h)	1167				355	678

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	413	391	125
Volume Left	11	0	82
Volume Right	0	49	43
cSH	1167	1700	426
Volume to Capacity	0.01	0.23	0.29
Queue Length 95th (ft)	1	0	30
Control Delay (s)	0.3	0.0	16.9
Lane LOS	A		C
Approach Delay (s)	0.3	0.0	16.9
Approach LOS			C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
18: site driveway & Federal St

8/5/2013

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	20	425	15	10	355
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	22	462	16	11	386
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	878	470			478	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	878	470			478	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	96			99	
cM capacity (veh/h)	315	593			1084	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	27	478	397
Volume Left	5	0	11
Volume Right	22	16	0
cSH	504	1700	1084
Volume to Capacity	0.05	0.28	0.01
Queue Length 95th (ft)	4	0	1
Control Delay (s)	12.5	0.0	0.3
Lane LOS	B		A
Approach Delay (s)	12.5	0.0	0.3
Approach LOS	B		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	590	15	15	430	10	35
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	641	16	16	467	11	38
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	615					
pX, platoon unblocked						
vC, conflicting volume			658		1149	649
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			658		1149	649
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		95	92
cM capacity (veh/h)			930		215	469

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	658	484	49
Volume Left	0	16	11
Volume Right	16	0	38
cSH	1700	930	372
Volume to Capacity	0.39	0.02	0.13
Queue Length 95th (ft)	0	1	11
Control Delay (s)	0.0	0.5	16.1
Lane LOS		A	C
Approach Delay (s)	0.0	0.5	16.1
Approach LOS			C

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	65	30	360	35	15	280
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	71	33	391	38	16	304
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			353			241
pX, platoon unblocked						
vC, conflicting volume	747	410			429	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	747	410			429	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	81	95			99	
cM capacity (veh/h)	375	641			1130	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	103	429	321
Volume Left	71	0	16
Volume Right	33	38	0
cSH	431	1700	1130
Volume to Capacity	0.24	0.25	0.01
Queue Length 95th (ft)	23	0	1
Control Delay (s)	15.9	0.0	0.6
Lane LOS	C		A
Approach Delay (s)	15.9	0.0	0.6
Approach LOS	C		

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	340	20	25	345	1	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	400	24	29	406	1	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	633					
pX, platoon unblocked						
vC, conflicting volume			424		876	412
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			424		876	412
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		100	99
cM capacity (veh/h)			1136		311	640

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	424	435	7
Volume Left	0	29	1
Volume Right	24	0	6
cSH	1700	1136	544
Volume to Capacity	0.25	0.03	0.01
Queue Length 95th (ft)	0	2	1
Control Delay (s)	0.0	0.8	11.7
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	11.7
Approach LOS			B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	48.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	5	5	265	50	20	190
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	6	6	312	59	24	224
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (ft)			351			244
pX, platoon unblocked						
vC, conflicting volume	612	341			371	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	612	341			371	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	99			98	
cM capacity (veh/h)	448	701			1188	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	12	371	247
Volume Left	6	0	24
Volume Right	6	59	0
cSH	546	1700	1188
Volume to Capacity	0.02	0.22	0.02
Queue Length 95th (ft)	2	0	2
Control Delay (s)	11.7	0.0	0.9
Lane LOS	B		A
Approach Delay (s)	11.7	0.0	0.9
Approach LOS	B		

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		

Houghton Street Closure

Cross Consulting Engineers, PC
August 2013

CCE

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August 20, 2013

City of St. Albans
P.O. Box 867
St. Albans, VT, 05478

Attn: Dominic Cloud, City Manager

Subject: Houghton Street Closure – Redistribution of Traffic File: 13031/7

Dear Dom:

The closure of Houghton Street will change local traffic patterns, and Cross Consulting Engineers was asked to estimate the potential impacts of this closure. Traffic data for the intersections within the study area was collected from various sources. In September 2010, Vanasse Hangen Brustlin (VHB) collected traffic data for the Federal Street project for the following intersections:

- Catherine Street, Allen Street, Stebbins Street, and Market Street;
- Federal Street, Catherine Street, and Lake Street; and
- Lower Welden Street, Allen Street, and Lemnah Drive.

In July 2013, Cross Consulting collected traffic data for the remainder of the intersections within the study area, including:

- Lake Street and Houghton Street;
- Lake Street and Elm Street;
- Lower Welden Street and South Elm Street;
- Lake Street and Market Street;
- Houghton Street and the State Office Building driveway;
- Houghton Street and the INS driveway; and
- Lower Welden Street, Houghton Street and the Jolley Associates driveway.

The raw traffic data was adjusted to account for seasonal and daily variations in the traffic flow. VTrans has installed two continuous traffic collectors (CTC) near the study area, one of which is located on Interstate 89 near Swanton (P6F096), and the other is located on Route 7 near Georgia (P6F029). While neither is identical to the local streets and arterials found within the study area, the CTCs provide some insight into the regional traffic patterns.

For each CTC station, the 30th highest hour volume was compared to the peak hour of the respective count dates. The ratio of 1.20 was determined to be a conservative ratio and was applied to the raw traffic volumes to estimate the 30th highest volumes at the intersections within the study area.

The growth factor for the two CTC stations were similar, and averaged to be 1.12 over the past 20 years, equivalent to an annual growth rate of 0.57%. The data collected by VHB in 2010 was adjusted to represent 2013 traffic volumes.

To better understand the traffic flow through the study area, the volumes within the study area were balanced to account for data collected on separate days. The effect of this balancing shows that traffic volumes leaving one intersection can be traced to the next intersection, all the way to the study area boundary. In all cases, traffic volume was adjusted upwards. The attached Exhibit presents the balanced volumes.

The distribution of traffic at the edges of the study area is assumed to be unaffected by the Houghton Street closure. In other words, vehicles traveling north or south on Federal Street will continue to do so after the closure.

With the closure of Houghton Street, traffic traveling to and from the local businesses, or passing through the area will be redirected to neighboring streets. Using the existing traffic patterns to anticipate the ultimate destination of the vehicles, traffic on Houghton Street was re-distributed. There were two assumptions made in the re-distribution:

- Vehicles traveling to or from Main Street may travel directly to Main Street, or pass through Allen Street.
- Vehicles traveling to or from the west on Lake Street make take South Elm Street, Edward Street, or Russell Street.

Results of Re-distribution

The attached Exhibit presents the resultant changes to the traffic volumes within the study area. As shown in the Exhibit, the majority of the traffic impacted by the closure uses Lake Street, and it is here that the greatest impact in traffic flow can be seen. The intersection at Federal Street will see less left-turning traffic, but significantly higher through traffic from the minor streets. The Federal Street Corridor study has analyzed this intersection and has recommended improvements. The changes to the traffic patterns can be easily incorporated into the improvements.

The remaining intersections will also see changes in traffic flow, but this should not create capacity or safety issues, with the exception of the intersection of Elm Street and Lake Street. This intersection will see higher left turns onto Lake Street from South Elm Street, and though it is offset by a decrease in the Lake Street traffic, higher left turns from the minor street typically result in longer delays. We have anticipated this somewhat by assuming that some traffic will divert to adjacent streets (Edward and

Russell) to turn left onto Lake Street. We expect a small degradation of intersection capacity at the intersection of Lake Street and Elm Street.

Summary

Traffic data collected in 2010 and 2013 was adjusted to the 30th highest hour, and then increased to balance the traffic flow between intersections within the study area. This balanced traffic was examined for current distribution and the traffic was re-distributed assuming a closure of Houghton Street. The increases and decreases shown in the exhibit show significant changes to the intersection of Federal Street, Catherine Street and Lake Street, but the changes can be easily accommodated with the proposed Federal Street Corridor improvements.

An increase in the left-turns from South Elm Street onto Lake Street is likely to increase delay and reduce the intersection capacity.

While the remaining intersections within the study area will see changes to the traffic patterns, there should not be any significant impacts to delay or intersection capacity.

Sincerely,

Cross Consulting Engineers, P.C.

By_____
Dereck S. Woolridge, P.E.

cc:

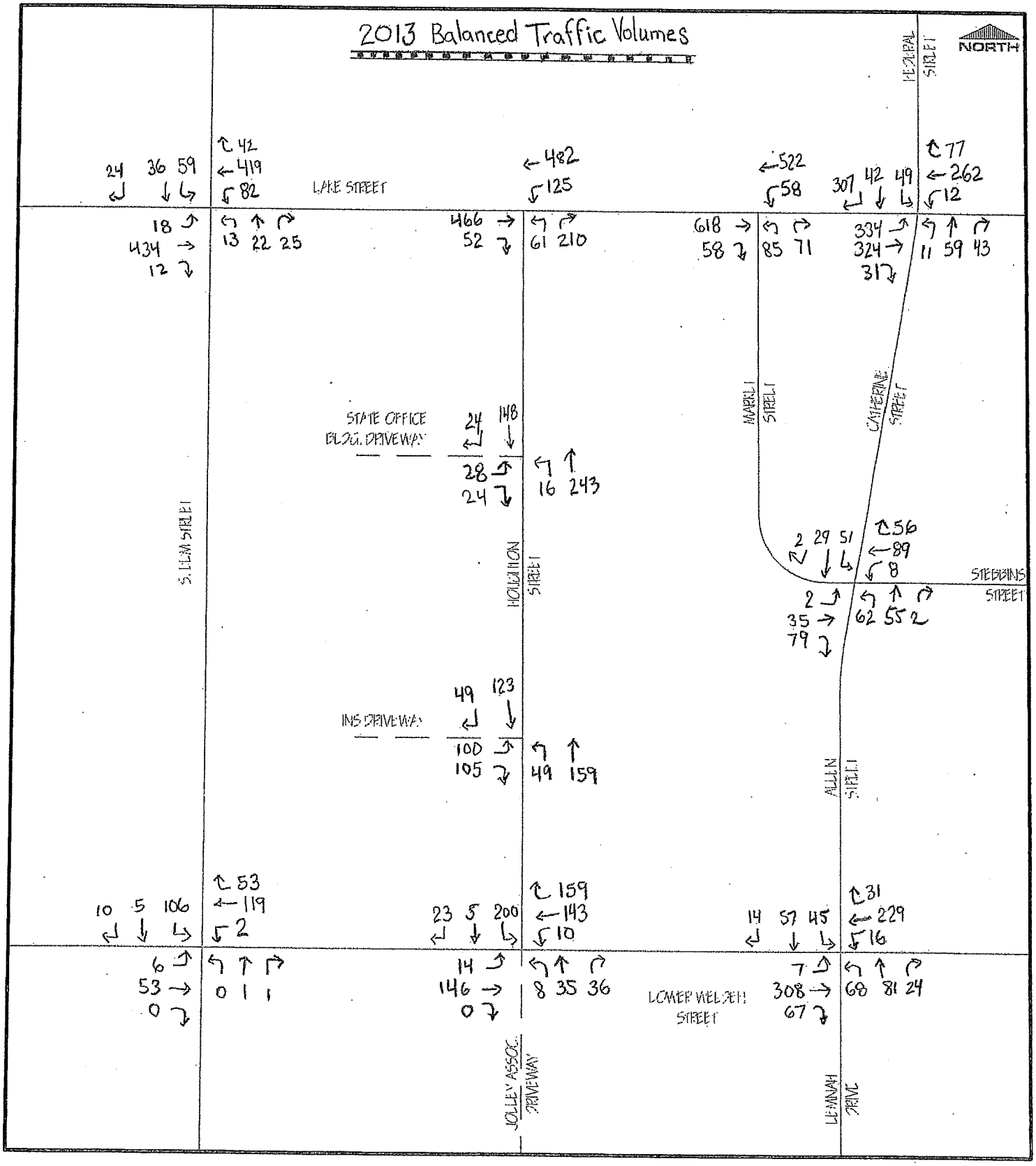
Enclosures: As Stated

admin:2013:13031 cosa houghton street:2013-08-15_mem_houghton-closure.docx

CROSS CONSULTING ENGINEERS, P.C.
ST. ALBANS, VERMONT 05478
(802) 524-2113
FAX (802) 524-9681

JOB Houghton Street Closure, 13031
SHEET NO. 1 OF 1
CALCULATED BY DSW DATE 2013/08/14
CHECKED BY _____ DATE 2013/08/15
SCALE Not to Scale

2013 Balanced Traffic Volumes



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JOB Houghton Street Closure, 13031
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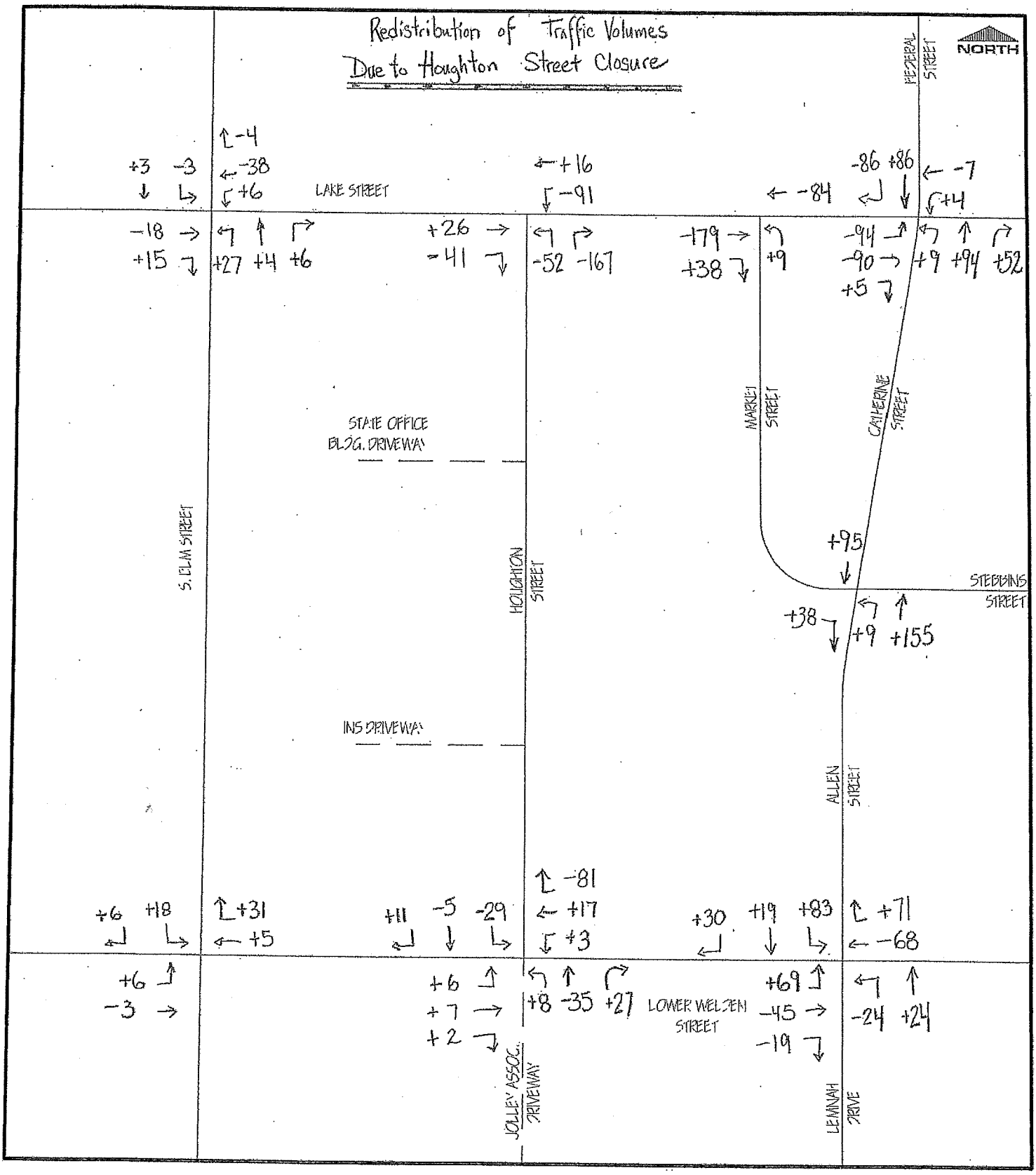

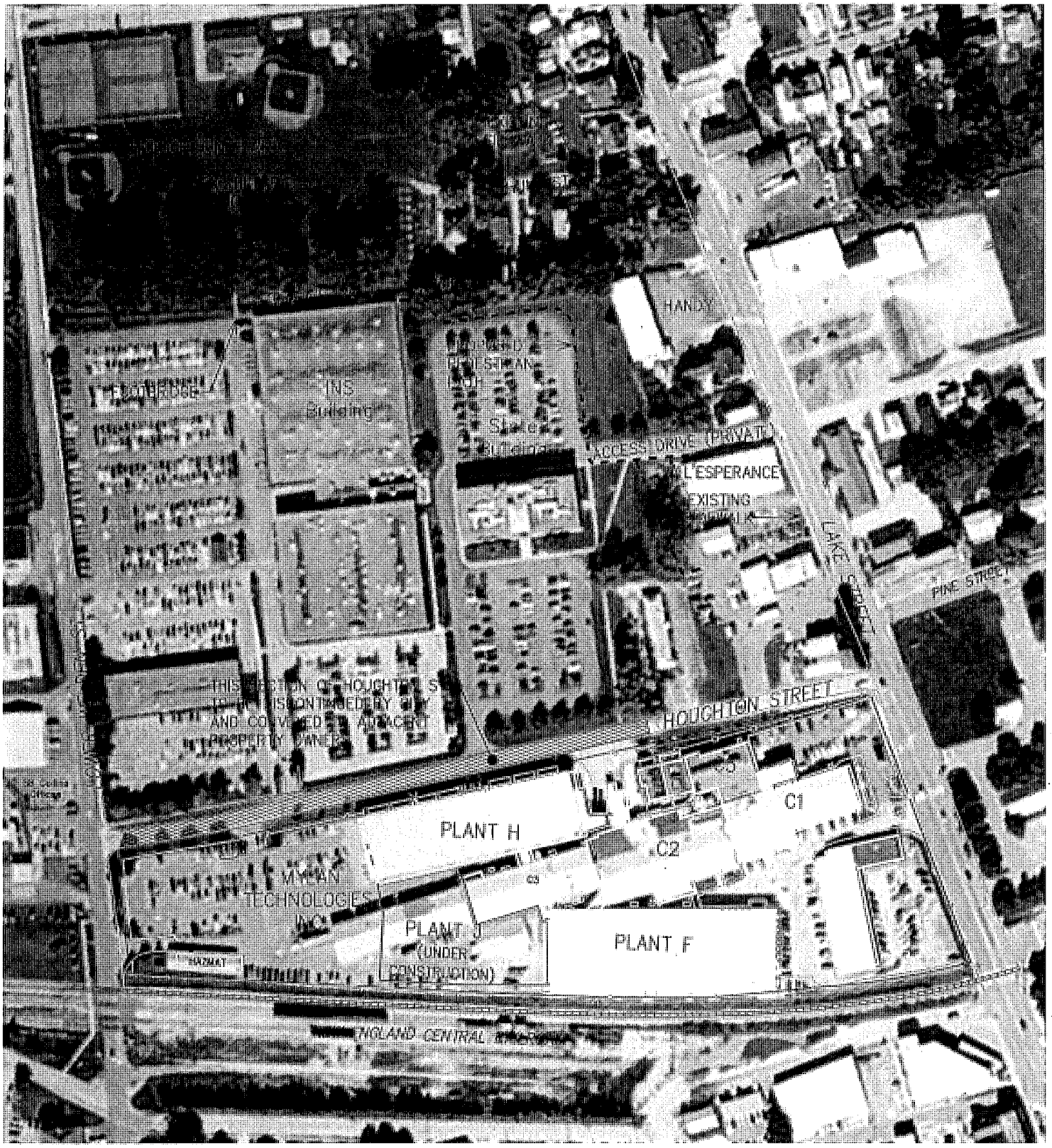

C-1

PROJECT: 12070
DATE: MAY 29, 2013
REVISED: JULY 24, 2013
DRAWN: WHP
SCALE: 1" = 200'
FILE: 12070/INS Footpath to Lake Revised.dwg

Pedestrian Path Option

City of St. Albans
LAKE STREET & HOUGHTON ST.
ST. ALBANS, VERMONT

Tel. 802-524-2113
Fax. 802-524-9681

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St. Albans, Vermont 05478

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Signalized Intersection Capacity Analysis

Timings
2: Lower Welden St & Lemnah Dr/Allen St

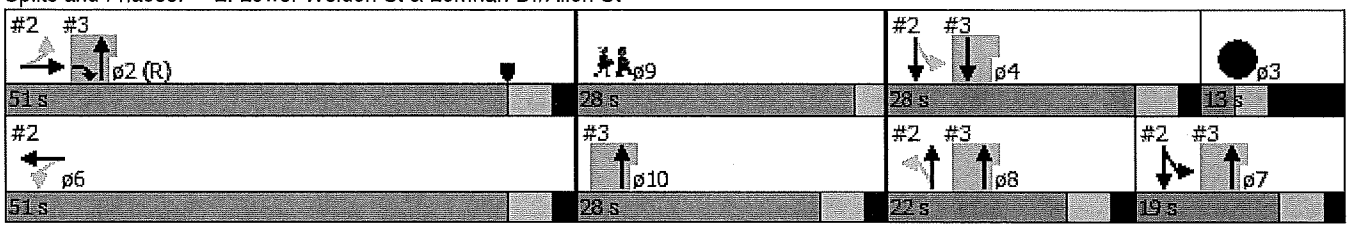
5/11/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	50	255	60	235	5	40	45	25				
Lane Group Flow (vph)	0	471	0	423	0	153	0	231				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	51.0	51.0	51.0	51.0	22.0	22.0	19.0		13.0	28.0	28.0	28.0
Total Split (%)	42.5%	42.5%	42.5%	42.5%	18.3%	18.3%	15.8%		11%	23%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0		-2.0		-2.0						
Total Lost Time (s)		4.0		4.0		4.0						
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio		0.75		0.72		0.60		0.32				
Control Delay		36.2		37.9		35.7		1.8				
Queue Delay		0.0		0.0		0.0		1.3				
Total Delay		36.2		37.9		35.7		3.1				
Queue Length 50th (ft)		270		265		57		10				
Queue Length 95th (ft)		279		392		102		0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)		625		589		322		728				
Starvation Cap Reductn		0		0		0		314				
Spillback Cap Reductn		0		0		0		0				
Storage Cap Reductn		0		0		0		0				
Reduced v/c Ratio		0.75		0.72		0.48		0.56				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 105
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	255	25	60	235	90	5	40	80	45	25	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.97			0.91			0.92	
Flt Protected		0.99			0.99			1.00			0.99	
Satd. Flow (prot)		1896			1808			1812			1670	
Flt Permitted		0.83			0.81			0.98			0.95	
Satd. Flow (perm)		1590			1482			1775			1608	
Peak-hour factor, PHF	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Adj. Flow (vph)	71	364	36	66	258	99	6	49	98	58	32	141
RTOR Reduction (vph)	0	2	0	0	9	0	0	56	0	0	40	0
Lane Group Flow (vph)	0	469	0	0	414	0	0	97	0	0	191	0
Heavy Vehicles (%)	5%	5%	5%	1%	1%	1%	2%	2%	2%	10%	10%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		45.0			45.0			11.5			48.1	
Effective Green, g (s)		47.0			47.0			13.5			50.1	
Actuated g/C Ratio		0.39			0.39			0.11			0.42	
Clearance Time (s)		6.0			6.0			6.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		622			580			199			688	
v/s Ratio Prot											c0.08	
v/s Ratio Perm		c0.29			0.28			c0.05			0.04	
v/c Ratio		0.75			0.71			0.49			0.28	
Uniform Delay, d1		31.5			30.8			50.0			23.0	
Progression Factor		0.88			1.00			0.92			0.05	
Incremental Delay, d2		7.9			7.3			1.8			0.2	
Delay (s)		35.7			38.1			47.6			1.4	
Level of Service		D			D			D			A	
Approach Delay (s)		35.7			38.1			47.6			1.4	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	31.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	52.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lower Welden St & Lemnah Dr/Allen St

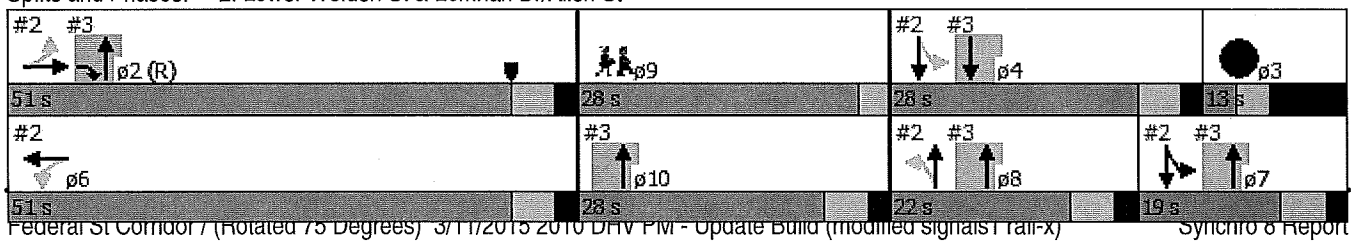
5/11/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	40	295	100	295	10	55	115	60				
Lane Group Flow (vph)	0	375	0	522	0	175	0	366				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	51.0	51.0	51.0	51.0	22.0	22.0	19.0		13.0	28.0	28.0	28.0
Total Split (%)	42.5%	42.5%	42.5%	42.5%	18.3%	18.3%	15.8%		11%	23%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0		-2.0		-2.0						
Total Lost Time (s)		4.0		4.0		4.0						
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio		0.55		0.96		0.67		0.56				
Control Delay		27.8		65.9		45.4		12.1				
Queue Delay		0.0		0.0		0.0		1.5				
Total Delay		27.8		65.9		45.4		13.6				
Queue Length 50th (ft)		195		384		87		145				
Queue Length 95th (ft)		m278		#615		149		209				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)		682		543		296		650				
Starvation Cap Reductn		0		0		0		138				
Spillback Cap Reductn		0		0		0		0				
Storage Cap Reductn		0		0		0		0				
Reduced v/c Ratio		0.55		0.96		0.59		0.71				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 115
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	295	10	100	295	85	10	55	85	115	60	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		1.00			0.98			0.92			0.95	
Flt Protected		0.99			0.99			1.00			0.98	
Satd. Flow (prot)		1968			1800			1760			1851	
Flt Permitted		0.88			0.75			0.95			0.54	
Satd. Flow (perm)		1742			1371			1669			1025	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Adj. Flow (vph)	43	321	11	109	321	92	12	64	99	153	80	133
RTOR Reduction (vph)	0	1	0	0	7	0	0	40	0	0	15	0
Lane Group Flow (vph)	0	374	0	0	515	0	0	135	0	0	351	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		44.9			44.9			13.9			48.2	
Effective Green, g (s)		46.9			46.9			15.9			50.2	
Actuated g/C Ratio		0.39			0.39			0.13			0.42	
Clearance Time (s)		6.0			6.0			6.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		680			535			221			637	
v/s Ratio Prot											c0.14	
v/s Ratio Perm		0.21			c0.38			c0.08			0.09	
v/c Ratio		0.55			0.96			0.61			0.55	
Uniform Delay, d1		28.4			35.7			49.1			26.4	
Progression Factor		0.87			1.00			0.92			0.28	
Incremental Delay, d2		2.8			30.8			4.7			0.7	
Delay (s)		27.4			66.5			50.0			8.0	
Level of Service		C			E			D			A	
Approach Delay (s)		27.4			66.5			50.0			8.0	
Approach LOS		C			E			D			A	

Intersection Summary			
HCM 2000 Control Delay	39.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lower Welden St & Lemnah Dr/Allen St

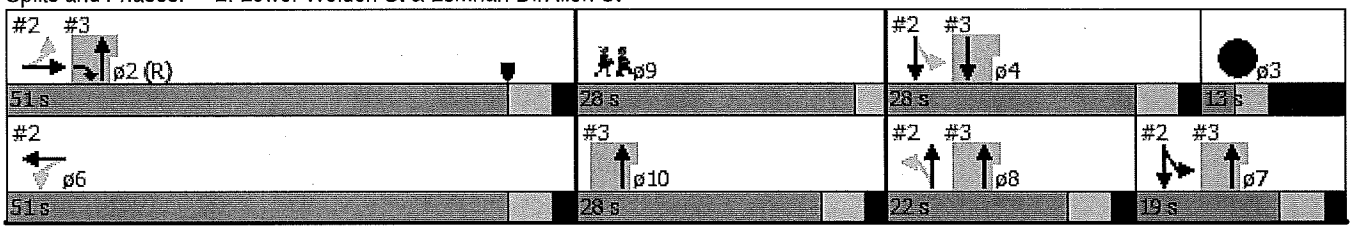
5/11/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	75	225	75	230	5	65	35	45				
Lane Group Flow (vph)	0	535	0	434	0	195	0	282				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	51.0	51.0	51.0	51.0	22.0	22.0	19.0		13.0	28.0	28.0	28.0
Total Split (%)	42.5%	42.5%	42.5%	42.5%	18.3%	18.3%	15.8%		11%	23%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0		-2.0		-2.0						
Total Lost Time (s)		4.0		4.0		4.0						
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio		0.95		0.80		0.68		0.38				
Control Delay		58.1		43.8		45.6		2.2				
Queue Delay		0.0		0.0		0.0		1.4				
Total Delay		58.1		43.8		45.6		3.6				
Queue Length 50th (ft)		325		285		103		14				
Queue Length 95th (ft)		331		#457		155		0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)		561		544		318		733				
Starvation Cap Reductn		0		0		0		275				
Spillback Cap Reductn		0		0		0		0				
Storage Cap Reductn		0		0		0		0				
Reduced v/c Ratio		0.95		0.80		0.61		0.62				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 115
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	225	75	75	230	90	5	65	90	35	45	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.97			0.92			0.91	
Flt Protected		0.99			0.99			1.00			0.99	
Satd. Flow (prot)		1859			1806			1833			1671	
Flt Permitted		0.75			0.75			0.98			0.97	
Satd. Flow (perm)		1415			1368			1803			1631	
Peak-hour factor, PHF	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Adj. Flow (vph)	107	321	107	82	253	99	6	79	110	45	58	179
RTOR Reduction (vph)	0	7	0	0	9	0	0	40	0	0	44	0
Lane Group Flow (vph)	0	528	0	0	425	0	0	155	0	0	238	0
Heavy Vehicles (%)	5%	5%	5%	1%	1%	1%	2%	2%	2%	10%	10%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		45.0			45.0			14.4			48.0	
Effective Green, g (s)		47.0			47.0			16.4			50.0	
Actuated g/C Ratio		0.39			0.39			0.14			0.42	
Clearance Time (s)		6.0			6.0			6.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		554			535			246			689	
v/s Ratio Prot											c0.09	
v/s Ratio Perm		c0.37			0.31			c0.09			0.06	
v/c Ratio		0.95			0.79			0.63			0.35	
Uniform Delay, d1		35.4			32.2			48.9			23.9	
Progression Factor		0.86			1.00			0.92			0.06	
Incremental Delay, d2		27.1			11.5			4.9			0.2	
Delay (s)		57.5			43.8			49.7			1.7	
Level of Service		E			D			D			A	
Approach Delay (s)		57.5			43.8			49.7			1.7	
Approach LOS		E			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	41.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	60.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lower Welden St & Lemnah Dr/Allen St

5/11/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	80	305	100	315	15	80	85	75				
Lane Group Flow (vph)	0	452	0	511	0	267	0	426				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	48.0	48.0	48.0	48.0	25.0	25.0	19.0		13.0	31.0	28.0	28.0
Total Split (%)	40.0%	40.0%	40.0%	40.0%	20.8%	20.8%	15.8%		11%	26%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0		-2.0		-2.0						
Total Lost Time (s)		4.0		4.0		4.0						
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio		0.84		1.05		0.75		0.62				
Control Delay		43.5		92.8		46.1		12.5				
Queue Delay		0.0		0.0		0.0		2.2				
Total Delay		43.5		92.8		46.1		14.8				
Queue Length 50th (ft)		258		~430		143		117				
Queue Length 95th (ft)		m#477		#648		#260		209				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)		536		485		367		692				
Starvation Cap Reductn		0		0		0		148				
Spillback Cap Reductn		0		0		0		0				
Storage Cap Reductn		0		0		0		0				
Reduced v/c Ratio		0.84		1.05		0.73		0.78				

Intersection Summary

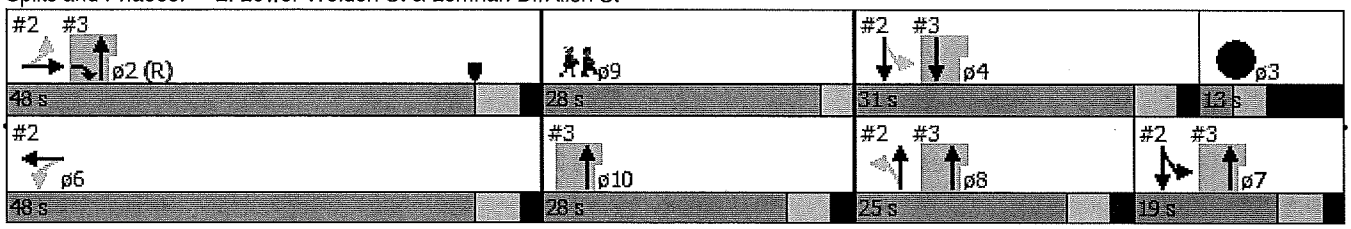
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 125
Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	305	30	100	315	55	15	80	135	85	75	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.99			0.98			0.92			0.93	
Flt Protected		0.99			0.99			1.00			0.99	
Satd. Flow (prot)		1949			1814			1755			1829	
Flt Permitted		0.74			0.72			0.94			0.64	
Satd. Flow (perm)		1456			1314			1656			1192	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Adj. Flow (vph)	87	332	33	109	342	60	17	93	157	113	100	213
RTOR Reduction (vph)	0	3	0	0	4	0	0	42	0	0	25	0
Lane Group Flow (vph)	0	449	0	0	507	0	0	225	0	0	401	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		42.0			42.0			20.6			51.1	
Effective Green, g (s)		44.0			44.0			22.6			53.1	
Actuated g/C Ratio		0.37			0.37			0.19			0.44	
Clearance Time (s)		6.0			6.0			6.0				
Vehicle Extension (s)		3.0			3.0			3.0				
Lane Grp Cap (vph)		533			481			311			668	
v/s Ratio Prot											c0.13	
v/s Ratio Perm		0.31			c0.39			c0.14			0.13	
v/c Ratio		0.84			1.05			0.72			0.60	
Uniform Delay, d1		34.8			38.0			45.8			25.4	
Progression Factor		0.84			1.00			0.89			0.32	
Incremental Delay, d2		13.5			56.1			7.6			1.1	
Delay (s)		42.7			94.1			48.4			9.2	
Level of Service		D			F			D			A	
Approach Delay (s)		42.7			94.1			48.4			9.2	
Approach LOS		D			F			D			A	

Intersection Summary			
HCM 2000 Control Delay	50.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	77.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lower Welden St & Lemnah Dr/Allen St

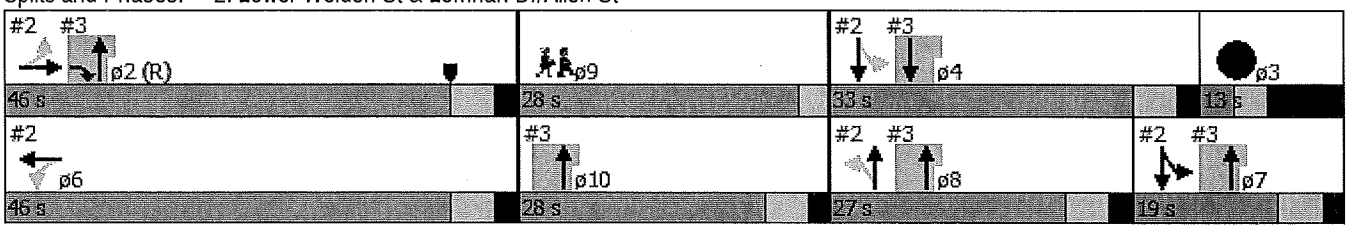
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	50	255	60	235	5	40	45	25				
Lane Group Flow (vph)	71	400	66	357	0	153	58	173				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	46.0	46.0	46.0	46.0	27.0	27.0	19.0		13.0	33.0	28.0	28.0
Total Split (%)	38.3%	38.3%	38.3%	38.3%	22.5%	22.5%	15.8%		11%	28%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0		-2.0	-2.0					
Total Lost Time (s)	4.0	4.0	4.0	4.0		4.0	4.0					
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio	0.30	0.60	0.34	0.56		0.59	0.09	0.21				
Control Delay	31.1	32.7	35.0	33.8		34.5	0.2	0.5				
Queue Delay	0.0	0.0	0.0	0.0		0.0	0.7	0.9				
Total Delay	31.1	32.7	35.0	33.8		34.5	1.0	1.4				
Queue Length 50th (ft)	37	224	37	210		55	0	0				
Queue Length 95th (ft)	m54	234	81	308		99	0	0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)	234	669	194	642		395	647	819				
Starvation Cap Reductn	0	0	0	0		0	418	431				
Spillback Cap Reductn	0	0	0	0		0	0	0				
Storage Cap Reductn	0	0	0	0		0	0	0				
Reduced v/c Ratio	0.30	0.60	0.34	0.56		0.39	0.25	0.45				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	255	25	60	235	90	5	40	80	45	25	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.96			0.91		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1834	1904		1787	1803			1812		1750	1617	
Flt Permitted	0.35	1.00		0.30	1.00			0.98		0.37	1.00	
Satd. Flow (perm)	671	1904		558	1803			1785		673	1617	
Peak-hour factor, PHF	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Adj. Flow (vph)	71	364	36	66	258	99	6	49	98	58	32	141
RTOR Reduction (vph)	0	3	0	0	12	0	0	59	0	0	76	0
Lane Group Flow (vph)	71	397	0	66	345	0	0	94	0	58	97	0
Heavy Vehicles (%)	5%	5%	5%	1%	1%	1%	2%	2%	2%	10%	10%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	39.9	39.9		39.9	39.9			11.4		53.2	53.2	
Effective Green, g (s)	41.9	41.9		41.9	41.9			13.4		55.2	55.2	
Actuated g/C Ratio	0.35	0.35		0.35	0.35			0.11		0.46	0.46	
Clearance Time (s)	6.0	6.0		6.0	6.0			6.0		6.0		
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0		
Lane Grp Cap (vph)	234	664		194	629			199		648	743	
v/s Ratio Prot		c0.21			0.19					0.03	c0.06	
v/s Ratio Perm	0.11			0.12				c0.05		0.01		
v/c Ratio	0.30	0.60		0.34	0.55			0.47		0.09	0.13	
Uniform Delay, d1	28.4	32.1		28.8	31.4			50.0		24.8	18.6	
Progression Factor	0.95	0.90		1.00	1.00			0.92		0.00	0.00	
Incremental Delay, d2	3.2	3.8		4.7	3.4			1.7		0.1	0.1	
Delay (s)	30.0	32.6		33.6	34.9			47.6		0.1	0.1	
Level of Service	C	C		C	C			D		A	A	
Approach Delay (s)		32.2			34.7			47.6			0.1	
Approach LOS		C			C			D			A	

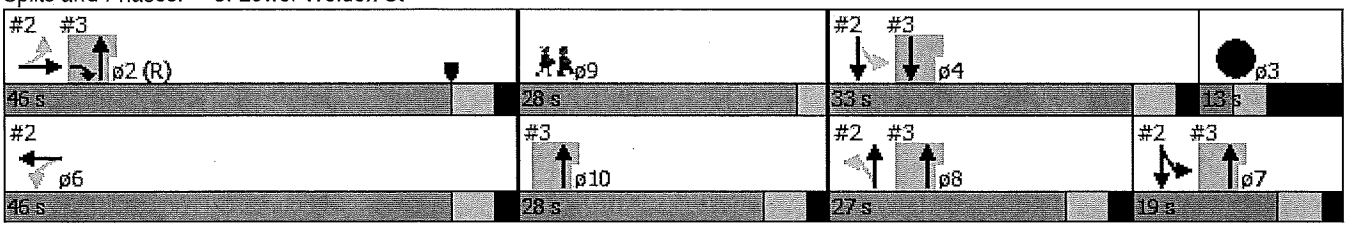
Intersection Summary			
HCM 2000 Control Delay	29.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	45.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	NBT	SBT	ø2	ø3	ø6	ø7	ø8	ø9	ø10
Lane Configurations									
Volume (vph)	180	180							
Lane Group Flow (vph)	200	240							
Turn Type	NA	NA							
Protected Phases	2 7 8 10	4	2	3	6	7	8	9	10
Permitted Phases									
Detector Phase	2 7 8 10	4							
Switch Phase									
Minimum Initial (s)		5.0	7.0	1.0	7.0	10.0	5.0	1.0	4.0
Minimum Split (s)		22.0	22.0	13.0	22.0	19.0	22.0	28.0	22.0
Total Split (s)		33.0	46.0	13.0	46.0	19.0	27.0	28.0	28.0
Total Split (%)		27.5%	38%	11%	38%	16%	23%	23%	23%
Yellow Time (s)		4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0
All-Red Time (s)		2.0	2.0	7.0	2.0	2.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0							
Total Lost Time (s)		4.0							
Lead/Lag		Lead		Lag		Lag	Lead		
Lead-Lag Optimize?		Yes		Yes		Yes	Yes		
Recall Mode		None	C-Max	Max	Max	None	None	None	None
v/c Ratio	0.10	0.68							
Control Delay	0.1	54.6							
Queue Delay	0.0	0.0							
Total Delay	0.1	54.6							
Queue Length 50th (ft)	0	175							
Queue Length 95th (ft)	0	196							
Internal Link Dist (ft)	102	238							
Turn Bay Length (ft)									
Base Capacity (vph)	1976	453							
Starvation Cap Reductn	0	0							
Spillback Cap Reductn	0	0							
Storage Cap Reductn	0	0							
Reduced v/c Ratio	0.10	0.53							

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated

Splits and Phases: 3: Lower Welden St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	0	0	180	180	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	14	14	12	12
Total Lost time (s)				4.0	4.0	
Lane Util. Factor				1.00	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	1.00	
Satd. Flow (prot)				1987	1863	
Flt Permitted				1.00	1.00	
Satd. Flow (perm)				1987	1863	
Peak-hour factor, PHF	0.92	0.92	0.90	0.90	0.75	0.75
Adj. Flow (vph)	0	0	0	200	240	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	200	240	0
Turn Type		Prot		NA	NA	
Protected Phases		2		2 7 8 10	4	
Permitted Phases						
Actuated Green, G (s)				120.0	20.8	
Effective Green, g (s)				120.0	22.8	
Actuated g/C Ratio				1.00	0.19	
Clearance Time (s)					6.0	
Vehicle Extension (s)					3.0	
Lane Grp Cap (vph)				1987	353	
v/s Ratio Prot				c0.10	c0.13	
v/s Ratio Perm						
v/c Ratio				0.10	0.68	
Uniform Delay, d1				0.0	45.2	
Progression Factor				1.00	1.00	
Incremental Delay, d2				0.0	5.1	
Delay (s)				0.0	50.4	
Level of Service				A	D	
Approach Delay (s)	0.0			0.0	50.4	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	27.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	12.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Lake St & Market St

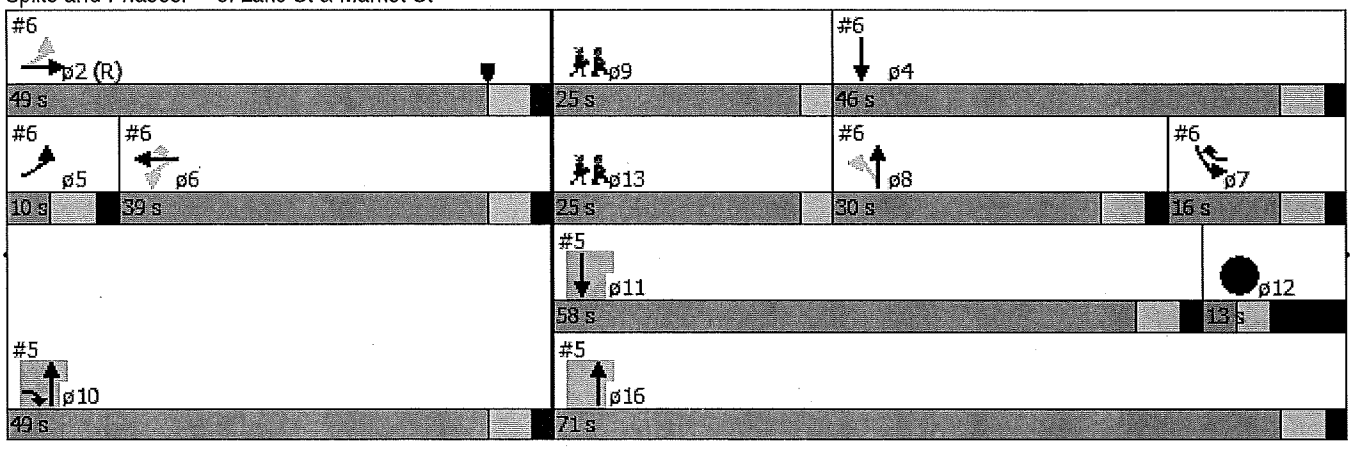
5/29/2015

Lane Group	EBR	NBT	SBT	ø2	ø4	ø5	ø6	ø7	ø8	ø9	ø12	ø13
Lane Configurations												
Volume (vph)	50	415	225									
Lane Group Flow (vph)	69	519	402									
Turn Type	Prot	NA	NA									
Protected Phases	10	10 16	11	2	4	5	6	7	8	9	12	13
Permitted Phases												
Detector Phase	10	10 16	11									
Switch Phase												
Minimum Initial (s)	4.0		4.0	10.0	10.0	4.0	10.0	5.0	10.0	1.0	1.0	1.0
Minimum Split (s)	22.0		22.0	16.0	16.0	10.0	16.0	16.0	16.0	25.0	13.0	25.0
Total Split (s)	49.0		58.0	49.0	46.0	10.0	39.0	16.0	30.0	25.0	13.0	25.0
Total Split (%)	40.8%		48.3%	41%	38%	8%	33%	13%	25%	21%	11%	21%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	7.0	0.0
Lost Time Adjust (s)	-4.0		-4.0									
Total Lost Time (s)	2.0		2.0									
Lead/Lag			Lead		Lag	Lead	Lag		Lag	Lead	Lag	Lead
Lead-Lag Optimize?			Yes			Yes					Yes	Yes
Recall Mode	Max		Max	C-Max	None	Min	Max	None	None	None	Max	None
v/c Ratio	0.07	0.29	0.25									
Control Delay	0.1	0.3	14.2									
Queue Delay	0.0	0.0	0.1									
Total Delay	0.1	0.3	14.3									
Queue Length 50th (ft)	0	0	67									
Queue Length 95th (ft)	m0	m0	94									
Internal Link Dist (ft)		70	148									
Turn Bay Length (ft)												
Base Capacity (vph)	950	1792	1629									
Starvation Cap Reductn	0	0	0									
Spillback Cap Reductn	69	0	418									
Storage Cap Reductn	0	0	0									
Reduced v/c Ratio	0.08	0.29	0.33									

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 115
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lake St & Market St



Lane Group	ø16
Lane Configurations	
Volume (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	16
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	71.0
Total Split (%)	59%
Yellow Time (s)	4.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	Max
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	50	0	415	225	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	14
Total Lost time (s)		2.0		2.0	2.0	
Lane Util. Factor		1.00		1.00	0.95	
Frt		0.86		1.00	0.95	
Flt Protected		1.00		1.00	1.00	
Satd. Flow (prot)		1550		1792	3367	
Flt Permitted		1.00		1.00	1.00	
Satd. Flow (perm)		1550		1792	3367	
Peak-hour factor, PHF	0.72	0.72	0.80	0.80	0.86	0.86
Adj. Flow (vph)	0	69	0	519	262	140
RTOR Reduction (vph)	0	43	0	0	58	0
Lane Group Flow (vph)	0	26	0	519	344	0
Heavy Vehicles (%)	6%	6%	6%	6%	5%	5%
Parking (#/hr)			0			
Turn Type		Prot		NA	NA	
Protected Phases		10		10 16	11	
Permitted Phases						
Actuated Green, G (s)		40.6		120.0	52.0	
Effective Green, g (s)		44.6		120.0	56.0	
Actuated g/C Ratio		0.37		1.00	0.47	
Clearance Time (s)		6.0			6.0	
Vehicle Extension (s)		3.0			3.0	
Lane Grp Cap (vph)		576		1792	1571	
v/s Ratio Prot		0.02		c0.29	0.10	
v/s Ratio Perm						
v/c Ratio		0.04		0.29	0.22	
Uniform Delay, d1		24.1		0.0	19.0	
Progression Factor		1.00		1.00	1.00	
Incremental Delay, d2		0.1		0.3	0.3	
Delay (s)		24.2		0.3	19.3	
Level of Service		C		A	B	
Approach Delay (s)	24.2			0.3	19.3	
Approach LOS	C			A	B	

Intersection Summary			
HCM 2000 Control Delay	9.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	25.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
6: Lake St & Catherine St/Federal St

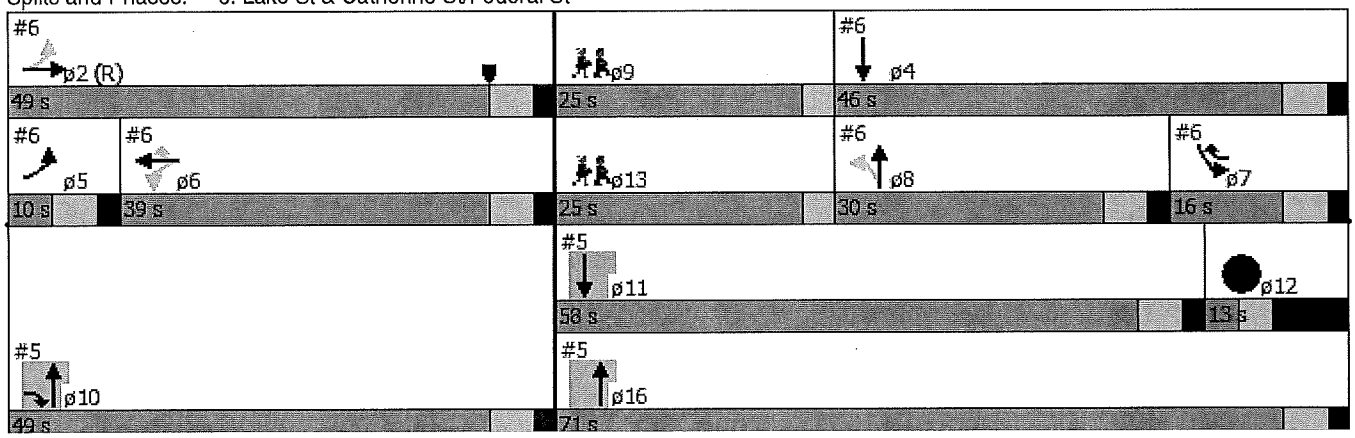
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	ø9	ø10	ø11
Lane Configurations												
Volume (vph)	105	215	25	170	145	30	220	75	100			
Lane Group Flow (vph)	0	466	0	232	173	0	401	87	168			
Turn Type	pm+pt	NA	Perm	NA	pm+ov	Perm	NA	Prot	NA			
Protected Phases	5	2		6	7		8	7	4	9	10	11
Permitted Phases	2		6		6	8						
Detector Phase	5	2	6	6	7	8	8	7	4			
Switch Phase												
Minimum Initial (s)	4.0	10.0	10.0	10.0	5.0	10.0	10.0	5.0	10.0	1.0	4.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	25.0	22.0	22.0
Total Split (s)	10.0	49.0	39.0	39.0	16.0	30.0	30.0	16.0	46.0	25.0	49.0	58.0
Total Split (%)	8.3%	40.8%	32.5%	32.5%	13.3%	25.0%	25.0%	13.3%	38.3%	21%	41%	48%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	2.0	2.0
Lost Time Adjust (s)		-4.0		-4.0	-4.0		-4.0	-4.0	-4.0			
Total Lost Time (s)		2.0		2.0	2.0		2.0	2.0	2.0			
Lead/Lag	Lead		Lag	Lag		Lag	Lag		Lag	Lead		Lead
Lead-Lag Optimize?	Yes											Yes
Recall Mode	Min	C-Max	Max	Max	None	None	None	None	None	None	Max	Max
v/c Ratio		0.99		0.46	0.20		0.75	0.26	0.18			
Control Delay		70.4		30.8	1.2		44.9	37.4	8.7			
Queue Delay		0.0		0.0	0.0		0.0	14.1	1.5			
Total Delay		70.4		30.8	1.2		44.9	51.5	10.2			
Queue Length 50th (ft)		304		175	0		272	59	17			
Queue Length 95th (ft)		#373		185	30		#424	118	130			
Internal Link Dist (ft)		480		474			526		70			
Turn Bay Length (ft)					100							
Base Capacity (vph)		470		509	851		537	337	922			
Starvation Cap Reductn		0		0	0		0	225	590			
Spillback Cap Reductn		0		0	0		0	0	0			
Storage Cap Reductn		0		0	0		0	0	0			
Reduced v/c Ratio		0.99		0.46	0.20		0.75	0.78	0.51			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 115
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Lake St & Catherine St/Federal St



Lane Group	ø12	ø13	ø16
Lane Configurations			
Volume (vph)			
Lane Group Flow (vph)			
Turn Type			
Protected Phases	12	13	16
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	1.0	1.0	4.0
Minimum Split (s)	13.0	25.0	22.0
Total Split (s)	13.0	25.0	71.0
Total Split (%)	11%	21%	59%
Yellow Time (s)	3.0	3.0	4.0
All-Red Time (s)	7.0	0.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Recall Mode	Max	None	Max
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	105	215	15	25	170	145	30	220	70	75	100	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	13	13	13	12	12	12	12	12	12	12	12	12
Total Lost time (s)		2.0			2.0	2.0		2.0		2.0	2.0	
Lane Util. Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00	0.99		0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.95	
Flt Protected		0.98			0.99	1.00		1.00		0.95	1.00	
Satd. Flow (prot)		1810			1797	1519		1712		1719	1707	
Flt Permitted		0.58			0.91	1.00		0.96		0.95	1.00	
Satd. Flow (perm)		1072			1653	1519		1649		1719	1707	
Peak-hour factor, PHF	0.72	0.72	0.72	0.84	0.84	0.84	0.80	0.80	0.80	0.86	0.86	0.86
Adj. Flow (vph)	146	299	21	30	202	173	38	275	88	87	116	52
RTOR Reduction (vph)	0	1	0	0	0	89	0	7	0	0	10	0
Lane Group Flow (vph)	0	465	0	0	232	84	0	394	0	87	158	0
Confl. Peds. (#/hr)	1		4	4		1	15		15	15		15
Heavy Vehicles (%)	6%	6%	6%	5%	5%	5%	6%	6%	6%	5%	5%	5%
Turn Type	pm+pt	NA		Perm	NA	pm+ov	Perm	NA		Prot	NA	
Protected Phases	5	2			6	7		8		7	4	
Permitted Phases	2			6		6	8					
Actuated Green, G (s)		40.6			30.6	50.1		34.7		19.5	60.2	
Effective Green, g (s)		44.6			34.6	58.1		38.7		23.5	64.2	
Actuated g/C Ratio		0.37			0.29	0.48		0.32		0.20	0.54	
Clearance Time (s)		6.0			6.0	6.0		6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0		3.0	3.0	
Lane Grp Cap (vph)		447			476	735		531		336	913	
v/s Ratio Prot		c0.07				0.02				c0.05	0.09	
v/s Ratio Perm		0.32			0.14	0.03		c0.24				
v/c Ratio		1.04			0.49	0.11		0.74		0.26	0.17	
Uniform Delay, d1		37.7			35.4	16.9		36.2		40.9	14.3	
Progression Factor		0.90			0.83	0.36		0.97		0.82	0.56	
Incremental Delay, d2		52.3			3.1	0.1		5.4		0.4	0.1	
Delay (s)		86.0			32.5	6.1		40.7		33.9	8.1	
Level of Service		F			C	A		D		C	A	
Approach Delay (s)		86.0			21.2			40.7			16.9	
Approach LOS		F			C			D			B	

Intersection Summary			
HCM 2000 Control Delay	45.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		

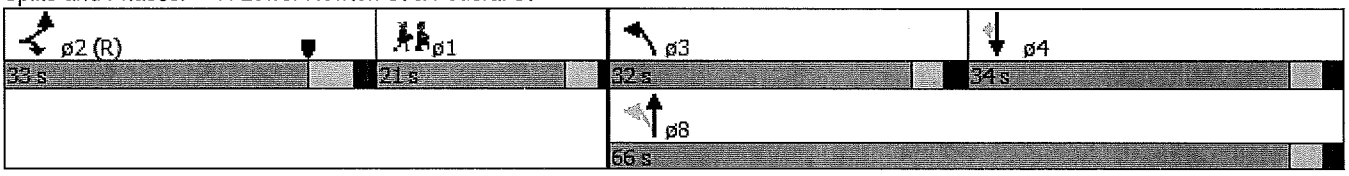
c Critical Lane Group

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1
Lane Configurations							
Volume (vph)	70	165	280	130	75	185	
Lane Group Flow (vph)	82	194	298	138	84	208	
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm	
Protected Phases	2	2	3	8	4		1
Permitted Phases			8			4	
Detector Phase	2	2	3	8	4	4	
Switch Phase							
Minimum Initial (s)	10.0	10.0	5.0	5.0	5.0	5.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	21.0
Total Split (s)	33.0	33.0	32.0	66.0	34.0	34.0	21.0
Total Split (%)	27.5%	27.5%	26.7%	55.0%	28.3%	28.3%	18%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead	Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?							
Recall Mode	C-Min	C-Min	None	None	None	None	None
v/c Ratio	0.08	0.20	0.61	0.22	0.44	0.60	
Control Delay	14.2	1.8	35.0	26.1	56.3	14.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	14.2	1.8	35.0	26.1	56.3	14.2	
Queue Length 50th (ft)	24	6	175	73	62	0	
Queue Length 95th (ft)	m39	m9	263	115	109	68	
Internal Link Dist (ft)	2598			579	189		
Turn Bay Length (ft)		225	175			100	
Base Capacity (vph)	966	952	514	940	458	533	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.08	0.20	0.58	0.15	0.18	0.39	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 91 (76%), Referenced to phase 2:EBL, Start of Yellow
Natural Cycle: 70
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 7: Lower Newton St & Federal St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	70	165	280	130	75	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	3.0	3.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.96
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1752	1568	1699	1792	1776	1452
Flt Permitted	0.95	1.00	0.47	1.00	1.00	1.00
Satd. Flow (perm)	1752	1568	845	1792	1776	1452
Peak-hour factor, PHF	0.85	0.85	0.94	0.94	0.89	0.89
Adj. Flow (vph)	82	194	298	138	84	208
RTOR Reduction (vph)	0	92	0	0	0	185
Lane Group Flow (vph)	82	102	298	138	84	23
Confl. Peds. (#/hr)			4			4
Heavy Vehicles (%)	3%	3%	6%	6%	7%	7%
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm
Protected Phases	2	2	3	8	4	
Permitted Phases			8			4
Actuated Green, G (s)	61.0	61.0	40.6	40.6	11.0	11.0
Effective Green, g (s)	63.0	63.0	42.6	42.6	13.0	13.0
Actuated g/C Ratio	0.52	0.52	0.36	0.36	0.11	0.11
Clearance Time (s)	6.0	6.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	919	823	489	636	192	157
v/s Ratio Prot	0.05	c0.06	c0.13	0.08	0.05	
v/s Ratio Perm			c0.08			0.02
v/c Ratio	0.09	0.12	0.61	0.22	0.44	0.14
Uniform Delay, d1	14.2	14.5	30.4	27.0	50.1	48.5
Progression Factor	0.79	0.45	1.02	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.2	2.1	0.2	1.6	0.4
Delay (s)	11.4	6.7	33.1	27.2	51.7	48.9
Level of Service	B	A	C	C	D	D
Approach Delay (s)	8.1			31.2	49.7	
Approach LOS	A			C	D	

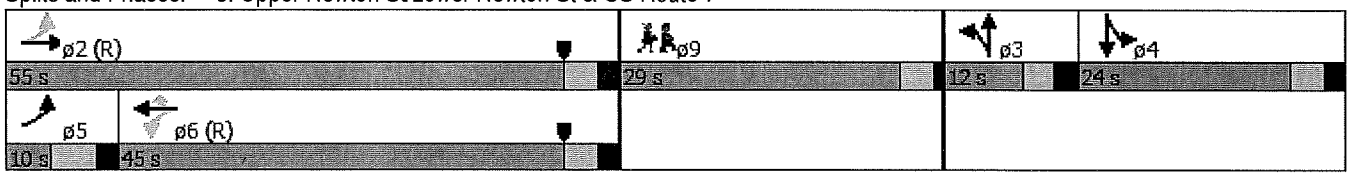
Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT	ø9
Lane Configurations									
Volume (vph)	35	310	5	285	350	25	175	10	
Lane Group Flow (vph)	40	362	0	334	402	55	192	71	
Turn Type	pm+pt	NA	Perm	NA	Perm	NA	Split	NA	
Protected Phases	5	2		6		3	4	4	9
Permitted Phases	2		6		6				
Detector Phase	5	2	6	6	6	3	4	4	
Switch Phase									
Minimum Initial (s)	4.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	10.0	16.0	16.0	29.0
Total Split (s)	10.0	55.0	45.0	45.0	45.0	12.0	24.0	24.0	29.0
Total Split (%)	8.3%	45.8%	37.5%	37.5%	37.5%	10.0%	20.0%	20.0%	24%
Yellow Time (s)	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead		Lag	Lag	Lag	Lead	Lag	Lag	
Lead-Lag Optimize?	Yes		Yes	Yes	Yes				
Recall Mode	None	C-Min	C-Min	C-Min	C-Min	None	None	None	None
v/c Ratio	0.07	0.31		0.32	0.38	0.42	0.68	0.23	
Control Delay	16.2	17.3		19.1	4.0	58.5	47.3	9.7	
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	16.2	17.3		19.1	4.0	58.5	47.3	9.7	
Queue Length 50th (ft)	11	126		127	4	38	98	5	
Queue Length 95th (ft)	m47	365		297	68	64	199	23	
Internal Link Dist (ft)		1214		511		209		579	
Turn Bay Length (ft)	115				150		315		
Base Capacity (vph)	580	1188		1063	1051	145	314	329	
Starvation Cap Reductn	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.07	0.30		0.31	0.38	0.38	0.61	0.22	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 85
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Upper Newton St/Lower Newton St & US Route 7



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	35	310	5	5	285	350	10	25	5	175	10	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			-4%			4%	
Total Lost time (s)	4.0	3.0			3.0	3.0		3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00	0.98		1.00		1.00	0.97	
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	1.00			1.00	0.85		0.98		1.00	0.87	
Flt Protected	0.95	1.00			1.00	1.00		0.99		0.95	1.00	
Satd. Flow (prot)	1703	1787			1825	1520		1881		1717	1528	
Flt Permitted	0.45	1.00			0.99	1.00		0.99		0.95	1.00	
Satd. Flow (perm)	802	1787			1816	1520		1881		1717	1528	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.73	0.73	0.73	0.91	0.91	0.91
Adj. Flow (vph)	40	356	6	6	328	402	14	34	7	192	11	60
RTOR Reduction (vph)	0	0	0	0	0	181	0	5	0	0	50	0
Lane Group Flow (vph)	40	362	0	0	334	221	0	50	0	192	21	0
Confl. Peds. (#/hr)			1	1		1	6					6
Heavy Vehicles (%)	6%	6%	6%	4%	4%	4%	0%	0%	0%	3%	3%	3%
Turn Type	pm+pt	NA		Perm	NA	Perm	Split	NA		Split	NA	
Protected Phases	5	2			6		3	3		4	4	
Permitted Phases	2			6		6						
Actuated Green, G (s)	72.9	72.9			62.3	62.3		5.2		17.9	17.9	
Effective Green, g (s)	74.9	74.9			64.3	64.3		7.2		19.9	19.9	
Actuated g/C Ratio	0.62	0.62			0.54	0.54		0.06		0.17	0.17	
Clearance Time (s)	6.0	5.0			5.0	5.0		5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0	3.0		1.0		3.0	3.0	
Lane Grp Cap (vph)	550	1115			973	814		112		284	253	
v/s Ratio Prot	0.00	c0.20						c0.03		c0.11	0.01	
v/s Ratio Perm	0.04				c0.18	0.15						
v/c Ratio	0.07	0.32			0.34	0.27		0.45		0.68	0.08	
Uniform Delay, d1	9.5	10.6			15.8	15.1		54.5		47.0	42.3	
Progression Factor	1.20	1.31			1.00	1.00		1.00		0.76	0.60	
Incremental Delay, d2	0.0	0.7			1.0	0.8		1.0		6.2	0.1	
Delay (s)	11.4	14.6			16.8	16.0		55.5		41.7	25.6	
Level of Service	B	B			B	B		E		D	C	
Approach Delay (s)		14.2			16.3			55.5			37.4	
Approach LOS		B			B			E			D	

Intersection Summary			
HCM 2000 Control Delay	21.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	52.6%	ICU Level of Service	A
Analysis Period (min)	15		

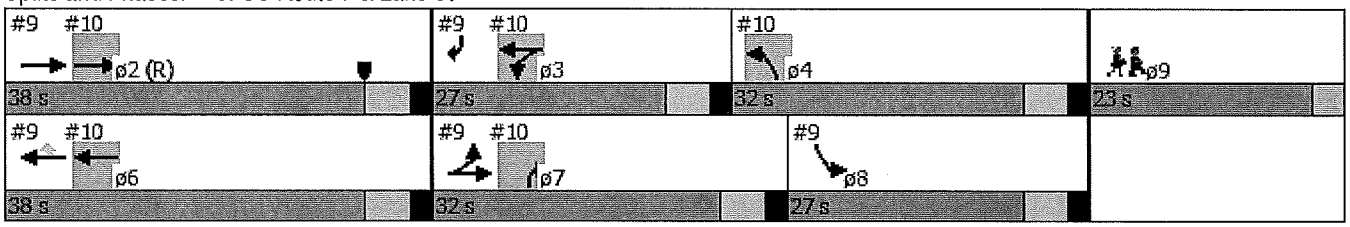
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø2	ø4	ø9
Lane Configurations									
Volume (vph)	155	330	265	160	95	75			
Lane Group Flow (vph)	168	359	288	174	103	82			
Turn Type	Prot	NA	NA	Perm	Prot	Prot			
Protected Phases	7	2 7	6		8	3	2	4	9
Permitted Phases				6					
Detector Phase	7	2 7	6	6	8	3			
Switch Phase									
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	23.0
Total Split (s)	32.0		38.0	38.0	27.0	27.0	38.0	32.0	23.0
Total Split (%)	26.7%		31.7%	31.7%	22.5%	22.5%	32%	27%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0		-2.0	-2.0	-2.0	-2.0			
Total Lost Time (s)	4.0		4.0	4.0	4.0	4.0			
Lead/Lag	Lead				Lag	Lead		Lag	
Lead-Lag Optimize?					Yes			Yes	
Recall Mode	None		None	None	None	None	C-Max	None	None
v/c Ratio	0.58	0.27	0.15	0.19	0.50	0.31			
Control Delay	48.6	2.5	20.1	9.2	62.8	16.5			
Queue Delay	1.9	0.3	0.1	0.0	0.0	0.1			
Total Delay	50.5	2.9	20.2	9.2	62.8	16.5			
Queue Length 50th (ft)	125	14	62	18	80	3			
Queue Length 95th (ft)	173	34	151	125	m132	m48			
Internal Link Dist (ft)		60	1628		526				
Turn Bay Length (ft)				100		275			
Base Capacity (vph)	405	1471	1869	916	329	361			
Starvation Cap Reductn	125	617	0	0	0	0			
Spillback Cap Reductn	0	0	755	0	0	24			
Storage Cap Reductn	0	0	0	0	0	0			
Reduced v/c Ratio	0.60	0.42	0.26	0.19	0.31	0.24			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 9: US Route 7 & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	155	330	265	160	95	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3471	1553	1719	1538
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3471	1553	1719	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	168	359	288	174	103	82
RTOR Reduction (vph)	0	0	0	83	0	72
Lane Group Flow (vph)	168	359	288	91	103	10
Heavy Vehicles (%)	4%	4%	4%	4%	5%	5%
Turn Type	Prot	NA	NA	Perm	Prot	Prot
Protected Phases	7	2 7	6		8	3
Permitted Phases				6		
Actuated Green, G (s)	18.1	84.9	60.8	60.8	12.5	13.3
Effective Green, g (s)	20.1	86.9	62.8	62.8	14.5	15.3
Actuated g/C Ratio	0.17	0.72	0.52	0.52	0.12	0.13
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	290	1323	1816	812	207	196
v/s Ratio Prot	c0.10	c0.20	0.08		c0.06	0.01
v/s Ratio Perm				0.06		
v/c Ratio	0.58	0.27	0.16	0.11	0.50	0.05
Uniform Delay, d1	46.1	5.7	14.9	14.5	49.3	46.0
Progression Factor	0.91	0.27	1.08	2.13	1.13	1.43
Incremental Delay, d2	2.6	0.1	0.0	0.1	1.8	0.1
Delay (s)	44.4	1.7	16.1	31.0	57.5	66.0
Level of Service	D	A	B	C	E	E
Approach Delay (s)		15.3	21.7		61.2	
Approach LOS		B	C		E	

Intersection Summary			
HCM 2000 Control Delay	25.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	32.2%	ICU Level of Service	A
Analysis Period (min)	15		

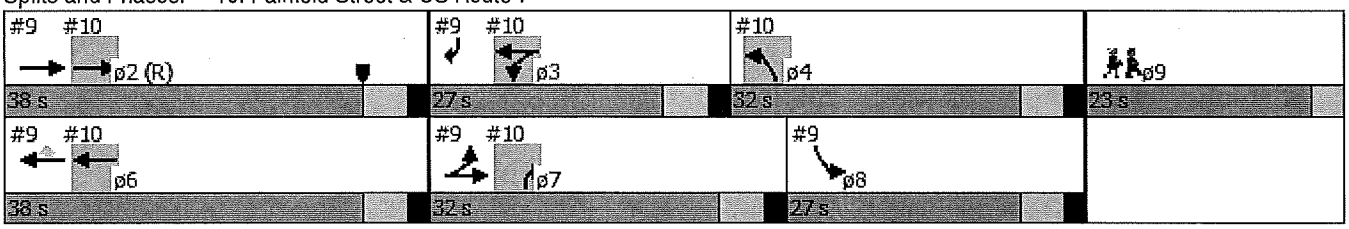
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBL	NBR	ø6	ø8	ø9
Lane Configurations								
Volume (vph)	285	105	235	85	200			
Lane Group Flow (vph)	424	114	255	92	217			
Turn Type	NA	Prot	NA	Prot	Prot			
Protected Phases	2	3	3 6	4	7	6	8	9
Permitted Phases								
Detector Phase	2	3	3 6	4	7			
Switch Phase								
Minimum Initial (s)	10.0	5.0		5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0	16.0		16.0	16.0	16.0	16.0	23.0
Total Split (s)	38.0	27.0		32.0	32.0	38.0	27.0	23.0
Total Split (%)	31.7%	22.5%		26.7%	26.7%	32%	23%	19%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0			
Total Lost Time (s)	4.0	4.0		4.0	4.0			
Lead/Lag		Lead		Lag	Lead		Lag	
Lead-Lag Optimize?				Yes			Yes	
Recall Mode	C-Max	None		None	None	None	None	None
v/c Ratio	0.23	0.52	0.20	0.32	0.49			
Control Delay	22.5	54.6	2.5	46.2	9.0			
Queue Delay	0.2	5.1	0.4	0.0	0.3			
Total Delay	22.7	59.7	2.9	46.2	9.3			
Queue Length 50th (ft)	64	92	7	64	0			
Queue Length 95th (ft)	180	150	44	108	63			
Internal Link Dist (ft)	1342		60	263				
Turn Bay Length (ft)					250			
Base Capacity (vph)	1815	332	1395	413	535			
Starvation Cap Reductn	0	160	734	0	0			
Spillback Cap Reductn	731	0	0	0	58			
Storage Cap Reductn	0	0	0	0	0			
Reduced v/c Ratio	0.39	0.66	0.39	0.22	0.45			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 10: Fairfield Street & US Route 7



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	285	105	105	235	85	200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	0.95		1.00	1.00	1.00	1.00
Frt	0.96		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3331		1736	1827	1770	1583
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3331		1736	1827	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	310	114	114	255	92	217
RTOR Reduction (vph)	21	0	0	0	0	181
Lane Group Flow (vph)	403	0	114	255	92	36
Heavy Vehicles (%)	4%	4%	4%	4%	2%	2%
Turn Type	NA		Prot	NA	Prot	Prot
Protected Phases	2		3	3 6	4	7
Permitted Phases						
Actuated Green, G (s)	60.8		13.3	80.1	17.3	18.1
Effective Green, g (s)	62.8		15.3	82.1	19.3	20.1
Actuated g/C Ratio	0.52		0.13	0.68	0.16	0.17
Clearance Time (s)	6.0		6.0		6.0	6.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	1743		221	1249	284	265
v/s Ratio Prot	c0.12		c0.07	0.14	c0.05	0.02
v/s Ratio Perm						
v/c Ratio	0.23		0.52	0.20	0.32	0.14
Uniform Delay, d1	15.5		48.9	7.0	44.6	42.6
Progression Factor	1.31		0.96	0.23	1.00	1.00
Incremental Delay, d2	0.2		2.0	0.1	0.7	0.2
Delay (s)	20.5		49.2	1.7	45.2	42.8
Level of Service	C		D	A	D	D
Approach Delay (s)	20.5			16.4	43.5	
Approach LOS	C			B	D	

Intersection Summary			
HCM 2000 Control Delay	25.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	31.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
2: Lower Welden St & Lemnah Dr/Allen St

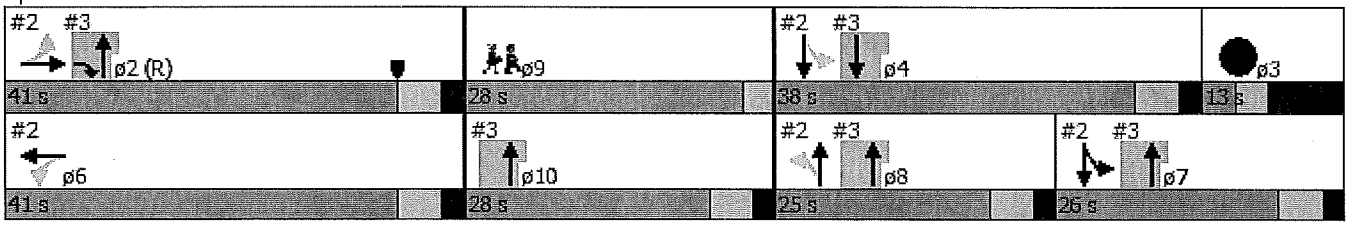
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	40	295	100	295	10	55	115	60				
Lane Group Flow (vph)	43	332	109	413	0	175	153	213				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	41.0	41.0	41.0	41.0	25.0	25.0	26.0		13.0	38.0	28.0	28.0
Total Split (%)	34.2%	34.2%	34.2%	34.2%	20.8%	20.8%	21.7%		11%	32%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0		-2.0	-2.0					
Total Lost Time (s)	4.0	4.0	4.0	4.0		4.0	4.0					
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio	0.31	0.54	0.56	0.73		0.64	0.20	0.23				
Control Delay	36.8	33.5	48.1	44.9		42.7	1.1	0.4				
Queue Delay	0.0	0.0	0.0	0.0		0.0	1.8	1.1				
Total Delay	36.8	33.5	48.1	44.9		42.7	2.9	1.5				
Queue Length 50th (ft)	23	183	71	277		86	2	0				
Queue Length 95th (ft)	m40	m269	138	398		141	0	0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)	139	610	193	563		340	752	942				
Starvation Cap Reductn	0	0	0	0		0	458	518				
Spillback Cap Reductn	0	0	0	0		0	0	0				
Storage Cap Reductn	0	0	0	0		0	0	0				
Reduced v/c Ratio	0.31	0.54	0.56	0.73		0.51	0.52	0.50				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	295	10	100	295	85	10	55	85	115	60	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	1.00		1.00	0.97			0.92		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1888	1977		1770	1801			1760		1888	1801	
Flt Permitted	0.23	1.00		0.34	1.00			0.97		0.37	1.00	
Satd. Flow (perm)	453	1977		625	1801			1707		744	1801	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Adj. Flow (vph)	43	321	11	109	321	92	12	64	99	153	80	133
RTOR Reduction (vph)	0	1	0	0	8	0	0	41	0	0	41	0
Lane Group Flow (vph)	43	331	0	109	405	0	0	134	0	153	172	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	34.9	34.9		34.9	34.9			14.3		58.2	58.2	
Effective Green, g (s)	36.9	36.9		36.9	36.9			16.3		60.2	60.2	
Actuated g/C Ratio	0.31	0.31		0.31	0.31			0.14		0.50	0.50	
Clearance Time (s)	6.0	6.0		6.0	6.0			6.0		6.0		
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0		
Lane Grp Cap (vph)	139	607		192	553			231		753	903	
v/s Ratio Prot		0.17			c0.22					c0.07	c0.10	
v/s Ratio Perm	0.10			0.17				c0.08		0.03		
v/c Ratio	0.31	0.55		0.57	0.73			0.58		0.20	0.19	
Uniform Delay, d1	31.8	34.6		34.9	37.1			48.7		23.5	16.5	
Progression Factor	0.94	0.87		1.00	1.00			0.92		0.03	0.00	
Incremental Delay, d2	5.1	3.1		11.6	8.3			3.5		0.1	0.1	
Delay (s)	35.0	33.2		46.5	45.4			48.3		0.8	0.1	
Level of Service	D	C		D	D			D		A	A	
Approach Delay (s)		33.4			45.7			48.3			0.4	
Approach LOS		C			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	31.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		

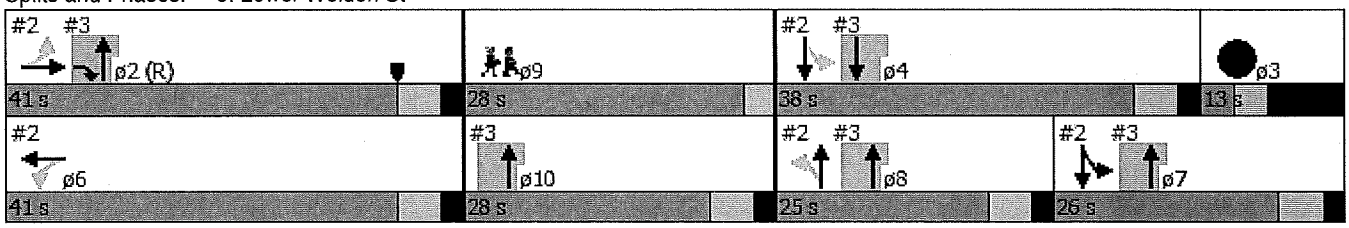
c Critical Lane Group

Lane Group	NBT	SBT	ø2	ø3	ø6	ø7	ø8	ø9	ø10
Lane Configurations									
Volume (vph)	180	275							
Lane Group Flow (vph)	200	367							
Turn Type	NA	NA							
Protected Phases	2 7 8 10	4	2	3	6	7	8	9	10
Permitted Phases									
Detector Phase	2 7 8 10	4							
Switch Phase									
Minimum Initial (s)		5.0	7.0	1.0	7.0	10.0	5.0	1.0	4.0
Minimum Split (s)		22.0	22.0	13.0	22.0	19.0	22.0	28.0	22.0
Total Split (s)		38.0	41.0	13.0	41.0	26.0	25.0	28.0	28.0
Total Split (%)		31.7%	34%	11%	34%	22%	21%	23%	23%
Yellow Time (s)		4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0
All-Red Time (s)		2.0	2.0	7.0	2.0	2.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0							
Total Lost Time (s)		4.0							
Lead/Lag		Lead		Lag		Lag	Lead		
Lead-Lag Optimize?		Yes		Yes		Yes	Yes		
Recall Mode		None	C-Max	Max	Max	None	None	None	None
v/c Ratio	0.10	0.78							
Control Delay	0.1	53.9							
Queue Delay	0.0	0.0							
Total Delay	0.1	53.9							
Queue Length 50th (ft)	0	262							
Queue Length 95th (ft)	m0	284							
Internal Link Dist (ft)	102	238							
Turn Bay Length (ft)									
Base Capacity (vph)	1970	532							
Starvation Cap Reductn	0	0							
Spillback Cap Reductn	0	0							
Storage Cap Reductn	0	0							
Reduced v/c Ratio	0.10	0.69							

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Lower Welden St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	0	0	180	275	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	14	14	12	12
Total Lost time (s)				4.0	4.0	
Lane Util. Factor				1.00	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	1.00	
Satd. Flow (prot)				1987	1863	
Flt Permitted				1.00	1.00	
Satd. Flow (perm)				1987	1863	
Peak-hour factor, PHF	0.92	0.92	0.90	0.90	0.75	0.75
Adj. Flow (vph)	0	0	0	200	367	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	200	367	0
Turn Type		Prot		NA	NA	
Protected Phases		2		2 7 8 10	4	
Permitted Phases						
Actuated Green, G (s)				120.0	28.2	
Effective Green, g (s)				120.0	30.2	
Actuated g/C Ratio				1.00	0.25	
Clearance Time (s)					6.0	
Vehicle Extension (s)					3.0	
Lane Grp Cap (vph)				1987	468	
v/s Ratio Prot				c0.10	c0.20	
v/s Ratio Perm						
v/c Ratio				0.10	0.78	
Uniform Delay, d1				0.0	41.9	
Progression Factor				1.00	1.00	
Incremental Delay, d2				0.0	8.4	
Delay (s)				0.0	50.2	
Level of Service				A	D	
Approach Delay (s)	0.0			0.0	50.2	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	32.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	17.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Lake St & Market St

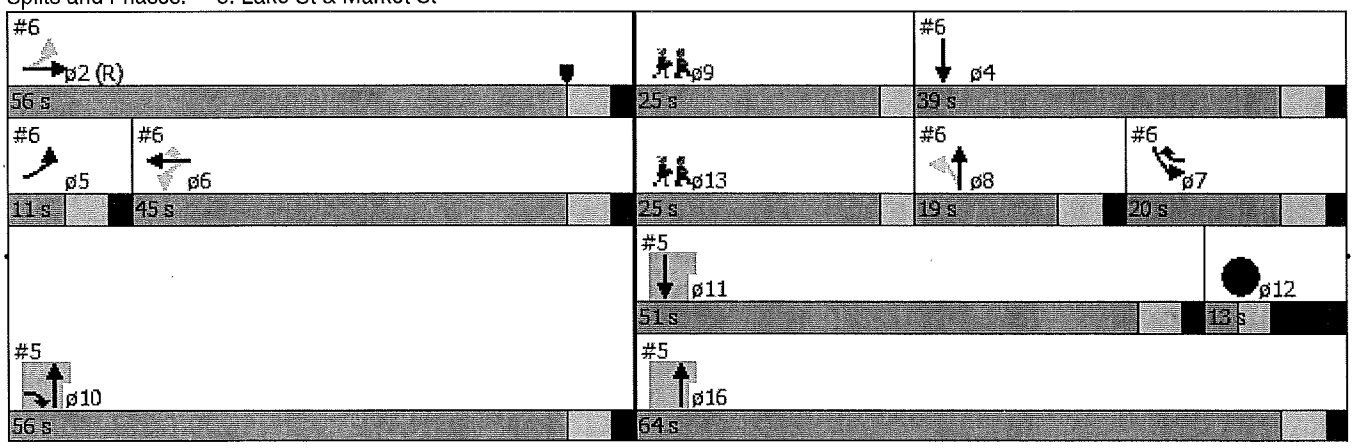
5/29/2015

Lane Group	EBR	NBT	SBT	ø2	ø4	ø5	ø6	ø7	ø8	ø9	ø12	ø13
Lane Configurations												
Volume (vph)	90	535	385									
Lane Group Flow (vph)	98	575	536									
Turn Type	Prot	NA	NA									
Protected Phases	10	10 16	11	2	4	5	6	7	8	9	12	13
Permitted Phases												
Detector Phase	10	10 16	11									
Switch Phase												
Minimum Initial (s)	4.0		4.0	10.0	10.0	4.0	10.0	5.0	10.0	1.0	1.0	1.0
Minimum Split (s)	22.0		22.0	16.0	16.0	10.0	16.0	16.0	16.0	25.0	13.0	25.0
Total Split (s)	56.0		51.0	56.0	39.0	11.0	45.0	20.0	19.0	25.0	13.0	25.0
Total Split (%)	46.7%		42.5%	47%	33%	9%	38%	17%	16%	21%	11%	21%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	7.0	0.0
Lost Time Adjust (s)	-4.0		-4.0									
Total Lost Time (s)	2.0		2.0									
Lead/Lag			Lead		Lag	Lead	Lag		Lag	Lead	Lag	Lead
Lead-Lag Optimize?			Yes			Yes					Yes	Yes
Recall Mode	Max		Max	C-Max	None	Min	Max	None	None	None	Max	None
v/c Ratio	0.11	0.31	0.36									
Control Delay	0.2	0.9	23.2									
Queue Delay	0.0	0.0	0.8									
Total Delay	0.2	0.9	23.9									
Queue Length 50th (ft)	0	0	135									
Queue Length 95th (ft)	m0	85	181									
Internal Link Dist (ft)		70	148									
Turn Bay Length (ft)												
Base Capacity (vph)	925	1845	1478									
Starvation Cap Reductn	0	0	0									
Spillback Cap Reductn	61	0	603									
Storage Cap Reductn	0	0	0									
Reduced v/c Ratio	0.11	0.31	0.61									

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 125
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lake St & Market St



Lane Group	ø16
Lane Configurations	
Volume (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	16
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	64.0
Total Split (%)	53%
Yellow Time (s)	4.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	Max
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	90	0	535	385	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	14
Total Lost time (s)		2.0		2.0	2.0	
Lane Util. Factor		1.00		1.00	0.95	
Frt		0.86		1.00	0.96	
Flt Protected		1.00		1.00	1.00	
Satd. Flow (prot)		1611		1845	3554	
Flt Permitted		1.00		1.00	1.00	
Satd. Flow (perm)		1611		1845	3554	
Peak-hour factor, PHF	0.92	0.92	0.93	0.93	0.96	0.96
Adj. Flow (vph)	0	98	0	575	401	135
RTOR Reduction (vph)	0	56	0	0	28	0
Lane Group Flow (vph)	0	42	0	575	508	0
Heavy Vehicles (%)	2%	2%	3%	3%	1%	1%
Parking (#/hr)			0			
Turn Type		Prot		NA	NA	
Protected Phases		10		10 16	11	
Permitted Phases						
Actuated Green, G (s)		47.6		120.0	45.0	
Effective Green, g (s)		51.6		120.0	49.0	
Actuated g/C Ratio		0.43		1.00	0.41	
Clearance Time (s)		6.0			6.0	
Vehicle Extension (s)		3.0			3.0	
Lane Grp Cap (vph)		692		1845	1451	
v/s Ratio Prot		0.03		c0.31	c0.14	
v/s Ratio Perm						
v/c Ratio		0.06		0.31	0.35	
Uniform Delay, d1		20.0		0.0	24.5	
Progression Factor		1.00		1.00	1.00	
Incremental Delay, d2		0.2		0.4	0.7	
Delay (s)		20.2		0.4	25.2	
Level of Service		C		A	C	
Approach Delay (s)	20.2			0.4	25.2	
Approach LOS	C			A	C	

Intersection Summary			
HCM 2000 Control Delay	13.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	31.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
6: Lake St & Catherine St/Federal St

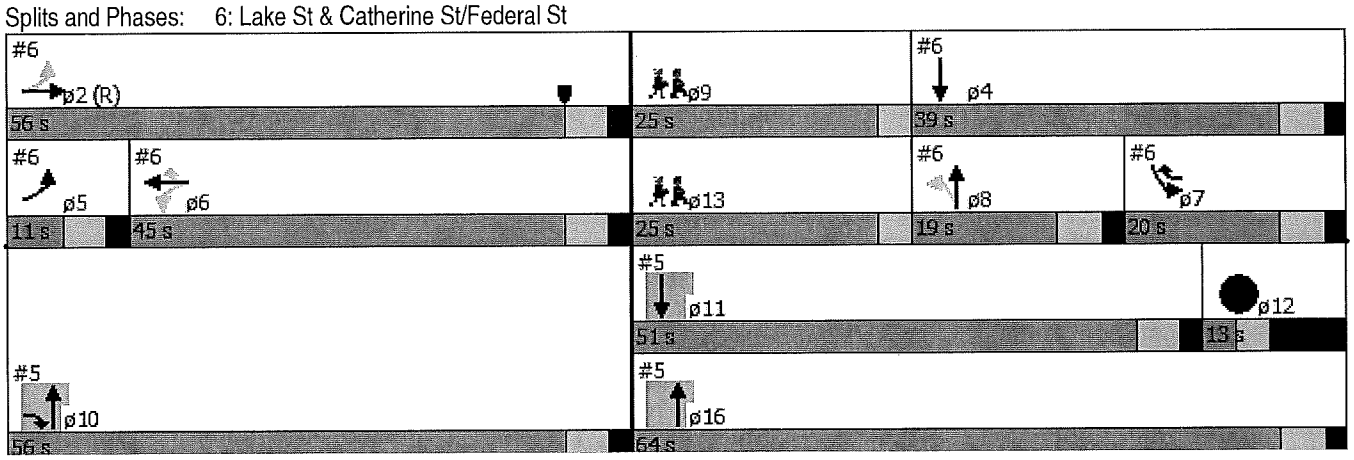
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	ø9	ø10	ø11
Lane Configurations												
Volume (vph)	85	335	30	260	150	40	275	225	200			
Lane Group Flow (vph)	0	483	0	316	163	0	387	234	255			
Turn Type	pm+pt	NA	Perm	NA	pm+ov	Perm	NA	Prot	NA			
Protected Phases	5	2		6	7		8	7	4	9	10	11
Permitted Phases	2		6		6	8						
Detector Phase	5	2	6	6	7	8	8	7	4			
Switch Phase												
Minimum Initial (s)	4.0	10.0	10.0	10.0	5.0	10.0	10.0	5.0	10.0	1.0	4.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	25.0	22.0	22.0
Total Split (s)	11.0	56.0	45.0	45.0	20.0	19.0	19.0	20.0	39.0	25.0	56.0	51.0
Total Split (%)	9.2%	46.7%	37.5%	37.5%	16.7%	15.8%	15.8%	16.7%	32.5%	21%	47%	43%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	2.0	2.0
Lost Time Adjust (s)		-4.0		-4.0	-4.0		-4.0	-4.0	-4.0			
Total Lost Time (s)		2.0		2.0	2.0		2.0	2.0	2.0			
Lead/Lag	Lead		Lag	Lag		Lag	Lag		Lag	Lead		Lead
Lead-Lag Optimize?	Yes											Yes
Recall Mode	Min	C-Max	Max	Max	None	None	None	None	None	None	Max	Max
v/c Ratio		0.78		0.52	0.19		0.74	0.87	0.29			
Control Delay		35.1		35.3	3.9		54.5	67.4	11.8			
Queue Delay		0.0		0.0	0.0		0.3	65.4	1.7			
Total Delay		35.1		35.3	3.9		54.9	132.7	13.5			
Queue Length 50th (ft)		250		235	38		315	193	36			
Queue Length 95th (ft)		493		277	35		#625	#339	245			
Internal Link Dist (ft)		480		474			526		70			
Turn Bay Length (ft)					100							
Base Capacity (vph)		617		613	870		525	268	870			
Starvation Cap Reductn		0		0	0		0	159	450			
Spillback Cap Reductn		0		0	10		12	0	0			
Storage Cap Reductn		0		0	0		0	0	0			
Reduced v/c Ratio		0.78		0.52	0.19		0.75	2.15	0.61			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 125
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Lake St & Catherine St/Federal St



Lane Group	ø12	ø13	ø16
Lane Configurations			
Volume (vph)			
Lane Group Flow (vph)			
Turn Type			
Protected Phases	12	13	16
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	1.0	1.0	4.0
Minimum Split (s)	13.0	25.0	22.0
Total Split (s)	13.0	25.0	64.0
Total Split (%)	11%	21%	53%
Yellow Time (s)	3.0	3.0	4.0
All-Red Time (s)	7.0	0.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Recall Mode	Max	None	Max
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	85	335	25	30	260	150	40	275	45	225	200	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	13	13	13	12	12	12	12	12	12	12	12	12
Total Lost time (s)		2.0			2.0	2.0		2.0		2.0	2.0	
Lane Util. Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00	0.99		0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.98		1.00	0.97	
Flt Protected		0.99			0.99	1.00		0.99		0.95	1.00	
Satd. Flow (prot)		1890			1853	1560		1791		1787	1817	
Flt Permitted		0.66			0.92	1.00		0.94		0.95	1.00	
Satd. Flow (perm)		1265			1713	1560		1691		1787	1817	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	92	364	27	33	283	163	43	296	48	234	208	47
RTOR Reduction (vph)	0	2	0	0	0	80	0	3	0	0	5	0
Lane Group Flow (vph)	0	481	0	0	316	83	0	384	0	234	250	0
Confl. Peds. (#/hr)	1		4	4		1	15		15	15		15
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%	3%	3%	1%	1%	1%
Turn Type	pm+pt	NA		Perm	NA	pm+ov	Perm	NA		Prot	NA	
Protected Phases	5	2			6	7		8		7	4	
Permitted Phases	2			6		6	8					
Actuated Green, G (s)		47.6			36.6	50.6		33.2		14.0	53.2	
Effective Green, g (s)		51.6			40.6	58.6		37.2		18.0	57.2	
Actuated g/C Ratio		0.43			0.34	0.49		0.31		0.15	0.48	
Clearance Time (s)		6.0			6.0	6.0		6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0		3.0	3.0	
Lane Grp Cap (vph)		590			579	761		524		268	866	
v/s Ratio Prot		c0.06				0.02				c0.13	0.14	
v/s Ratio Perm		0.29			0.18	0.04		c0.23				
v/c Ratio		0.82			0.55	0.11		0.73		0.87	0.29	
Uniform Delay, d1		30.0			32.2	16.6		37.0		49.9	19.1	
Progression Factor		0.96			1.05	1.92		1.26		0.73	0.53	
Incremental Delay, d2		8.1			3.5	0.1		5.0		24.5	0.2	
Delay (s)		36.8			37.2	31.9		51.5		61.0	10.3	
Level of Service		D			D	C		D		E	B	
Approach Delay (s)		36.8			35.4			51.5			34.6	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM 2000 Control Delay	38.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		

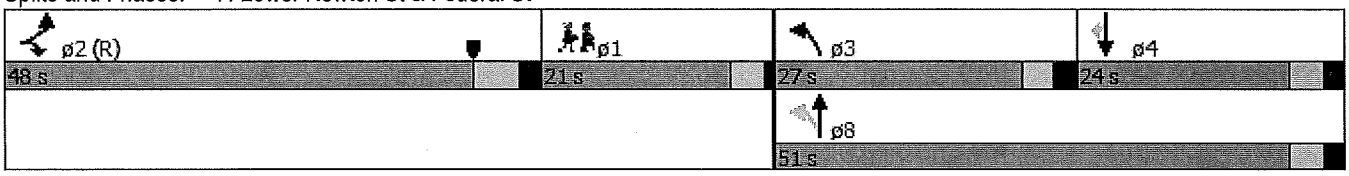
c Critical Lane Group

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1
Lane Configurations							
Volume (vph)	130	515	260	135	130	90	
Lane Group Flow (vph)	151	599	265	138	134	93	
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm	
Protected Phases	2	2	3	8	4		1
Permitted Phases			8			4	
Detector Phase	2	2	3	8	4	4	
Switch Phase							
Minimum Initial (s)	10.0	10.0	5.0	5.0	5.0	5.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	21.0
Total Split (s)	48.0	48.0	27.0	51.0	24.0	24.0	21.0
Total Split (%)	40.0%	40.0%	22.5%	42.5%	20.0%	20.0%	18%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead	Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?							
Recall Mode	C-Min	C-Min	None	None	None	None	None
v/c Ratio	0.15	0.52	0.61	0.22	0.55	0.33	
Control Delay	12.5	3.0	35.7	24.4	56.5	12.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	12.5	3.0	35.7	24.4	56.5	12.0	
Queue Length 50th (ft)	35	3	154	70	98	0	
Queue Length 95th (ft)	m96	m197	177	68	156	47	
Internal Link Dist (ft)	2598			579	189		
Turn Bay Length (ft)		225	175			100	
Base Capacity (vph)	1002	1156	460	749	320	340	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.15	0.52	0.58	0.18	0.42	0.27	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 91 (76%), Referenced to phase 2:EBL, Start of Yellow
Natural Cycle: 70
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 7: Lower Newton St & Federal St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	130	515	260	135	130	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	3.0	3.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1750	1845	1827	1499
Flt Permitted	0.95	1.00	0.38	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	695	1845	1827	1499
Peak-hour factor, PHF	0.86	0.86	0.98	0.98	0.97	0.97
Adj. Flow (vph)	151	599	265	138	134	93
RTOR Reduction (vph)	0	280	0	0	0	81
Lane Group Flow (vph)	151	319	265	138	134	12
Confl. Peds. (#/hr)			4			4
Heavy Vehicles (%)	2%	2%	3%	3%	4%	4%
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm
Protected Phases	2	2	3	8	4	
Permitted Phases			8			4
Actuated Green, G (s)	62.0	62.0	39.6	39.6	14.1	14.1
Effective Green, g (s)	64.0	64.0	41.6	41.6	16.1	16.1
Actuated g/C Ratio	0.53	0.53	0.35	0.35	0.13	0.13
Clearance Time (s)	6.0	6.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	944	844	438	639	245	201
v/s Ratio Prot	0.09	c0.20	c0.11	0.07	0.07	
v/s Ratio Perm			c0.10			0.01
v/c Ratio	0.16	0.38	0.61	0.22	0.55	0.06
Uniform Delay, d1	14.3	16.4	30.6	27.7	48.5	45.4
Progression Factor	0.72	0.83	1.04	0.91	1.00	1.00
Incremental Delay, d2	0.3	0.9	2.1	0.1	2.5	0.1
Delay (s)	10.6	14.4	34.0	25.3	51.0	45.5
Level of Service	B	B	C	C	D	D
Approach Delay (s)	13.7			31.0	48.8	
Approach LOS	B			C	D	

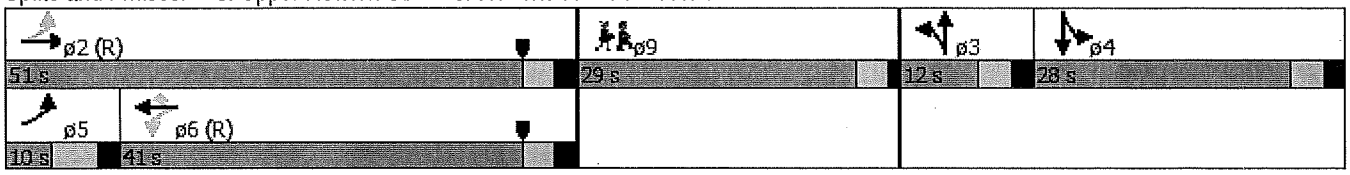
Intersection Summary			
HCM 2000 Control Delay	24.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	45.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT	ø9
Lane Configurations									
Volume (vph)	55	515	5	445	325	15	580	25	
Lane Group Flow (vph)	60	577	0	473	342	42	630	70	
Turn Type	pm+pt	NA	Perm	NA	Perm	NA	Split	NA	
Protected Phases	5	2		6		3	4	4	9
Permitted Phases	2		6		6				
Detector Phase	5	2	6	6	6	3	4	4	
Switch Phase									
Minimum Initial (s)	4.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	10.0	16.0	16.0	29.0
Total Split (s)	10.0	51.0	41.0	41.0	41.0	12.0	28.0	28.0	29.0
Total Split (%)	8.3%	42.5%	34.2%	34.2%	34.2%	10.0%	23.3%	23.3%	24%
Yellow Time (s)	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead		Lag	Lag	Lag	Lead	Lag	Lag	
Lead-Lag Optimize?	Yes		Yes	Yes	Yes				
Recall Mode	None	C-Min	C-Min	C-Min	C-Min	None	None	None	None
v/c Ratio	0.39	0.83		1.00	0.54	0.33	0.80	0.09	
Control Delay	34.9	45.7		82.7	15.0	48.3	36.5	12.9	
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	34.9	45.7		82.7	15.0	48.3	36.5	12.9	
Queue Length 50th (ft)	24	315		361	69	23	284	7	
Queue Length 95th (ft)	m78	590		#579	164	56	#948	49	
Internal Link Dist (ft)		1214		511		209		579	
Turn Bay Length (ft)	115				150		315		
Base Capacity (vph)	154	743		485	642	144	783	756	
Starvation Cap Reductn	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.39	0.78		0.98	0.53	0.29	0.80	0.09	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Upper Newton St/Lower Newton St & US Route 7



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	515	10	5	445	325	10	15	10	580	25	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			-4%			4%	
Total Lost time (s)	4.0	3.0			3.0	3.0		3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00	0.98		1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	1.00			1.00	0.85		0.96		1.00	0.91	
Flt Protected	0.95	1.00			1.00	1.00		0.99		0.95	1.00	
Satd. Flow (prot)	1770	1857			1862	1549		1784		1734	1630	
Flt Permitted	0.11	1.00			0.82	1.00		0.99		0.95	1.00	
Satd. Flow (perm)	208	1857			1533	1549		1784		1734	1630	
Peak-hour factor, PHF	0.91	0.91	0.91	0.95	0.95	0.95	0.85	0.85	0.85	0.92	0.92	0.92
Adj. Flow (vph)	60	566	11	5	468	342	12	18	12	630	27	43
RTOR Reduction (vph)	0	1	0	0	0	163	0	11	0	0	24	0
Lane Group Flow (vph)	60	576	0	0	473	179	0	31	0	630	46	0
Confl. Peds. (#/hr)			1	1		1	6					6
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%	3%	3%	2%	2%	2%
Turn Type	pm+pt	NA		Perm	NA	Perm	Split	NA		Split	NA	
Protected Phases	5	2			6		3	3		4	4	
Permitted Phases	2			6		6						
Actuated Green, G (s)	39.0	39.0			29.8	29.8		4.8		52.2	52.2	
Effective Green, g (s)	41.0	41.0			31.8	31.8		6.8		54.2	54.2	
Actuated g/C Ratio	0.34	0.34			0.27	0.27		0.06		0.45	0.45	
Clearance Time (s)	6.0	5.0			5.0	5.0		5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0	3.0		1.0		3.0	3.0	
Lane Grp Cap (vph)	138	634			406	410		101		783	736	
v/s Ratio Prot	0.02	c0.31						c0.02		c0.36	0.03	
v/s Ratio Perm	0.13				c0.31	0.12						
v/c Ratio	0.43	0.91			1.17	0.44		0.30		0.80	0.06	
Uniform Delay, d1	31.3	37.7			44.1	36.6		54.3		28.3	18.6	
Progression Factor	1.21	1.07			1.00	1.00		1.00		0.88	0.91	
Incremental Delay, d2	1.9	17.1			98.0	3.4		0.6		5.3	0.0	
Delay (s)	39.7	57.6			142.1	40.0		54.9		30.3	16.9	
Level of Service	D	E			F	D		D		C	B	
Approach Delay (s)		55.9			99.2			54.9			28.9	
Approach LOS		E			F			D			C	

Intersection Summary			
HCM 2000 Control Delay	63.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	91.2%	ICU Level of Service	F
Analysis Period (min)	15		

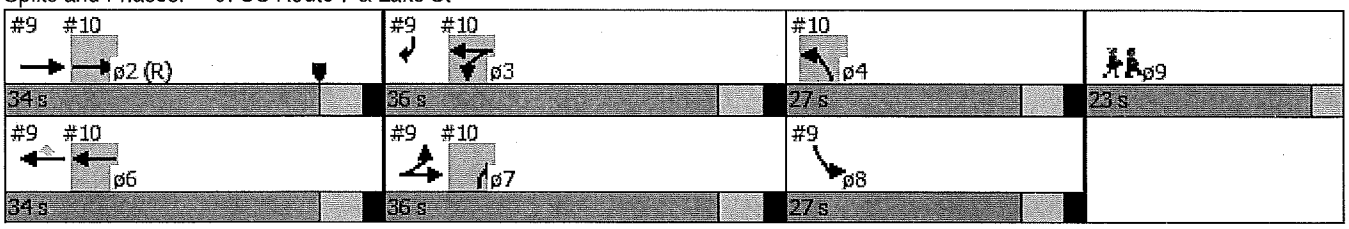
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø2	ø4	ø9
Lane Configurations									
Volume (vph)	170	515	355	225	140	165			
Lane Group Flow (vph)	185	560	386	245	152	179			
Turn Type	Prot	NA	NA	Perm	Prot	Prot			
Protected Phases	7	2 7	6		8	3	2	4	9
Permitted Phases				6					
Detector Phase	7	2 7	6	6	8	3			
Switch Phase									
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	23.0
Total Split (s)	36.0		34.0	34.0	27.0	36.0	34.0	27.0	23.0
Total Split (%)	30.0%		28.3%	28.3%	22.5%	30.0%	28%	23%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0		-2.0	-2.0	-2.0	-2.0			
Total Lost Time (s)	4.0		4.0	4.0	4.0	4.0			
Lead/Lag	Lead				Lag	Lead		Lag	
Lead-Lag Optimize?					Yes			Yes	
Recall Mode	None		None	None	None	None	C-Max	None	None
v/c Ratio	0.57	0.43	0.22	0.27	0.59	0.41			
Control Delay	46.2	4.6	10.9	4.2	72.8	18.8			
Queue Delay	1.8	0.2	0.1	0.0	0.0	0.1			
Total Delay	48.0	4.8	11.0	4.2	72.8	18.9			
Queue Length 50th (ft)	136	46	13	0	121	41			
Queue Length 95th (ft)	188	529	201	141	m190	m109			
Internal Link Dist (ft)		60	1628		526				
Turn Bay Length (ft)				100		275			
Base Capacity (vph)	462	1452	1751	905	340	553			
Starvation Cap Reductn	153	323	0	0	0	0			
Spillback Cap Reductn	0	0	538	0	0	35			
Storage Cap Reductn	0	0	0	0	0	0			
Reduced v/c Ratio	0.60	0.50	0.32	0.27	0.45	0.35			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 9: US Route 7 & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	170	515	355	225	140	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3539	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3539	1583	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	560	386	245	152	179
RTOR Reduction (vph)	0	0	0	128	0	146
Lane Group Flow (vph)	185	560	386	117	152	33
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	Prot	NA	NA	Perm	Prot	Prot
Protected Phases	7	2 7	6		8	3
Permitted Phases				6		
Actuated Green, G (s)	20.3	80.7	54.4	54.4	16.7	19.9
Effective Green, g (s)	22.3	82.7	56.4	56.4	18.7	21.9
Actuated g/C Ratio	0.19	0.69	0.47	0.47	0.16	0.18
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	322	1259	1663	744	275	288
v/s Ratio Prot	c0.11	c0.31	0.11		c0.09	0.02
v/s Ratio Perm				0.07		
v/c Ratio	0.57	0.44	0.23	0.16	0.55	0.11
Uniform Delay, d1	44.5	8.4	18.9	18.2	46.8	40.9
Progression Factor	0.91	0.35	0.48	0.80	1.35	2.67
Incremental Delay, d2	2.3	0.2	0.1	0.1	2.3	0.2
Delay (s)	42.7	3.2	9.2	14.7	65.4	109.5
Level of Service	D	A	A	B	E	F
Approach Delay (s)		13.0	11.3		89.3	
Approach LOS		B	B		F	

Intersection Summary			
HCM 2000 Control Delay	27.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		

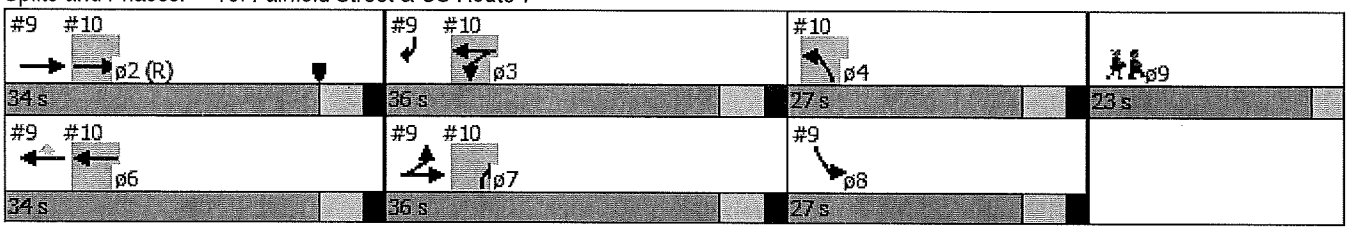
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBL	NBR	ø6	ø8	ø9
Lane Configurations								
Volume (vph)	460	130	390	70	225			
Lane Group Flow (vph)	587	141	424	76	245			
Turn Type	NA	Prot	NA	Prot	Prot			
Protected Phases	2	3	3 6	4	7	6	8	9
Permitted Phases								
Detector Phase	2	3	3 6	4	7			
Switch Phase								
Minimum Initial (s)	10.0	5.0		5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0	16.0		16.0	16.0	16.0	16.0	23.0
Total Split (s)	34.0	36.0		27.0	36.0	34.0	27.0	23.0
Total Split (%)	28.3%	30.0%		22.5%	30.0%	28%	23%	19%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0			
Total Lost Time (s)	4.0	4.0		4.0	4.0			
Lead/Lag		Lead		Lag	Lead		Lag	
Lead-Lag Optimize?				Yes			Yes	
Recall Mode	C-Max	None		None	None	None	None	None
v/c Ratio	0.35	0.44	0.32	0.25	0.50			
Control Delay	27.5	41.2	3.3	42.7	8.2			
Queue Delay	0.7	1.5	0.2	0.0	0.2			
Total Delay	28.2	42.6	3.6	42.7	8.4			
Queue Length 50th (ft)	117	110	15	51	0			
Queue Length 95th (ft)	253	163	98	90	63			
Internal Link Dist (ft)	1342		60	263				
Turn Bay Length (ft)					250			
Base Capacity (vph)	1687	472	1480	359	601			
Starvation Cap Reductn	0	192	457	0	0			
Spillback Cap Reductn	723	0	0	0	64			
Storage Cap Reductn	0	0	0	0	0			
Reduced v/c Ratio	0.61	0.50	0.41	0.21	0.46			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 10: Fairfield Street & US Route 7



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	460	80	130	390	70	225
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	0.95		1.00	1.00	1.00	1.00
Frt	0.98		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3394		1770	1863	1770	1583
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3394		1770	1863	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	500	87	141	424	76	245
RTOR Reduction (vph)	8	0	0	0	0	199
Lane Group Flow (vph)	579	0	141	424	76	46
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	NA		Prot	NA	Prot	Prot
Protected Phases	2		3	3 6	4	7
Permitted Phases						
Actuated Green, G (s)	54.4		19.9	80.3	17.1	20.3
Effective Green, g (s)	56.4		21.9	82.3	19.1	22.3
Actuated g/C Ratio	0.47		0.18	0.69	0.16	0.19
Clearance Time (s)	6.0		6.0		6.0	6.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	1595		323	1277	281	294
v/s Ratio Prot	c0.17		c0.08	0.23	c0.04	0.03
v/s Ratio Perm						
v/c Ratio	0.36		0.44	0.33	0.27	0.15
Uniform Delay, d1	20.3		43.6	7.7	44.3	41.0
Progression Factor	1.19		0.83	0.25	1.00	1.00
Incremental Delay, d2	0.5		0.9	0.2	0.5	0.2
Delay (s)	24.7		37.1	2.1	44.8	41.2
Level of Service	C		D	A	D	D
Approach Delay (s)	24.7			10.8	42.1	
Approach LOS	C			B	D	

Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
2: Lower Welden St & Lemnah Dr/Allen St

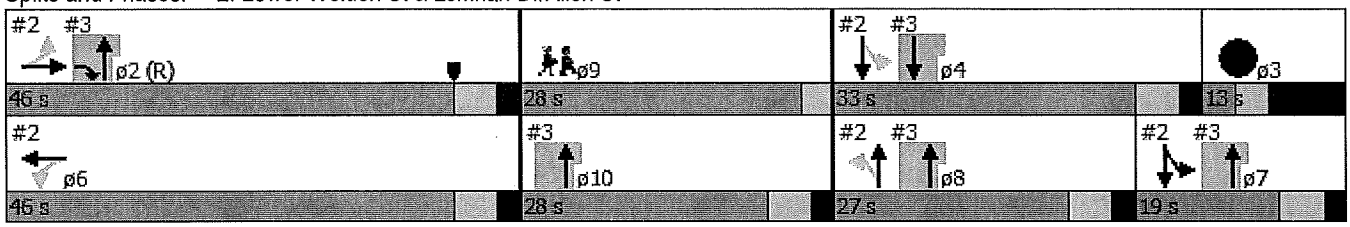
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	75	225	75	230	5	65	35	45				
Lane Group Flow (vph)	107	428	82	352	0	195	45	237				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	46.0	46.0	46.0	46.0	27.0	27.0	19.0		13.0	33.0	28.0	28.0
Total Split (%)	38.3%	38.3%	38.3%	38.3%	22.5%	22.5%	15.8%		11%	28%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0		-2.0	-2.0					
Total Lost Time (s)	4.0	4.0	4.0	4.0		4.0	4.0					
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio	0.45	0.65	0.47	0.55		0.65	0.07	0.29				
Control Delay	34.7	33.1	41.3	33.5		42.6	0.2	0.7				
Queue Delay	0.0	0.0	0.0	0.0		0.0	0.6	1.1				
Total Delay	34.7	33.1	41.3	33.5		42.6	0.8	1.8				
Queue Length 50th (ft)	57	235	49	207		102	0	0				
Queue Length 95th (ft)	m80	245	105	304		149	m0	0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)	239	659	174	642		389	602	826				
Starvation Cap Reductn	0	0	0	0		0	393	382				
Spillback Cap Reductn	0	0	0	0		0	0	0				
Storage Cap Reductn	0	0	0	0		0	0	0				
Reduced v/c Ratio	0.45	0.65	0.47	0.55		0.50	0.22	0.53				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	225	75	75	230	90	5	65	90	35	45	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.96		1.00	0.96			0.92		1.00	0.89	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1834	1858		1787	1802			1833		1750	1634	
Flt Permitted	0.35	1.00		0.26	1.00			0.99		0.34	1.00	
Satd. Flow (perm)	684	1858		498	1802			1811		620	1634	
Peak-hour factor, PHF	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Adj. Flow (vph)	107	321	107	82	253	99	6	79	110	45	58	179
RTOR Reduction (vph)	0	10	0	0	12	0	0	41	0	0	77	0
Lane Group Flow (vph)	107	418	0	82	340	0	0	154	0	45	160	0
Heavy Vehicles (%)	5%	5%	5%	1%	1%	1%	2%	2%	2%	10%	10%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	40.0	40.0		40.0	40.0			15.3		53.0	53.0	
Effective Green, g (s)	42.0	42.0		42.0	42.0			17.3		55.0	55.0	
Actuated g/C Ratio	0.35	0.35		0.35	0.35			0.14		0.46	0.46	
Clearance Time (s)	6.0	6.0		6.0	6.0			6.0		6.0		
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0		
Lane Grp Cap (vph)	239	650		174	630			261		601	748	
v/s Ratio Prot		c0.23			0.19					0.02	c0.10	
v/s Ratio Perm	0.16			0.16				c0.08		0.01		
v/c Ratio	0.45	0.64		0.47	0.54			0.59		0.07	0.21	
Uniform Delay, d1	30.1	32.7		30.4	31.3			48.0		26.3	19.5	
Progression Factor	0.92	0.88		1.00	1.00			0.93		0.00	0.00	
Incremental Delay, d2	5.6	4.6		8.9	3.3			3.2		0.0	0.1	
Delay (s)	33.4	33.5		39.2	34.6			47.9		0.0	0.1	
Level of Service	C	C		D	C			D		A	A	
Approach Delay (s)		33.5			35.4			47.9			0.1	
Approach LOS		C			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	29.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	53.2%	ICU Level of Service	A
Analysis Period (min)	15		

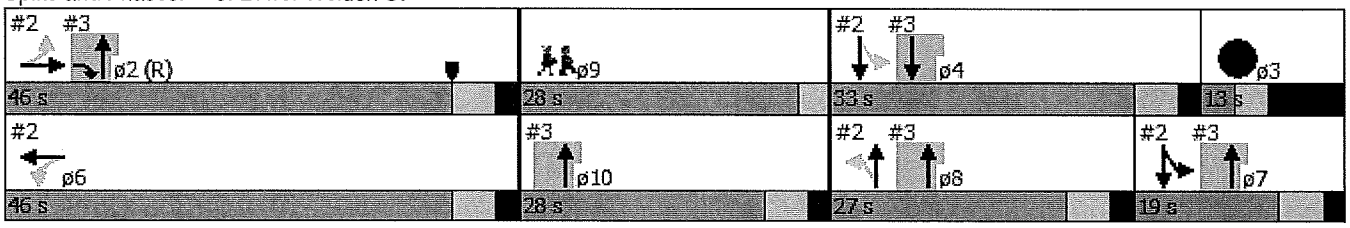
c Critical Lane Group

Lane Group	NBT	SBT	ø2	ø3	ø6	ø7	ø8	ø9	ø10
Lane Configurations									
Volume (vph)	230	220							
Lane Group Flow (vph)	256	293							
Turn Type	NA	NA							
Protected Phases	2 7 8 10	4	2	3	6	7	8	9	10
Permitted Phases									
Detector Phase	2 7 8 10	4							
Switch Phase									
Minimum Initial (s)		5.0	7.0	1.0	7.0	10.0	5.0	1.0	4.0
Minimum Split (s)		22.0	22.0	13.0	22.0	19.0	22.0	28.0	22.0
Total Split (s)		33.0	46.0	13.0	46.0	19.0	27.0	28.0	28.0
Total Split (%)		27.5%	38%	11%	38%	16%	23%	23%	23%
Yellow Time (s)		4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0
All-Red Time (s)		2.0	2.0	7.0	2.0	2.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0							
Total Lost Time (s)		4.0							
Lead/Lag		Lead		Lag		Lag	Lead		
Lead-Lag Optimize?		Yes		Yes		Yes	Yes		
Recall Mode		None	C-Max	Max	Max	None	None	None	None
v/c Ratio	0.13	0.74							
Control Delay	0.1	55.8							
Queue Delay	0.0	0.0							
Total Delay	0.1	55.8							
Queue Length 50th (ft)	0	213							
Queue Length 95th (ft)	0	238							
Internal Link Dist (ft)	102	238							
Turn Bay Length (ft)									
Base Capacity (vph)	1974	455							
Starvation Cap Reductn	0	0							
Spillback Cap Reductn	0	0							
Storage Cap Reductn	0	0							
Reduced v/c Ratio	0.13	0.64							

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated

Splits and Phases: 3: Lower Welden St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	0	0	230	220	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	14	14	12	12
Total Lost time (s)				4.0	4.0	
Lane Util. Factor				1.00	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	1.00	
Satd. Flow (prot)				1987	1863	
Flt Permitted				1.00	1.00	
Satd. Flow (perm)				1987	1863	
Peak-hour factor, PHF	0.92	0.92	0.90	0.90	0.75	0.75
Adj. Flow (vph)	0	0	0	256	293	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	256	293	0
Turn Type		Prot		NA	NA	
Protected Phases		2		2 7 8 10	4	
Permitted Phases						
Actuated Green, G (s)				120.0	23.4	
Effective Green, g (s)				120.0	25.4	
Actuated g/C Ratio				1.00	0.21	
Clearance Time (s)					6.0	
Vehicle Extension (s)					3.0	
Lane Grp Cap (vph)				1987	394	
v/s Ratio Prot				c0.13	c0.16	
v/s Ratio Perm						
v/c Ratio				0.13	0.74	
Uniform Delay, d1				0.0	44.3	
Progression Factor				1.00	1.00	
Incremental Delay, d2				0.0	7.4	
Delay (s)				0.0	51.7	
Level of Service				A	D	
Approach Delay (s)	0.0			0.0	51.7	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	27.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	15.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Lake St & Market St

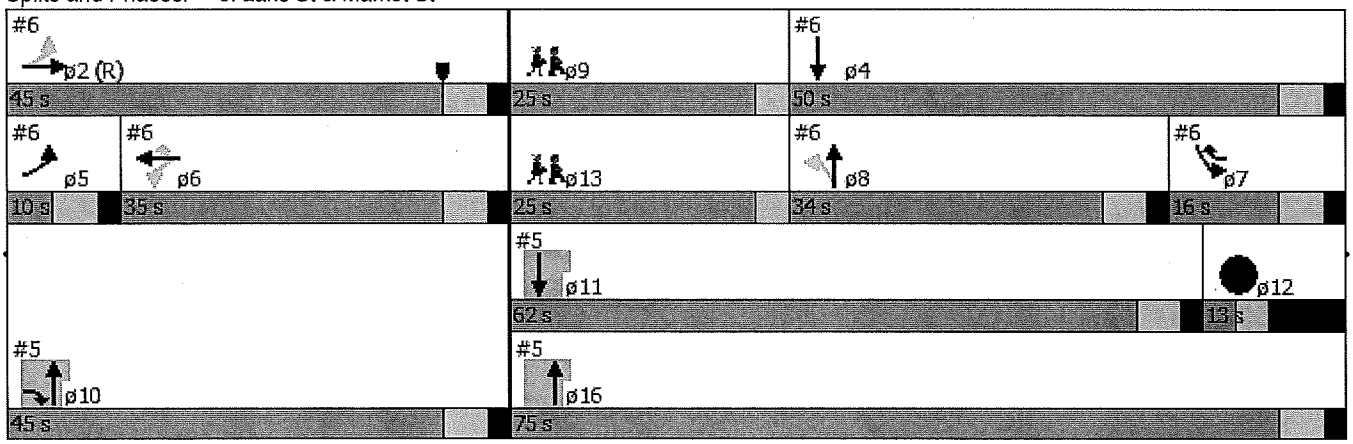
5/29/2015

Lane Group	EBR	NBT	SBT	ø2	ø4	ø5	ø6	ø7	ø8	ø9	ø12	ø13
Lane Configurations												
Volume (vph)	65	480	280									
Lane Group Flow (vph)	90	600	489									
Turn Type	Prot	NA	NA									
Protected Phases	10	10 16	11	2	4	5	6	7	8	9	12	13
Permitted Phases												
Detector Phase	10	10 16	11									
Switch Phase												
Minimum Initial (s)	4.0		4.0	10.0	10.0	4.0	10.0	5.0	10.0	1.0	1.0	1.0
Minimum Split (s)	22.0		22.0	16.0	16.0	10.0	16.0	16.0	16.0	25.0	13.0	25.0
Total Split (s)	45.0		62.0	45.0	50.0	10.0	35.0	16.0	34.0	25.0	13.0	25.0
Total Split (%)	37.5%		51.7%	38%	42%	8%	29%	13%	28%	21%	11%	21%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	7.0	0.0
Lost Time Adjust (s)	-4.0		-4.0									
Total Lost Time (s)	2.0		2.0									
Lead/Lag			Lead		Lag	Lead	Lag		Lag	Lead	Lag	Lead
Lead-Lag Optimize?			Yes			Yes					Yes	Yes
Recall Mode	Max		Max	C-Max	None	Min	Max	None	None	None	Max	None
v/c Ratio	0.10	0.33	0.28									
Control Delay	0.2	0.4	13.9									
Queue Delay	0.0	0.0	0.2									
Total Delay	0.2	0.4	14.2									
Queue Length 50th (ft)	0	0	86									
Queue Length 95th (ft)	0	m0	114									
Internal Link Dist (ft)		70	148									
Turn Bay Length (ft)												
Base Capacity (vph)	880	1792	1739									
Starvation Cap Reductn	0	0	0									
Spillback Cap Reductn	86	0	578									
Storage Cap Reductn	0	0	0									
Reduced v/c Ratio	0.11	0.33	0.42									

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 135
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lake St & Market St



Lane Group	ø16
Lane Configurations	
Volume (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	16
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	75.0
Total Split (%)	63%
Yellow Time (s)	4.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	Max
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	65	0	480	280	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	14
Total Lost time (s)		2.0		2.0	2.0	
Lane Util. Factor		1.00		1.00	0.95	
Frt		0.86		1.00	0.95	
Flt Protected		1.00		1.00	1.00	
Satd. Flow (prot)		1550		1792	3375	
Flt Permitted		1.00		1.00	1.00	
Satd. Flow (perm)		1550		1792	3375	
Peak-hour factor, PHF	0.72	0.72	0.80	0.80	0.86	0.86
Adj. Flow (vph)	0	90	0	600	326	163
RTOR Reduction (vph)	0	60	0	0	52	0
Lane Group Flow (vph)	0	30	0	600	437	0
Heavy Vehicles (%)	6%	6%	6%	6%	5%	5%
Parking (#/hr)			0			
Turn Type		Prot		NA	NA	
Protected Phases		10		10 16	11	
Permitted Phases						
Actuated Green, G (s)		36.6		120.0	56.0	
Effective Green, g (s)		40.6		120.0	60.0	
Actuated g/C Ratio		0.34		1.00	0.50	
Clearance Time (s)		6.0			6.0	
Vehicle Extension (s)		3.0			3.0	
Lane Grp Cap (vph)		524		1792	1687	
v/s Ratio Prot		0.02		c0.33	0.13	
v/s Ratio Perm						
v/c Ratio		0.06		0.33	0.26	
Uniform Delay, d1		26.8		0.0	17.2	
Progression Factor		1.00		1.00	1.00	
Incremental Delay, d2		0.2		0.4	0.4	
Delay (s)		27.0		0.4	17.6	
Level of Service		C		A	B	
Approach Delay (s)	27.0			0.4	17.6	
Approach LOS	C			A	B	

Intersection Summary			
HCM 2000 Control Delay	9.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
6: Lake St & Catherine St/Federal St

5/29/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	ø9	ø10	ø11
Lane Configurations												
Volume (vph)	115	175	35	170	135	30	235	80	200			
Lane Group Flow (vph)	0	431	0	244	161	0	444	93	297			
Turn Type	pm+pt	NA	Perm	NA	pm+ov	Perm	NA	Prot	NA			
Protected Phases	5	2		6	7		8	7	4	9	10	11
Permitted Phases	2		6		6	8						
Detector Phase	5	2	6	6	7	8	8	7	4			
Switch Phase												
Minimum Initial (s)	4.0	10.0	10.0	10.0	5.0	10.0	10.0	5.0	10.0	1.0	4.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	25.0	22.0	22.0
Total Split (s)	10.0	45.0	35.0	35.0	16.0	34.0	34.0	16.0	50.0	25.0	45.0	62.0
Total Split (%)	8.3%	37.5%	29.2%	29.2%	13.3%	28.3%	28.3%	13.3%	41.7%	21%	38%	52%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	2.0	2.0
Lost Time Adjust (s)		-4.0		-4.0	-4.0		-4.0	-4.0	-4.0			
Total Lost Time (s)		2.0		2.0	2.0		2.0	2.0	2.0			
Lead/Lag	Lead		Lag	Lag		Lag	Lag		Lag	Lead		Lead
Lead-Lag Optimize?	Yes											Yes
Recall Mode	Min	C-Max	Max	Max	None	None	None	None	None	None	Max	Max
v/c Ratio		1.15		0.56	0.23		0.65	0.41	0.30			
Control Delay		122.6		36.9	3.0		36.2	46.7	8.8			
Queue Delay		0.0		0.0	0.0		0.0	91.3	1.2			
Total Delay		122.6		36.9	3.0		36.2	138.0	10.0			
Queue Length 50th (ft)		~324		187	24		261	70	33			
Queue Length 95th (ft)		#406		206	23		#450	129	218			
Internal Link Dist (ft)		480		474			526		70			
Turn Bay Length (ft)					100							
Base Capacity (vph)		376		437	714		688	228	993			
Starvation Cap Reductn		0		0	0		0	168	482			
Spillback Cap Reductn		0		0	0		0	0	0			
Storage Cap Reductn		0		0	0		0	0	0			
Reduced v/c Ratio		1.15		0.56	0.23		0.65	1.55	0.58			

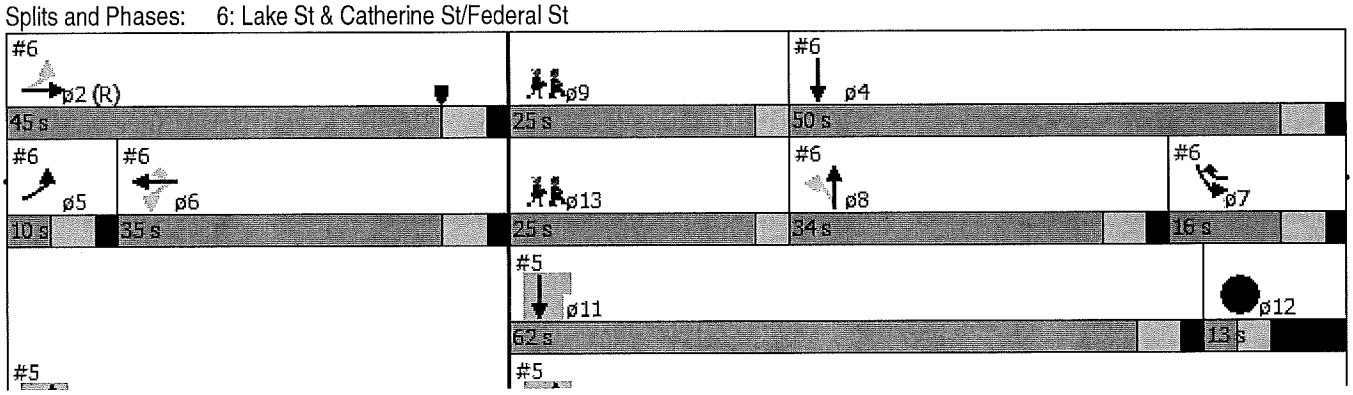
Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 135
Control Type: Actuated-Coordinated

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Lake St & Catherine St/Federal St



Lane Group	ø12	ø13	ø16
Lane Configurations			
Volume (vph)			
Lane Group Flow (vph)			
Turn Type			
Protected Phases	12	13	16
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	1.0	1.0	4.0
Minimum Split (s)	13.0	25.0	22.0
Total Split (s)	13.0	25.0	75.0
Total Split (%)	11%	21%	63%
Yellow Time (s)	3.0	3.0	4.0
All-Red Time (s)	7.0	0.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Recall Mode	Max	None	Max
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	115	175	20	35	170	135	30	235	90	80	200	55
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	13	13	13	12	12	12	12	12	12	12	12	12
Total Lost time (s)		2.0			2.0	2.0		2.0		2.0	2.0	
Lane Util. Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00	0.99		0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.97	
Flt Protected		0.98			0.99	1.00		1.00		0.95	1.00	
Satd. Flow (prot)		1799			1793	1517		1706		1719	1739	
Flt Permitted		0.48			0.88	1.00		0.95		0.95	1.00	
Satd. Flow (perm)		873			1591	1517		1630		1719	1739	
Peak-hour factor, PHF	0.72	0.72	0.72	0.84	0.84	0.84	0.80	0.80	0.80	0.86	0.86	0.86
Adj. Flow (vph)	160	243	28	42	202	161	38	294	112	93	233	64
RTOR Reduction (vph)	0	2	0	0	0	98	0	8	0	0	6	0
Lane Group Flow (vph)	0	429	0	0	244	63	0	436	0	93	291	0
Confl. Peds. (#/hr)	1		4	4		1	15		15	15		15
Heavy Vehicles (%)	6%	6%	6%	5%	5%	5%	6%	6%	6%	5%	5%	5%
Turn Type	pm+pt	NA		Perm	NA	pm+ov	Perm	NA		Prot	NA	
Protected Phases	5	2			6	7		8		7	4	
Permitted Phases	2			6		6	8					
Actuated Green, G (s)		36.6			26.6	38.6		46.2		12.0	64.2	
Effective Green, g (s)		40.6			30.6	46.6		50.2		16.0	68.2	
Actuated g/C Ratio		0.34			0.26	0.39		0.42		0.13	0.57	
Clearance Time (s)		6.0			6.0	6.0		6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0		3.0	3.0	
Lane Grp Cap (vph)		357			405	589		681		229	988	
v/s Ratio Prot		c0.08				0.01				c0.05	c0.17	
v/s Ratio Perm		0.33			0.15	0.03		c0.27				
v/c Ratio		1.20			0.60	0.11		0.64		0.41	0.29	
Uniform Delay, d1		39.7			39.3	23.4		27.7		47.6	13.4	
Progression Factor		0.89			0.86	0.94		1.09		0.86	0.54	
Incremental Delay, d2		113.6			5.6	0.1		2.0		1.1	0.2	
Delay (s)		148.8			39.3	22.1		32.1		42.1	7.4	
Level of Service		F			D	C		C		D	A	
Approach Delay (s)		148.8			32.5			32.1			15.7	
Approach LOS		F			C			C			B	

Intersection Summary			
HCM 2000 Control Delay	58.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		

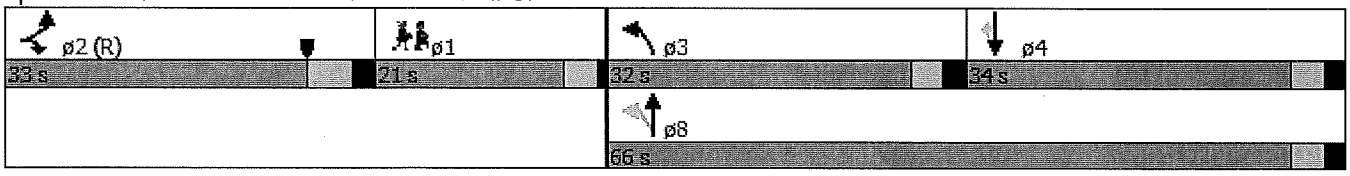
c Critical Lane Group

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1
Lane Configurations							
Volume (vph)	90	175	300	150	85	225	
Lane Group Flow (vph)	106	206	319	160	96	253	
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm	
Protected Phases	2	2	3	8	4		1
Permitted Phases			8			4	
Detector Phase	2	2	3	8	4	4	
Switch Phase							
Minimum Initial (s)	10.0	10.0	5.0	5.0	5.0	5.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	21.0
Total Split (s)	33.0	33.0	32.0	66.0	34.0	34.0	21.0
Total Split (%)	27.5%	27.5%	26.7%	55.0%	28.3%	28.3%	18%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead	Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?							
Recall Mode	C-Min	C-Min	None	None	None	None	None
v/c Ratio	0.11	0.22	0.63	0.24	0.47	0.64	
Control Delay	14.7	1.9	34.0	24.9	56.4	13.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	14.7	1.9	34.0	24.9	56.4	13.8	
Queue Length 50th (ft)	32	4	191	87	71	0	
Queue Length 95th (ft)	m57	m11	287	121	120	73	
Internal Link Dist (ft)	2598			579	189		
Turn Bay Length (ft)		225	175			100	
Base Capacity (vph)	938	935	524	940	458	566	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.11	0.22	0.61	0.17	0.21	0.45	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 91 (76%), Referenced to phase 2:EBL, Start of Yellow
Natural Cycle: 70
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 7: Lower Newton St & Federal St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	90	175	300	150	85	225
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	3.0	3.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.96
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1752	1568	1700	1792	1776	1453
Flt Permitted	0.95	1.00	0.45	1.00	1.00	1.00
Satd. Flow (perm)	1752	1568	800	1792	1776	1453
Peak-hour factor, PHF	0.85	0.85	0.94	0.94	0.89	0.89
Adj. Flow (vph)	106	206	319	160	96	253
RTOR Reduction (vph)	0	101	0	0	0	224
Lane Group Flow (vph)	106	105	319	160	96	29
Confl. Peds. (#/hr)			4			4
Heavy Vehicles (%)	3%	3%	6%	6%	7%	7%
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm
Protected Phases	2	2	3	8	4	
Permitted Phases			8			4
Actuated Green, G (s)	59.1	59.1	42.5	42.5	11.8	11.8
Effective Green, g (s)	61.1	61.1	44.5	44.5	13.8	13.8
Actuated g/C Ratio	0.51	0.51	0.37	0.37	0.12	0.12
Clearance Time (s)	6.0	6.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	892	798	504	664	204	167
v/s Ratio Prot	0.06	c0.07	c0.15	0.09	0.05	
v/s Ratio Perm			c0.09			0.02
v/c Ratio	0.12	0.13	0.63	0.24	0.47	0.17
Uniform Delay, d1	15.4	15.5	29.4	26.1	49.7	48.0
Progression Factor	0.78	0.46	1.01	0.98	1.00	1.00
Incremental Delay, d2	0.1	0.2	2.4	0.2	1.7	0.5
Delay (s)	12.2	7.3	32.2	25.9	51.4	48.5
Level of Service	B	A	C	C	D	D
Approach Delay (s)	8.9			30.1	49.3	
Approach LOS	A			C	D	

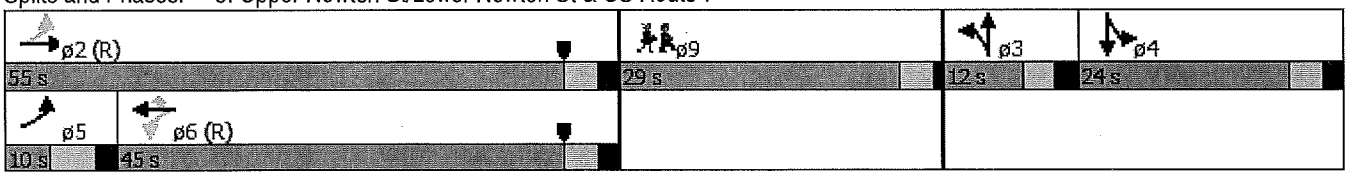
Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT	ø9
Lane Configurations									
Volume (vph)	40	395	10	355	380	30	170	20	
Lane Group Flow (vph)	46	460	0	419	437	76	187	99	
Turn Type	pm+pt	NA	Perm	NA	Perm	NA	Split	NA	
Protected Phases	5	2		6		3	4	4	9
Permitted Phases	2		6		6				
Detector Phase	5	2	6	6	6	3	4	4	
Switch Phase									
Minimum Initial (s)	4.0	10.0	10.0	10.0	10.0	5.0	5.0	5.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	10.0	16.0	16.0	29.0
Total Split (s)	10.0	55.0	45.0	45.0	45.0	12.0	24.0	24.0	29.0
Total Split (%)	8.3%	45.8%	37.5%	37.5%	37.5%	10.0%	20.0%	20.0%	24%
Yellow Time (s)	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead		Lag	Lag	Lag	Lead	Lag	Lag	
Lead-Lag Optimize?	Yes		Yes	Yes	Yes				
Recall Mode	None	C-Min	C-Min	C-Min	C-Min	None	None	None	None
v/c Ratio	0.09	0.39		0.40	0.43	0.55	0.69	0.32	
Control Delay	15.4	18.0		19.8	6.6	64.2	47.9	11.5	
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	15.4	18.0		19.8	6.6	64.2	47.9	11.5	
Queue Length 50th (ft)	12	161		170	33	52	91	7	
Queue Length 95th (ft)	m55	448		371	140	82	0	28	
Internal Link Dist (ft)		1214		511		209		579	
Turn Bay Length (ft)	115				150		315		
Base Capacity (vph)	516	1187		1054	1028	146	305	339	
Starvation Cap Reductn	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.09	0.39		0.40	0.43	0.52	0.61	0.29	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 85
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Upper Newton St/Lower Newton St & US Route 7



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	395	5	10	355	380	15	30	10	170	20	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			-4%			4%	
Total Lost time (s)	4.0	3.0			3.0	3.0		3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00	0.98		1.00		1.00	0.97	
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	1.00			1.00	0.85		0.98		1.00	0.88	
Flt Protected	0.95	1.00			1.00	1.00		0.99		0.95	1.00	
Satd. Flow (prot)	1703	1788			1825	1520		1864		1717	1549	
Flt Permitted	0.38	1.00			0.99	1.00		0.99		0.95	1.00	
Satd. Flow (perm)	687	1788			1803	1520		1864		1717	1549	
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.73	0.73	0.73	0.91	0.91	0.91
Adj. Flow (vph)	46	454	6	11	408	437	21	41	14	187	22	77
RTOR Reduction (vph)	0	0	0	0	0	155	0	7	0	0	65	0
Lane Group Flow (vph)	46	460	0	0	419	282	0	69	0	187	34	0
Confl. Peds. (#/hr)			1	1		1	6					6
Heavy Vehicles (%)	6%	6%	6%	4%	4%	4%	0%	0%	0%	3%	3%	3%
Turn Type	pm+pt	NA		Perm	NA	Perm	Split	NA		Split	NA	
Protected Phases	5	2			6		3	3		4	4	
Permitted Phases	2			6		6						
Actuated Green, G (s)	73.4	73.4			62.7	62.7		5.5		17.1	17.1	
Effective Green, g (s)	75.4	75.4			64.7	64.7		7.5		19.1	19.1	
Actuated g/C Ratio	0.63	0.63			0.54	0.54		0.06		0.16	0.16	
Clearance Time (s)	6.0	5.0			5.0	5.0		5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0	3.0		1.0		3.0	3.0	
Lane Grp Cap (vph)	488	1123			972	819		116		273	246	
v/s Ratio Prot	0.01	c0.26						c0.04		c0.11	0.02	
v/s Ratio Perm	0.05				c0.23	0.19						
v/c Ratio	0.09	0.41			0.43	0.34		0.60		0.68	0.14	
Uniform Delay, d1	9.9	11.2			16.6	15.6		54.8		47.6	43.4	
Progression Factor	1.20	1.32			1.00	1.00		1.00		0.73	0.62	
Incremental Delay, d2	0.1	0.9			1.4	1.1		5.4		6.9	0.3	
Delay (s)	12.0	15.7			18.0	16.8		60.2		41.8	27.3	
Level of Service	B	B			B	B		E		D	C	
Approach Delay (s)		15.4			17.4			60.2			36.8	
Approach LOS		B			B			E			D	

Intersection Summary			
HCM 2000 Control Delay	21.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	58.9%	ICU Level of Service	B
Analysis Period (min)	15		

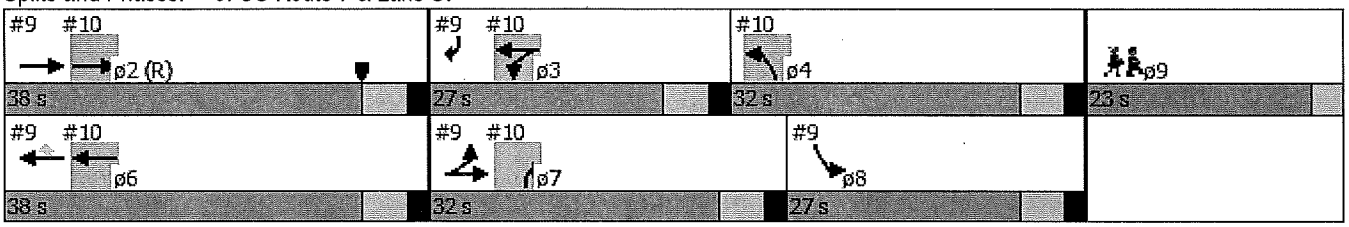
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø2	ø4	ø9
Lane Configurations									
Volume (vph)	170	410	295	230	135	105			
Lane Group Flow (vph)	185	446	321	250	147	114			
Turn Type	Prot	NA	NA	Perm	Prot	Prot			
Protected Phases	7	2 7	6		8	3	2	4	9
Permitted Phases				6					
Detector Phase	7	2 7	6	6	8	3			
Switch Phase									
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	23.0
Total Split (s)	32.0		38.0	38.0	27.0	27.0	38.0	32.0	23.0
Total Split (%)	26.7%		31.7%	31.7%	22.5%	22.5%	32%	27%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0		-2.0	-2.0	-2.0	-2.0			
Total Lost Time (s)	4.0		4.0	4.0	4.0	4.0			
Lead/Lag	Lead				Lag	Lead		Lag	
Lead-Lag Optimize?					Yes			Yes	
Recall Mode	None		None	None	None	None	C-Max	None	None
v/c Ratio	0.60	0.34	0.18	0.28	0.59	0.35			
Control Delay	48.0	3.5	21.7	10.3	69.3	18.5			
Queue Delay	3.2	0.3	0.2	0.0	0.0	0.1			
Total Delay	51.1	3.8	21.9	10.3	69.3	18.7			
Queue Length 50th (ft)	136	20	75	45	117	12			
Queue Length 95th (ft)	194	45	174	175	m181	m77			
Internal Link Dist (ft)		60	1628		526				
Turn Bay Length (ft)				100		275			
Base Capacity (vph)	405	1406	1747	906	329	386			
Starvation Cap Reductn	136	469	0	0	0	0			
Spillback Cap Reductn	0	0	761	0	0	32			
Storage Cap Reductn	0	0	0	0	0	0			
Reduced v/c Ratio	0.69	0.48	0.33	0.28	0.45	0.32			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 9: US Route 7 & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	170	410	295	230	135	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3471	1553	1719	1538
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3471	1553	1719	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	446	321	250	147	114
RTOR Reduction (vph)	0	0	0	128	0	97
Lane Group Flow (vph)	185	446	321	122	147	17
Heavy Vehicles (%)	4%	4%	4%	4%	5%	5%
Turn Type	Prot	NA	NA	Perm	Prot	Prot
Protected Phases	7	2 7	6		8	3
Permitted Phases				6		
Actuated Green, G (s)	19.4	82.0	56.6	56.6	15.4	15.5
Effective Green, g (s)	21.4	84.0	58.6	58.6	17.4	17.5
Actuated g/C Ratio	0.18	0.70	0.49	0.49	0.14	0.15
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	309	1278	1695	758	249	224
v/s Ratio Prot	c0.11	c0.24	0.09		c0.09	0.01
v/s Ratio Perm				0.08		
v/c Ratio	0.60	0.35	0.19	0.16	0.59	0.07
Uniform Delay, d1	45.4	7.1	17.3	17.0	48.0	44.3
Progression Factor	0.91	0.30	1.02	2.47	1.27	2.03
Incremental Delay, d2	2.9	0.2	0.1	0.1	3.5	0.1
Delay (s)	44.0	2.3	17.7	42.2	64.6	90.1
Level of Service	D	A	B	D	E	F
Approach Delay (s)		14.5	28.4		75.7	
Approach LOS		B	C		E	

Intersection Summary			
HCM 2000 Control Delay	30.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	35.7%	ICU Level of Service	A
Analysis Period (min)	15		

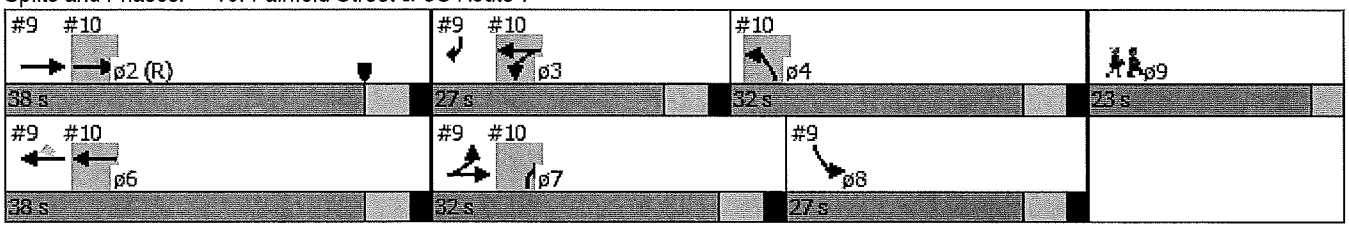
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBL	NBR	ø6	ø8	ø9
Lane Configurations								
Volume (vph)	340	135	265	95	240			
Lane Group Flow (vph)	490	147	288	103	261			
Turn Type	NA	Prot	NA	Prot	Prot			
Protected Phases	2	3	3 6	4	7	6	8	9
Permitted Phases								
Detector Phase	2	3	3 6	4	7			
Switch Phase								
Minimum Initial (s)	10.0	5.0		5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0	16.0		16.0	16.0	16.0	16.0	23.0
Total Split (s)	38.0	27.0		32.0	32.0	38.0	27.0	23.0
Total Split (%)	31.7%	22.5%		26.7%	26.7%	32%	23%	19%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0			
Total Lost Time (s)	4.0	4.0		4.0	4.0			
Lead/Lag		Lead		Lag	Lead		Lag	
Lead-Lag Optimize?				Yes			Yes	
Recall Mode	C-Max	None		None	None	None	None	None
v/c Ratio	0.29	0.58	0.23	0.33	0.53			
Control Delay	25.4	53.1	2.7	44.5	8.7			
Queue Delay	0.4	26.2	0.4	0.0	0.4			
Total Delay	25.9	79.2	3.2	44.5	9.1			
Queue Length 50th (ft)	92	119	9	70	0			
Queue Length 95th (ft)	210	183	45	116	68			
Internal Link Dist (ft)	1342		60	263				
Turn Bay Length (ft)					250			
Base Capacity (vph)	1700	332	1330	413	569			
Starvation Cap Reductn	0	176	637	0	0			
Spillback Cap Reductn	734	0	0	0	71			
Storage Cap Reductn	0	0	0	0	0			
Reduced v/c Ratio	0.51	0.94	0.42	0.25	0.52			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 10: Fairfield Street & US Route 7



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	340	110	135	265	95	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	0.95		1.00	1.00	1.00	1.00
Frt	0.96		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3344		1736	1827	1770	1583
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3344		1736	1827	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	370	120	147	288	103	261
RTOR Reduction (vph)	18	0	0	0	0	214
Lane Group Flow (vph)	472	0	147	288	103	47
Heavy Vehicles (%)	4%	4%	4%	4%	2%	2%
Turn Type	NA		Prot	NA	Prot	Prot
Protected Phases	2		3	3 6	4	7
Permitted Phases						
Actuated Green, G (s)	56.6		15.5	78.1	19.3	19.4
Effective Green, g (s)	58.6		17.5	80.1	21.3	21.4
Actuated g/C Ratio	0.49		0.15	0.67	0.18	0.18
Clearance Time (s)	6.0		6.0		6.0	6.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	1632		253	1219	314	282
v/s Ratio Prot	c0.14		c0.08	0.16	c0.06	0.03
v/s Ratio Perm						
v/c Ratio	0.29		0.58	0.24	0.33	0.17
Uniform Delay, d1	18.3		47.8	7.9	43.1	41.7
Progression Factor	1.23		0.93	0.22	1.00	1.00
Incremental Delay, d2	0.4		3.3	0.1	0.6	0.3
Delay (s)	22.9		47.9	1.9	43.7	42.0
Level of Service	C		D	A	D	D
Approach Delay (s)	22.9			17.4	42.5	
Approach LOS	C			B	D	

Intersection Summary			
HCM 2000 Control Delay	26.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	35.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
2: Lower Welden St & Lemnah Dr/Allen St

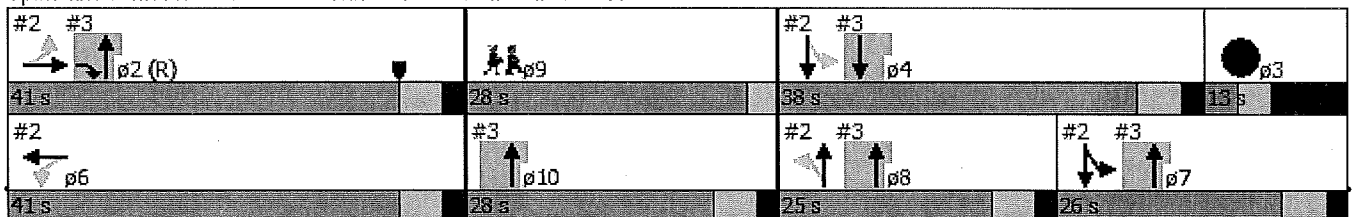
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø3	ø4	ø9	ø10
Lane Configurations												
Volume (vph)	80	305	100	315	15	80	85	75				
Lane Group Flow (vph)	87	365	109	402	0	267	113	313				
Turn Type	Perm	NA	Perm	NA	Perm	NA	custom	NA				
Protected Phases		2		6		8	7	4 7	3	4	9	10
Permitted Phases	2		6		8		4					
Detector Phase	2	2	6	6	8	8	7	4 7				
Switch Phase												
Minimum Initial (s)	7.0	7.0	7.0	7.0	5.0	5.0	10.0		1.0	5.0	1.0	4.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	19.0		13.0	22.0	28.0	22.0
Total Split (s)	41.0	41.0	41.0	41.0	25.0	25.0	26.0		13.0	38.0	28.0	28.0
Total Split (%)	34.2%	34.2%	34.2%	34.2%	20.8%	20.8%	21.7%		11%	32%	23%	23%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0		3.0	4.0	3.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0		7.0	2.0	0.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0		-2.0	-2.0					
Total Lost Time (s)	4.0	4.0	4.0	4.0		4.0	4.0					
Lead/Lag					Lead	Lead	Lag		Lag	Lead		
Lead-Lag Optimize?					Yes	Yes	Yes		Yes	Yes		
Recall Mode	C-Max	C-Max	Max	Max	None	None	None		Max	None	None	None
v/c Ratio	0.59	0.60	0.65	0.71		0.59	0.18	0.34				
Control Delay	48.0	34.5	56.4	44.0		34.0	0.4	0.6				
Queue Delay	0.0	0.0	0.0	0.0		0.0	0.9	0.9				
Total Delay	48.0	34.5	56.4	44.0		34.0	1.2	1.5				
Queue Length 50th (ft)	49	202	73	270		123	0	1				
Queue Length 95th (ft)	m84	m296	#160	388		#240	m0	0				
Internal Link Dist (ft)		1181		341		813		102				
Turn Bay Length (ft)												
Base Capacity (vph)	148	606	167	567		453	628	943				
Starvation Cap Reductn	0	0	0	0		0	324	376				
Spillback Cap Reductn	0	0	0	0		0	0	0				
Storage Cap Reductn	0	0	0	0		0	0	0				
Reduced v/c Ratio	0.59	0.60	0.65	0.71		0.59	0.37	0.55				

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Lower Welden St & Lemnah Dr/Allen St



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	305	30	100	315	55	15	80	135	85	75	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	14	14	14	12	12	12	14	14	14	14	14	14
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98			0.92		1.00	0.90	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1888	1960		1770	1821			1755		1888	1784	
Flt Permitted	0.24	1.00		0.29	1.00			0.97		0.39	1.00	
Satd. Flow (perm)	484	1960		544	1821			1700		779	1784	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Adj. Flow (vph)	87	332	33	109	342	60	17	93	157	113	100	213
RTOR Reduction (vph)	0	3	0	0	6	0	0	39	0	0	52	0
Lane Group Flow (vph)	87	362	0	109	396	0	0	228	0	113	261	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	6%	6%	6%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		custom	NA	
Protected Phases		2			6			8		7	4 7	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	35.0	35.0		35.0	35.0			27.2		56.6	56.6	
Effective Green, g (s)	37.0	37.0		37.0	37.0			29.2		60.1	60.1	
Actuated g/C Ratio	0.31	0.31		0.31	0.31			0.24		0.50	0.50	
Clearance Time (s)	6.0	6.0		6.0	6.0			6.0		6.0		
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0		
Lane Grp Cap (vph)	149	604		167	561			413		638	893	
v/s Ratio Prot		0.18			c0.22					0.04	c0.15	
v/s Ratio Perm	0.18			0.20				c0.13		0.05		
v/c Ratio	0.58	0.60		0.65	0.71			0.55		0.18	0.29	
Uniform Delay, d1	35.0	35.2		35.9	36.7			39.7		25.6	17.5	
Progression Factor	0.90	0.86		1.00	1.00			0.87		0.00	0.00	
Incremental Delay, d2	14.0	3.9		18.1	7.3			1.5		0.1	0.1	
Delay (s)	45.4	34.3		54.1	44.0			36.0		0.1	0.1	
Level of Service	D	C		D	D			D		A	A	
Approach Delay (s)		36.4			46.2			36.0			0.1	
Approach LOS		D			D			D			A	

Intersection Summary			
HCM 2000 Control Delay	30.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		

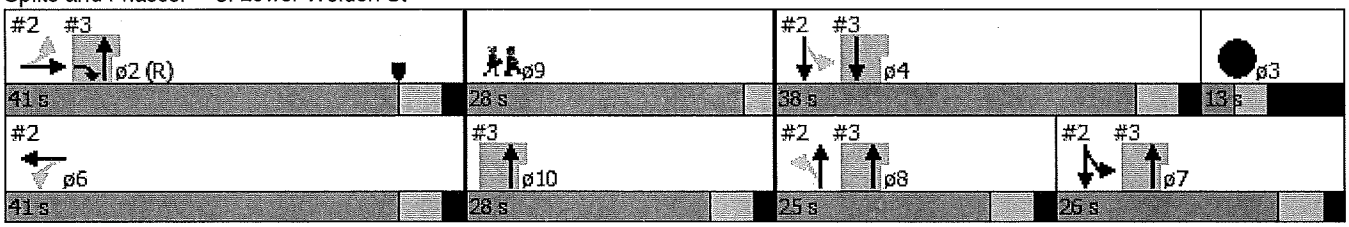
c Critical Lane Group

Lane Group	NBT	SBT	ø2	ø3	ø6	ø7	ø8	ø9	ø10
Lane Configurations									
Volume (vph)	215	320							
Lane Group Flow (vph)	239	427							
Turn Type	NA	NA							
Protected Phases	2 7 8 10	4	2	3	6	7	8	9	10
Permitted Phases									
Detector Phase	2 7 8 10	4							
Switch Phase									
Minimum Initial (s)		5.0	7.0	1.0	7.0	10.0	5.0	1.0	4.0
Minimum Split (s)		22.0	22.0	13.0	22.0	19.0	22.0	28.0	22.0
Total Split (s)		38.0	41.0	13.0	41.0	26.0	25.0	28.0	28.0
Total Split (%)		31.7%	34%	11%	34%	22%	21%	23%	23%
Yellow Time (s)		4.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0
All-Red Time (s)		2.0	2.0	7.0	2.0	2.0	2.0	0.0	2.0
Lost Time Adjust (s)		-2.0							
Total Lost Time (s)		4.0							
Lead/Lag		Lead		Lag		Lag	Lead		
Lead-Lag Optimize?		Yes		Yes		Yes	Yes		
Recall Mode		None	C-Max	Max	Max	None	None	None	None
v/c Ratio	0.12	0.82							
Control Delay	0.1	53.5							
Queue Delay	0.0	0.0							
Total Delay	0.1	53.5							
Queue Length 50th (ft)	0	301							
Queue Length 95th (ft)	m0	335							
Internal Link Dist (ft)	102	238							
Turn Bay Length (ft)									
Base Capacity (vph)	1977	552							
Starvation Cap Reductn	0	0							
Spillback Cap Reductn	0	0							
Storage Cap Reductn	0	0							
Reduced v/c Ratio	0.12	0.77							

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 55 (46%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 95
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Lower Welden St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	0	0	215	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	14	14	12	12
Total Lost time (s)				4.0	4.0	
Lane Util. Factor				1.00	1.00	
Frt				1.00	1.00	
Flt Protected				1.00	1.00	
Satd. Flow (prot)				1987	1863	
Flt Permitted				1.00	1.00	
Satd. Flow (perm)				1987	1863	
Peak-hour factor, PHF	0.92	0.92	0.90	0.90	0.75	0.75
Adj. Flow (vph)	0	0	0	239	427	0
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	239	427	0
Turn Type		Prot		NA	NA	
Protected Phases		2		2 7 8 10	4	
Permitted Phases						
Actuated Green, G (s)				120.0	31.7	
Effective Green, g (s)				120.0	33.7	
Actuated g/C Ratio				1.00	0.28	
Clearance Time (s)					6.0	
Vehicle Extension (s)					3.0	
Lane Grp Cap (vph)				1987	523	
v/s Ratio Prot				c0.12	c0.23	
v/s Ratio Perm						
v/c Ratio				0.12	0.82	
Uniform Delay, d1				0.0	40.3	
Progression Factor				1.00	1.00	
Incremental Delay, d2				0.0	9.6	
Delay (s)				0.0	49.8	
Level of Service				A	D	
Approach Delay (s)	0.0			0.0	49.8	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	31.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	20.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Lake St & Market St

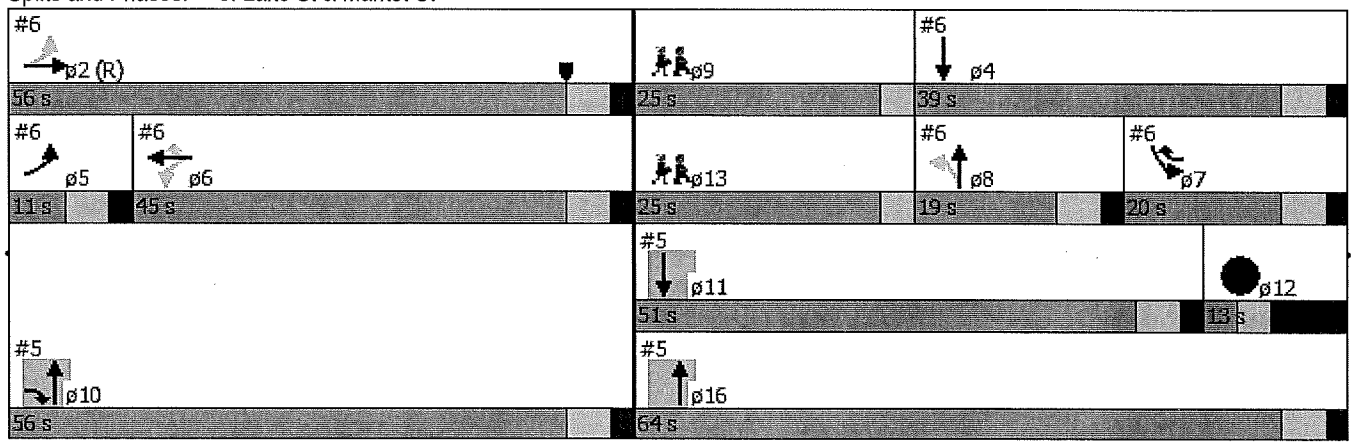
5/29/2015

Lane Group	EBR	NBT	SBT	ø2	ø4	ø5	ø6	ø7	ø8	ø9	ø12	ø13
Lane Configurations												
Volume (vph)	110	620	480									
Lane Group Flow (vph)	120	667	656									
Turn Type	Prot	NA	NA									
Protected Phases	10	10 16	11	2	4	5	6	7	8	9	12	13
Permitted Phases												
Detector Phase	10	10 16	11									
Switch Phase												
Minimum Initial (s)	4.0		4.0	10.0	10.0	4.0	10.0	5.0	10.0	1.0	1.0	1.0
Minimum Split (s)	22.0		22.0	16.0	16.0	10.0	16.0	16.0	16.0	25.0	13.0	25.0
Total Split (s)	56.0		51.0	56.0	39.0	11.0	45.0	20.0	19.0	25.0	13.0	25.0
Total Split (%)	46.7%		42.5%	47%	33%	9%	38%	17%	16%	21%	11%	21%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	3.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	7.0	0.0
Lost Time Adjust (s)	-4.0		-4.0									
Total Lost Time (s)	2.0		2.0									
Lead/Lag			Lead		Lag	Lead	Lag		Lag	Lead	Lag	Lead
Lead-Lag Optimize?			Yes			Yes					Yes	Yes
Recall Mode	Max		Max	C-Max	None	Min	Max	None	None	None	Max	None
v/c Ratio	0.14	0.36	0.44									
Control Delay	0.5	0.8	25.0									
Queue Delay	0.0	0.0	1.5									
Total Delay	0.5	0.8	26.5									
Queue Length 50th (ft)	0	0	177									
Queue Length 95th (ft)	m1	m30	230									
Internal Link Dist (ft)		70	148									
Turn Bay Length (ft)												
Base Capacity (vph)	882	1845	1478									
Starvation Cap Reductn	0	0	0									
Spillback Cap Reductn	76	0	596									
Storage Cap Reductn	0	0	0									
Reduced v/c Ratio	0.15	0.36	0.74									

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lake St & Market St



Lane Group	ø16
Lane Configurations	
Volume (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	16
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	64.0
Total Split (%)	53%
Yellow Time (s)	4.0
All-Red Time (s)	2.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	Max
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	0	110	0	620	480	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	13	14
Total Lost time (s)		2.0		2.0	2.0	
Lane Util. Factor		1.00		1.00	0.95	
Frt		0.86		1.00	0.96	
Flt Protected		1.00		1.00	1.00	
Satd. Flow (prot)		1611		1845	3562	
Flt Permitted		1.00		1.00	1.00	
Satd. Flow (perm)		1611		1845	3562	
Peak-hour factor, PHF	0.92	0.92	0.93	0.93	0.96	0.96
Adj. Flow (vph)	0	120	0	667	500	156
RTOR Reduction (vph)	0	68	0	0	25	0
Lane Group Flow (vph)	0	52	0	667	631	0
Heavy Vehicles (%)	2%	2%	3%	3%	1%	1%
Parking (#/hr)			0			
Turn Type		Prot		NA	NA	
Protected Phases		10		10 16	11	
Permitted Phases						
Actuated Green, G (s)		47.6		120.0	45.0	
Effective Green, g (s)		51.6		120.0	49.0	
Actuated g/C Ratio		0.43		1.00	0.41	
Clearance Time (s)		6.0			6.0	
Vehicle Extension (s)		3.0			3.0	
Lane Grp Cap (vph)		692		1845	1454	
v/s Ratio Prot		0.03		c0.36	c0.18	
v/s Ratio Perm						
v/c Ratio		0.07		0.36	0.43	
Uniform Delay, d1		20.1		0.0	25.5	
Progression Factor		1.00		1.00	1.00	
Incremental Delay, d2		0.2		0.3	0.9	
Delay (s)		20.3		0.3	26.5	
Level of Service		C		A	C	
Approach Delay (s)	20.3			0.3	26.5	
Approach LOS	C			A	C	

Intersection Summary			
HCM 2000 Control Delay	13.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	36.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Timings
6: Lake St & Catherine St/Federal St

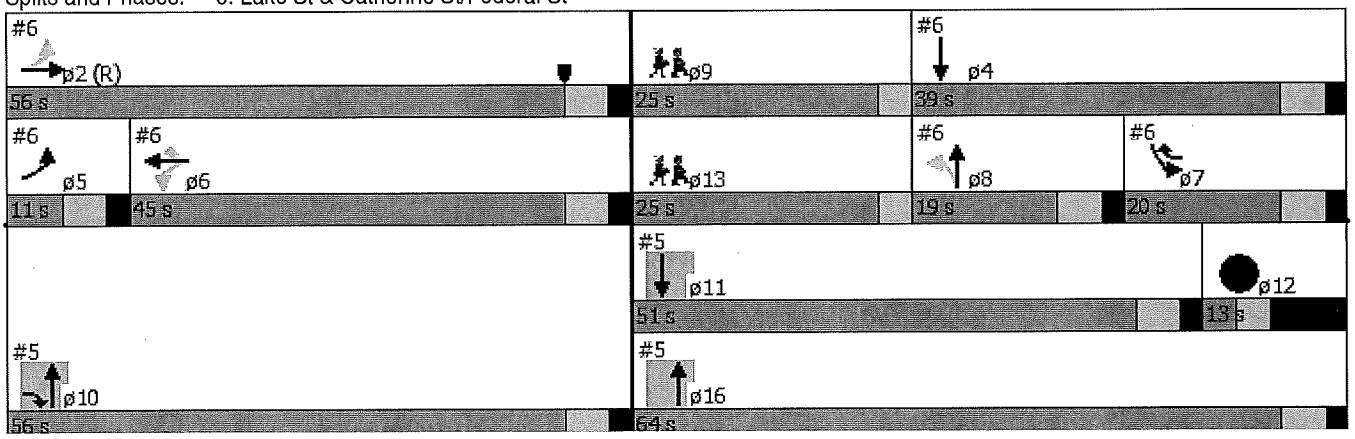
5/29/2015

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	ø9	ø10	ø11
Lane Configurations												
Volume (vph)	140	320	35	230	170	55	285	245	280			
Lane Group Flow (vph)	0	533	0	288	185	0	451	255	354			
Turn Type	pm+pt	NA	Perm	NA	pm+ov	Perm	NA	Prot	NA			
Protected Phases	5	2		6	7		8	7	4	9	10	11
Permitted Phases	2		6		6	8						
Detector Phase	5	2	6	6	7	8	8	7	4			
Switch Phase												
Minimum Initial (s)	4.0	10.0	10.0	10.0	5.0	10.0	10.0	5.0	10.0	1.0	4.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	25.0	22.0	22.0
Total Split (s)	11.0	56.0	45.0	45.0	20.0	19.0	19.0	20.0	39.0	25.0	56.0	51.0
Total Split (%)	9.2%	46.7%	37.5%	37.5%	16.7%	15.8%	15.8%	16.7%	32.5%	21%	47%	43%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0	2.0	2.0
Lost Time Adjust (s)		-4.0		-4.0	-4.0		-4.0	-4.0	-4.0			
Total Lost Time (s)		2.0		2.0	2.0		2.0	2.0	2.0			
Lead/Lag	Lead		Lag	Lag		Lag	Lag		Lag	Lead		Lead
Lead-Lag Optimize?	Yes											Yes
Recall Mode	Min	C-Max	Max	Max	None	None	None	None	None	None	Max	Max
v/c Ratio		0.96		0.49	0.21		1.08	0.95	0.41			
Control Delay		57.1		31.1	2.9		108.9	79.8	12.8			
Queue Delay		0.0		0.0	0.0		8.1	55.7	1.4			
Total Delay		57.1		31.1	2.9		117.0	135.4	14.2			
Queue Length 50th (ft)		299		220	43		369	210	48			
Queue Length 95th (ft)		#635		157	0		#784	#374	350			
Internal Link Dist (ft)		480		474			526		70			
Turn Bay Length (ft)					100							
Base Capacity (vph)		553		593	883		418	268	871			
Starvation Cap Reductn		0		0	0		0	155	329			
Spillback Cap Reductn		0		0	10		9	0	0			
Storage Cap Reductn		0		0	0		0	0	0			
Reduced v/c Ratio		0.96		0.49	0.21		1.10	2.26	0.65			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Lake St & Catherine St/Federal St



Lane Group	ø12	ø13	ø16
Lane Configurations			
Volume (vph)			
Lane Group Flow (vph)			
Turn Type			
Protected Phases	12	13	16
Permitted Phases			
Detector Phase			
Switch Phase			
Minimum Initial (s)	1.0	1.0	4.0
Minimum Split (s)	13.0	25.0	22.0
Total Split (s)	13.0	25.0	64.0
Total Split (%)	11%	21%	53%
Yellow Time (s)	3.0	3.0	4.0
All-Red Time (s)	7.0	0.0	2.0
Lost Time Adjust (s)			
Total Lost Time (s)			
Lead/Lag	Lag	Lead	
Lead-Lag Optimize?	Yes	Yes	
Recall Mode	Max	None	Max
v/c Ratio			
Control Delay			
Queue Delay			
Total Delay			
Queue Length 50th (ft)			
Queue Length 95th (ft)			
Internal Link Dist (ft)			
Turn Bay Length (ft)			
Base Capacity (vph)			
Starvation Cap Reductn			
Spillback Cap Reductn			
Storage Cap Reductn			
Reduced v/c Ratio			

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	140	320	30	35	230	170	55	285	80	245	280	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	13	13	13	12	12	12	12	12	12	12	12	12
Total Lost time (s)		2.0			2.0	2.0		2.0		2.0	2.0	
Lane Util. Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00	0.99		0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.99			1.00	0.85		0.97		1.00	0.97	
Flt Protected		0.99			0.99	1.00		0.99		0.95	1.00	
Satd. Flow (prot)		1879			1850	1560		1768		1787	1820	
Flt Permitted		0.57			0.89	1.00		0.75		0.95	1.00	
Satd. Flow (perm)		1094			1657	1560		1340		1787	1820	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	152	348	33	38	250	185	59	306	86	255	292	62
RTOR Reduction (vph)	0	2	0	0	0	95	0	6	0	0	5	0
Lane Group Flow (vph)	0	531	0	0	288	90	0	445	0	255	349	0
Confl. Peds. (#/hr)	1		4	4		1	15		15	15		15
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%	3%	3%	1%	1%	1%
Turn Type	pm+pt	NA		Perm	NA	pm+ov	Perm	NA		Prot	NA	
Protected Phases	5	2			6	7		8		7	4	
Permitted Phases	2			6		6	8					
Actuated Green, G (s)		47.6			36.6	50.6		33.2		14.0	53.2	
Effective Green, g (s)		51.6			40.6	58.6		37.2		18.0	57.2	
Actuated g/C Ratio		0.43			0.34	0.49		0.31		0.15	0.48	
Clearance Time (s)		6.0			6.0	6.0		6.0		6.0	6.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0		3.0	3.0	
Lane Grp Cap (vph)		529			560	761		415		268	867	
v/s Ratio Prot		c0.08				0.02				c0.14	0.19	
v/s Ratio Perm		0.36			0.17	0.04		c0.33				
v/c Ratio		1.00			0.51	0.12		1.07		0.95	0.40	
Uniform Delay, d1		34.2			31.8	16.7		41.4		50.6	20.3	
Progression Factor		0.91			0.94	1.65		1.17		0.71	0.51	
Incremental Delay, d2		38.4			3.0	0.1		63.7		39.7	0.3	
Delay (s)		69.7			32.8	27.6		112.1		75.6	10.7	
Level of Service		E			C	C		F		E	B	
Approach Delay (s)		69.7			30.8			112.1			37.9	
Approach LOS		E			C			F			D	

Intersection Summary			
HCM 2000 Control Delay	60.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	95.6%	ICU Level of Service	F
Analysis Period (min)	15		

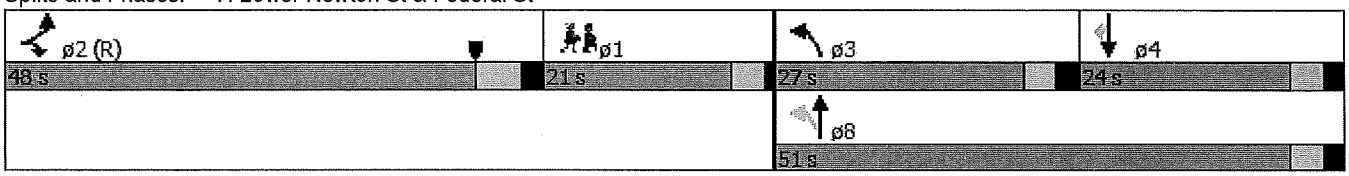
c Critical Lane Group

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	ø1
Lane Configurations							
Volume (vph)	185	590	305	130	170	90	
Lane Group Flow (vph)	215	686	311	133	175	93	
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm	
Protected Phases	2	2	3	8	4		1
Permitted Phases			8			4	
Detector Phase	2	2	3	8	4	4	
Switch Phase							
Minimum Initial (s)	10.0	10.0	5.0	5.0	5.0	5.0	4.0
Minimum Split (s)	16.0	16.0	16.0	16.0	16.0	16.0	21.0
Total Split (s)	48.0	48.0	27.0	51.0	24.0	24.0	21.0
Total Split (%)	40.0%	40.0%	22.5%	42.5%	20.0%	20.0%	18%
Yellow Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	4.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead	Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?							
Recall Mode	C-Min	C-Min	None	None	None	None	None
v/c Ratio	0.23	0.59	0.68	0.19	0.62	0.30	
Control Delay	15.6	3.9	37.9	18.1	56.3	10.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	15.6	3.9	37.9	18.1	56.3	10.8	
Queue Length 50th (ft)	58	1	166	46	128	0	
Queue Length 95th (ft)	m150	m167	299	77	193	45	
Internal Link Dist (ft)	2598			579	189		
Turn Bay Length (ft)		225	175			100	
Base Capacity (vph)	951	1167	474	772	330	348	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.23	0.59	0.66	0.17	0.53	0.27	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 91 (76%), Referenced to phase 2:EBL, Start of Yellow
Natural Cycle: 70
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 7: Lower Newton St & Federal St



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	185	590	305	130	170	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	3.0	3.0	3.0	3.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1751	1845	1827	1502
Flt Permitted	0.95	1.00	0.32	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	593	1845	1827	1502
Peak-hour factor, PHF	0.86	0.86	0.98	0.98	0.97	0.97
Adj. Flow (vph)	215	686	311	133	175	93
RTOR Reduction (vph)	0	345	0	0	0	79
Lane Group Flow (vph)	215	341	311	133	175	14
Confl. Peds. (#/hr)			4			4
Heavy Vehicles (%)	2%	2%	3%	3%	4%	4%
Turn Type	Prot	Prot	pm+pt	NA	NA	Perm
Protected Phases	2	2	3	8	4	
Permitted Phases			8			4
Actuated Green, G (s)	57.7	57.7	43.9	43.9	16.7	16.7
Effective Green, g (s)	59.7	59.7	45.9	45.9	18.7	18.7
Actuated g/C Ratio	0.50	0.50	0.38	0.38	0.16	0.16
Clearance Time (s)	6.0	6.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	880	787	460	705	284	234
v/s Ratio Prot	0.12	c0.22	c0.14	0.07	0.10	
v/s Ratio Perm			c0.12			0.01
v/c Ratio	0.24	0.43	0.68	0.19	0.62	0.06
Uniform Delay, d1	17.2	19.3	28.5	24.7	47.3	43.2
Progression Factor	0.77	1.06	1.17	0.77	1.00	1.00
Incremental Delay, d2	0.4	1.1	3.3	0.1	3.9	0.1
Delay (s)	13.7	21.5	36.7	19.0	51.2	43.3
Level of Service	B	C	D	B	D	D
Approach Delay (s)	19.7			31.4	48.5	
Approach LOS	B			C	D	

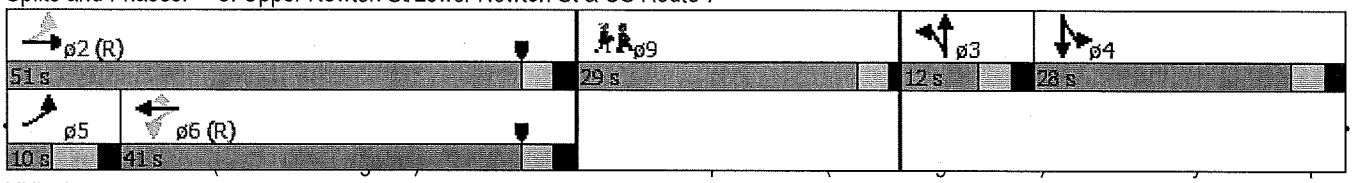
Intersection Summary			
HCM 2000 Control Delay	27.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	WBR	NBT	SBL	SBT	ø9
Lane Configurations								
Volume (vph)	70	615	615	345	20	655	35	
Lane Group Flow (vph)	77	687	647	363	60	712	114	
Turn Type	pm+pt	NA	NA	Perm	NA	Split	NA	
Protected Phases	5	2	6		3	4	4	9
Permitted Phases	2			6				
Detector Phase	5	2	6	6	3	4	4	
Switch Phase								
Minimum Initial (s)	4.0	10.0	10.0	10.0	5.0	5.0	5.0	4.0
Minimum Split (s)	10.0	16.0	16.0	16.0	10.0	16.0	16.0	29.0
Total Split (s)	10.0	51.0	41.0	41.0	12.0	28.0	28.0	29.0
Total Split (%)	8.3%	42.5%	34.2%	34.2%	10.0%	23.3%	23.3%	24%
Yellow Time (s)	4.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	
Total Lost Time (s)	4.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lead/Lag	Lead		Lag	Lag	Lead	Lag	Lag	
Lead-Lag Optimize?	Yes		Yes	Yes				
Recall Mode	None	C-Min	C-Min	C-Min	None	None	None	None
v/c Ratio	0.50	0.92	1.04	0.58	0.45	0.97	0.16	
Control Delay	38.2	53.2	87.8	21.4	53.3	55.0	11.1	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	38.2	53.2	87.8	21.4	53.3	55.0	11.1	
Queue Length 50th (ft)	30	441	~567	123	35	499	10	
Queue Length 95th (ft)	m102	#764	#795	227	75	#1094	63	
Internal Link Dist (ft)		1214	511		209		579	
Turn Bay Length (ft)	115			150		315		
Base Capacity (vph)	154	743	620	631	146	737	726	
Starvation Cap Reductn	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.50	0.92	1.04	0.58	0.41	0.97	0.16	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 145
Control Type: Actuated-Coordinated
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Upper Newton St/Lower Newton St & US Route 7



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	615	10	0	615	345	15	20	15	655	35	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			-4%			4%	
Total Lost time (s)	4.0	3.0			3.0	3.0		3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00	0.98		1.00		1.00	0.98	
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00		1.00	1.00	
Frt	1.00	1.00			1.00	0.85		0.96		1.00	0.90	
Flt Protected	0.95	1.00			1.00	1.00		0.99		0.95	1.00	
Satd. Flow (prot)	1770	1858			1863	1549		1779		1734	1613	
Flt Permitted	0.10	1.00			1.00	1.00		0.99		0.95	1.00	
Satd. Flow (perm)	193	1858			1863	1549		1779		1734	1613	
Peak-hour factor, PHF	0.91	0.91	0.91	0.95	0.95	0.95	0.85	0.85	0.85	0.92	0.92	0.92
Adj. Flow (vph)	77	676	11	0	647	363	18	24	18	712	38	76
RTOR Reduction (vph)	0	1	0	0	0	122	0	13	0	0	44	0
Lane Group Flow (vph)	77	686	0	0	647	241	0	47	0	712	70	0
Confl. Peds. (#/hr)			1	1		1	6					6
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	3%	3%	3%	2%	2%	2%
Turn Type	pm+pt	NA			NA	Perm	Split	NA		Split	NA	
Protected Phases	5	2			6		3	3		4	4	
Permitted Phases	2			6		6						
Actuated Green, G (s)	41.8	41.8			32.6	32.6		5.1		49.1	49.1	
Effective Green, g (s)	43.8	43.8			34.6	34.6		7.1		51.1	51.1	
Actuated g/C Ratio	0.36	0.36			0.29	0.29		0.06		0.43	0.43	
Clearance Time (s)	6.0	5.0			5.0	5.0		5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0	3.0		1.0		3.0	3.0	
Lane Grp Cap (vph)	138	678			537	446		105		738	686	
v/s Ratio Prot	0.02	c0.37			c0.35			c0.03		c0.41	0.04	
v/s Ratio Perm	0.18					0.16						
v/c Ratio	0.56	1.01			1.20	0.54		0.45		0.96	0.10	
Uniform Delay, d1	30.5	38.1			42.7	36.0		54.5		33.6	20.7	
Progression Factor	1.21	1.04			1.00	1.00		1.00		0.90	0.91	
Incremental Delay, d2	4.1	35.1			108.9	4.6		1.1		21.7	0.1	
Delay (s)	41.1	74.7			151.6	40.6		55.6		51.9	18.9	
Level of Service	D	E			F	D		E		D	B	
Approach Delay (s)		71.3			111.7			55.6			47.4	
Approach LOS		E			F			E			D	

Intersection Summary			
HCM 2000 Control Delay	78.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	107.8%	ICU Level of Service	G
Analysis Period (min)	15		

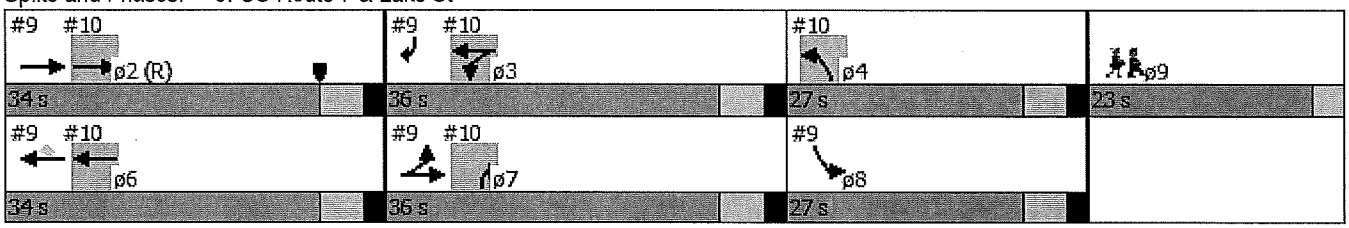
c Critical Lane Group

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR	ø2	ø4	ø9
Lane Configurations									
Volume (vph)	210	620	440	245	190	205			
Lane Group Flow (vph)	228	674	478	266	207	223			
Turn Type	Prot	NA	NA	Perm	Prot	Prot			
Protected Phases	7	2 7	6		8	3	2	4	9
Permitted Phases				6					
Detector Phase	7	2 7	6	6	8	3			
Switch Phase									
Minimum Initial (s)	5.0		10.0	10.0	5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0		16.0	16.0	16.0	16.0	16.0	16.0	23.0
Total Split (s)	36.0		34.0	34.0	27.0	36.0	34.0	27.0	23.0
Total Split (%)	30.0%		28.3%	28.3%	22.5%	30.0%	28%	23%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0		-2.0	-2.0	-2.0	-2.0			
Total Lost Time (s)	4.0		4.0	4.0	4.0	4.0			
Lead/Lag	Lead				Lag	Lead		Lag	
Lead-Lag Optimize?					Yes			Yes	
Recall Mode	None		None	None	None	None	C-Max	None	None
v/c Ratio	0.62	0.53	0.30	0.32	0.70	0.48			
Control Delay	45.3	7.0	14.8	6.1	73.2	20.7			
Queue Delay	4.4	0.5	0.4	0.0	0.0	0.1			
Total Delay	49.7	7.5	15.1	6.1	73.2	20.8			
Queue Length 50th (ft)	168	77	25	0	155	63			
Queue Length 95th (ft)	239	234	258	175	m244	m141			
Internal Link Dist (ft)		60	1628		526				
Turn Bay Length (ft)				100		275			
Base Capacity (vph)	462	1366	1585	825	341	585			
Starvation Cap Reductn	163	317	0	0	0	0			
Spillback Cap Reductn	0	0	589	0	0	46			
Storage Cap Reductn	0	0	0	0	0	0			
Reduced v/c Ratio	0.76	0.64	0.48	0.32	0.61	0.41			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 9: US Route 7 & Lake St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	210	620	440	245	190	205
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1736	1827	3539	1583	1770	1583
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1736	1827	3539	1583	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	228	674	478	266	207	223
RTOR Reduction (vph)	0	0	0	120	0	183
Lane Group Flow (vph)	228	674	478	146	207	40
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	Prot	NA	NA	Perm	Prot	Prot
Protected Phases	7	2 7	6		8	3
Permitted Phases				6		
Actuated Green, G (s)	23.2	79.1	49.9	49.9	18.3	19.7
Effective Green, g (s)	25.2	81.1	51.9	51.9	20.3	21.7
Actuated g/C Ratio	0.21	0.68	0.43	0.43	0.17	0.18
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	364	1234	1530	684	299	286
v/s Ratio Prot	c0.13	c0.37	0.14		c0.12	0.03
v/s Ratio Perm				0.09		
v/c Ratio	0.63	0.55	0.31	0.21	0.69	0.14
Uniform Delay, d1	43.1	10.0	22.3	21.3	46.9	41.3
Progression Factor	0.90	0.44	0.55	0.62	1.31	3.51
Incremental Delay, d2	3.1	0.4	0.1	0.2	6.4	0.2
Delay (s)	42.0	4.9	12.4	13.5	67.9	145.4
Level of Service	D	A	B	B	E	F
Approach Delay (s)		14.3	12.8		108.1	
Approach LOS		B	B		F	

Intersection Summary			
HCM 2000 Control Delay	33.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

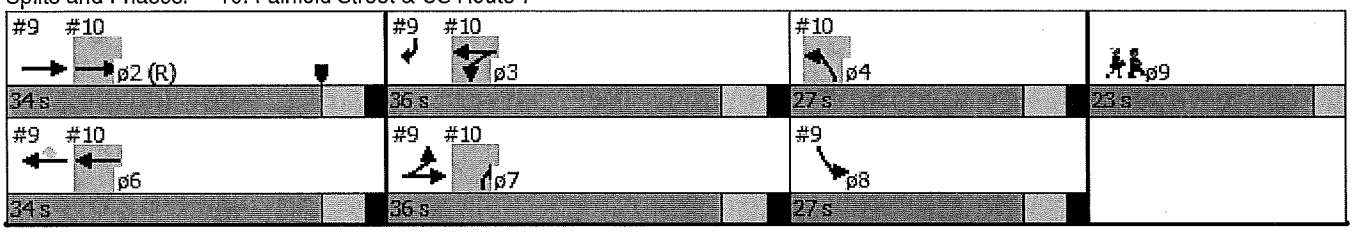
c Critical Lane Group

Lane Group	EBT	WBL	WBT	NBL	NBR	ø6	ø8	ø9
Lane Configurations								
Volume (vph)	600	165	485	95	250			
Lane Group Flow (vph)	744	179	527	103	272			
Turn Type	NA	Prot	NA	Prot	Prot			
Protected Phases	2	3	3 6	4	7	6	8	9
Permitted Phases								
Detector Phase	2	3	3 6	4	7			
Switch Phase								
Minimum Initial (s)	10.0	5.0		5.0	5.0	10.0	5.0	1.0
Minimum Split (s)	16.0	16.0		16.0	16.0	16.0	16.0	23.0
Total Split (s)	34.0	36.0		27.0	36.0	34.0	27.0	23.0
Total Split (%)	28.3%	30.0%		22.5%	30.0%	28%	23%	19%
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	0.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0			
Total Lost Time (s)	4.0	4.0		4.0	4.0			
Lead/Lag		Lead		Lag	Lead		Lag	
Lead-Lag Optimize?				Yes			Yes	
Recall Mode	C-Max	None		None	None	None	None	None
v/c Ratio	0.49	0.56	0.43	0.29	0.50			
Control Delay	32.4	41.8	4.4	42.4	7.4			
Queue Delay	4.0	5.8	0.2	0.0	0.3			
Total Delay	36.3	47.6	4.6	42.4	7.7			
Queue Length 50th (ft)	154	145	21	67	0			
Queue Length 95th (ft)	#324	202	122	120	65			
Internal Link Dist (ft)	1342		60	263				
Turn Bay Length (ft)					250			
Base Capacity (vph)	1532	472	1393	371	621			
Starvation Cap Reductn	0	234	305	0	0			
Spillback Cap Reductn	686	0	0	0	70			
Storage Cap Reductn	0	0	0	0	0			
Reduced v/c Ratio	0.88	0.75	0.48	0.28	0.49			

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 88 (73%), Referenced to phase 2:EBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 10: Fairfield Street & US Route 7



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	600	85	165	485	95	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	0.95		1.00	1.00	1.00	1.00
Frt	0.98		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3407		1770	1863	1770	1583
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3407		1770	1863	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	652	92	179	527	103	272
RTOR Reduction (vph)	7	0	0	0	0	215
Lane Group Flow (vph)	737	0	179	527	103	57
Heavy Vehicles (%)	4%	4%	2%	2%	2%	2%
Turn Type	NA		Prot	NA	Prot	Prot
Protected Phases	2		3	3 6	4	7
Permitted Phases						
Actuated Green, G (s)	49.9		19.7	75.6	21.8	23.2
Effective Green, g (s)	51.9		21.7	77.6	23.8	25.2
Actuated g/C Ratio	0.43		0.18	0.65	0.20	0.21
Clearance Time (s)	6.0		6.0		6.0	6.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	1473		320	1204	351	332
v/s Ratio Prot	c0.22		c0.10	0.28	c0.06	0.04
v/s Ratio Perm						
v/c Ratio	0.50		0.56	0.44	0.29	0.17
Uniform Delay, d1	24.7		44.8	10.4	40.9	38.8
Progression Factor	1.13		0.80	0.26	1.00	1.00
Incremental Delay, d2	1.0		2.0	0.2	0.5	0.2
Delay (s)	28.9		38.0	3.0	41.4	39.1
Level of Service	C		D	A	D	D
Approach Delay (s)	28.9			11.9	39.7	
Approach LOS	C			B	D	

Intersection Summary			
HCM 2000 Control Delay	24.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Unsignalized Intersection Capacity Analyses

HCM Unsignalized Intersection Capacity Analysis
1: Nason St & Nason St Connector/Lemnah Dr

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	45	210	40	5	270	75	30	5	20	100	15	55
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.77	0.77	0.77	0.64	0.64	0.64	0.73	0.73	0.73
Hourly flow rate (vph)	49	228	43	6	351	97	47	8	31	137	21	75
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1046										
pX, platoon unblocked												
vC, conflicting volume	448			272			797	809	250	774	782	399
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	448			272			797	809	250	774	782	399
tC, single (s)	4.1			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			99			81	97	96	52	93	88
cM capacity (veh/h)	1112			1269			246	299	789	287	311	653

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	49	272	6	448	86	233
Volume Left	49	0	6	0	47	137
Volume Right	0	43	0	97	31	75
cSH	1112	1700	1269	1700	336	354
Volume to Capacity	0.04	0.16	0.01	0.26	0.26	0.66
Queue Length 95th (ft)	3	0	0	0	25	112
Control Delay (s)	8.4	0.0	7.9	0.0	19.4	32.8
Lane LOS	A		A		C	D
Approach Delay (s)	1.3		0.1		19.4	32.8
Approach LOS					C	D

Intersection Summary			
Average Delay	8.9		
Intersection Capacity Utilization	44.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
4: Stebbins St/Market St & Catherine St

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	40	305	35	20	220	10	10	10	25	5	20	90
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.65	0.65	0.65	0.82	0.82	0.82
Hourly flow rate (vph)	43	332	38	22	239	11	15	15	38	6	24	110
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					560							
pX, platoon unblocked	0.93						0.93	0.93		0.93	0.93	0.93
vC, conflicting volume	250			370			847	731	351	772	745	245
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	151			370			796	670	351	714	685	146
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			93	95	94	98	92	87
cM capacity (veh/h)	1325			1189			221	330	688	280	325	833

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	413	272	69	140
Volume Left	43	22	15	6
Volume Right	38	11	38	110
cSH	1325	1189	402	614
Volume to Capacity	0.03	0.02	0.17	0.23
Queue Length 95th (ft)	3	1	15	22
Control Delay (s)	1.1	0.8	15.8	12.6
Lane LOS	A	A	C	B
Approach Delay (s)	1.1	0.8	15.8	12.6
Approach LOS			C	B

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	42.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
1: Nason St & Nason St Connector/Lemnah Dr

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	240	15	5	295	105	30	5	5	100	10	40
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.76	0.76	0.76	0.79	0.79	0.79
Hourly flow rate (vph)	76	261	16	6	343	122	39	7	7	127	13	51
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1046										
pX, platoon unblocked												
vC, conflicting volume	465			277			833	898	269	839	845	404
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	465			277			833	898	269	839	845	404
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			100			84	97	99	51	95	92
cM capacity (veh/h)	1086			1274			240	256	765	261	276	644

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	76	277	6	465	53	190
Volume Left	76	0	6	0	39	127
Volume Right	0	16	0	122	7	51
cSH	1086	1700	1274	1700	265	311
Volume to Capacity	0.07	0.16	0.00	0.27	0.20	0.61
Queue Length 95th (ft)	6	0	0	0	18	94
Control Delay (s)	8.6	0.0	7.8	0.0	22.0	33.1
Lane LOS	A		A		C	D
Approach Delay (s)	1.8		0.1		22.0	33.1
Approach LOS					C	D

Intersection Summary			
Average Delay	7.6		
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	400	25	20	315	15	10	20	40	5	20	100
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.84	0.84	0.84	0.92	0.92	0.92
Hourly flow rate (vph)	76	435	27	22	342	16	12	24	48	5	22	109
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					560							
pX, platoon unblocked	0.88						0.88	0.88		0.88	0.88	0.88
vC, conflicting volume	359			462			1114	1003	448	1054	1008	351
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	198			462			1060	933	448	991	939	189
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			98			91	89	92	97	90	85
cM capacity (veh/h)	1205			1099			131	214	610	156	213	748

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	538	380	83	136
Volume Left	76	22	12	5
Volume Right	27	16	48	109
cSH	1205	1099	298	481
Volume to Capacity	0.06	0.02	0.28	0.28
Queue Length 95th (ft)	5	2	28	29
Control Delay (s)	1.8	0.7	21.7	15.4
Lane LOS	A	A	C	C
Approach Delay (s)	1.8	0.7	21.7	15.4
Approach LOS			C	C

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	61.3%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
1: Nason St & Nason St Connector/Lemnah Dr

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	45	255	50	5	275	95	65	5	5	115	15	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.77	0.77	0.77	0.64	0.64	0.64	0.73	0.73	0.73
Hourly flow rate (vph)	49	277	54	6	357	123	102	8	8	158	21	96
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1046										
pX, platoon unblocked												
vC, conflicting volume	481			332			878	896	304	819	861	419
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	481			332			878	896	304	819	861	419
tC, single (s)	4.1			4.2			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.3			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			99			51	97	99	43	93	85
cM capacity (veh/h)	1082			1206			207	266	735	275	279	636

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	49	332	6	481	117	274
Volume Left	49	0	6	0	102	158
Volume Right	0	54	0	123	8	96
cSH	1082	1700	1206	1700	221	344
Volume to Capacity	0.05	0.20	0.01	0.28	0.53	0.80
Queue Length 95th (ft)	4	0	0	0	70	167
Control Delay (s)	8.5	0.0	8.0	0.0	38.4	46.2
Lane LOS	A		A		E	E
Approach Delay (s)	1.1		0.1		38.4	46.2
Approach LOS					E	E

Intersection Summary			
Average Delay	14.0		
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
4: Stebbins St/Market St & Catherine St

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	260	30	20	225	15	15	10	45	5	25	100
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.65	0.65	0.65	0.82	0.82	0.82
Hourly flow rate (vph)	65	283	33	22	245	16	23	15	69	6	30	122
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					560							
pX, platoon unblocked	0.92						0.92	0.92		0.92	0.92	0.92
vC, conflicting volume	261			315			863	734	299	802	742	253
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	156			315			809	669	299	743	677	147
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			98			89	95	91	98	91	85
cM capacity (veh/h)	1313			1245			205	324	736	252	321	827

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	380	283	108	159
Volume Left	65	22	23	6
Volume Right	33	16	69	122
cSH	1313	1245	424	595
Volume to Capacity	0.05	0.02	0.25	0.27
Queue Length 95th (ft)	4	1	25	27
Control Delay (s)	1.8	0.8	16.4	13.2
Lane LOS	A	A	C	B
Approach Delay (s)	1.8	0.8	16.4	13.2
Approach LOS			C	B

Intersection Summary			
Average Delay	5.1		
Intersection Capacity Utilization	50.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
1: Nason St & Nason St Connector/Lemnah Dr

5/11/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	45	290	30	5	325	160	35	10	5	120	10	40
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.86	0.86	0.86	0.76	0.76	0.76	0.79	0.79	0.79
Hourly flow rate (vph)	49	315	33	6	378	186	46	13	7	152	13	51
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1046										
pX, platoon unblocked												
vC, conflicting volume	564			348			876	1005	332	909	928	471
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	564			348			876	1005	332	909	928	471
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			100			80	94	99	34	95	91
cM capacity (veh/h)	998			1200			225	227	706	231	253	591

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	49	348	6	564	66	215
Volume Left	49	0	6	0	46	152
Volume Right	0	33	0	186	7	51
cSH	998	1700	1200	1700	242	272
Volume to Capacity	0.05	0.20	0.00	0.33	0.27	0.79
Queue Length 95th (ft)	4	0	0	0	27	153
Control Delay (s)	8.8	0.0	8.0	0.0	25.3	54.6
Lane LOS	A		A		D	F
Approach Delay (s)	1.1		0.1		25.3	54.6
Approach LOS					D	F

Intersection Summary			
Average Delay	11.1		
Intersection Capacity Utilization	51.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	75	435	20	20	310	25	15	30	50	10	20	120
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.84	0.84	0.84	0.92	0.92	0.92
Hourly flow rate (vph)	82	473	22	22	337	27	18	36	60	11	22	130
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)					560							
pX, platoon unblocked	0.90						0.90	0.90		0.90	0.90	0.90
vC, conflicting volume	364			495			1182	1054	484	1118	1052	351
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	232			495			1145	1003	484	1074	1000	217
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			98			84	82	90	92	89	82
cM capacity (veh/h)	1196			1069			112	198	583	128	199	737

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	576	386	113	163
Volume Left	82	22	18	11
Volume Right	22	27	60	130
cSH	1196	1069	256	439
Volume to Capacity	0.07	0.02	0.44	0.37
Queue Length 95th (ft)	5	2	53	42
Control Delay (s)	1.8	0.7	29.8	17.9
Lane LOS	A	A	D	C
Approach Delay (s)	1.8	0.7	29.8	17.9
Approach LOS			D	C

Intersection Summary			
Average Delay	6.2		
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	255	25	60	235	90	5	40	80	45	25	110
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	71	364	36	66	258	99	6	49	98	58	32	141
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	357			400			1072	1014	382	1069	982	308
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	357			400			1072	1014	382	1069	982	308
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.6	4.1	3.4
p0 queue free %	94			94			95	77	85	53	85	80
cM capacity (veh/h)	1185			1164			129	211	665	124	214	714

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	71	400	66	357	152	58	173
Volume Left	71	0	66	0	6	58	0
Volume Right	0	36	0	99	98	0	141
cSH	1185	1700	1164	1700	359	124	498
Volume to Capacity	0.06	0.24	0.06	0.21	0.42	0.47	0.35
Queue Length 95th (ft)	5	0	4	0	51	52	38
Control Delay (s)	8.2	0.0	8.3	0.0	22.2	57.3	16.0
Lane LOS	A		A		C	F	C
Approach Delay (s)	1.2		1.3		22.2	26.3	
Approach LOS					C	D	

Intersection Summary			
Average Delay	8.3		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	40	295	10	100	295	85	10	55	85	115	60	100
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	43	321	11	109	321	92	12	64	99	153	80	133
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	413			332			1124	1043	326	1123	1003	367
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	413			332			1124	1043	326	1123	1003	367
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	96			91			87	68	86	0	62	80
cM capacity (veh/h)	1146			1228			93	198	706	107	212	678

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	43	332	109	413	174	153	213
Volume Left	43	0	109	0	12	153	0
Volume Right	0	11	0	92	99	0	133
cSH	1146	1700	1228	1700	296	107	372
Volume to Capacity	0.04	0.20	0.09	0.24	0.59	1.43	0.57
Queue Length 95th (ft)	3	0	7	0	87	274	86
Control Delay (s)	8.3	0.0	8.2	0.0	33.2	310.1	26.9
Lane LOS	A		A		D	F	D
Approach Delay (s)	1.0		1.7		33.2	145.3	
Approach LOS					D	F	

Intersection Summary			
Average Delay	42.0		
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	75	225	75	75	230	90	5	65	90	35	45	140
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	107	321	107	82	253	99	6	79	110	45	58	179
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	352			429			1215	1106	375	1152	1110	302
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	352			429			1215	1106	375	1152	1110	302
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.2	6.6	6.3
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.6	4.1	3.4
p0 queue free %	91			93			92	55	84	45	66	75
cM capacity (veh/h)	1191			1136			78	178	671	82	171	719

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	107	429	82	352	195	45	237
Volume Left	107	0	82	0	6	45	0
Volume Right	0	107	0	99	110	0	179
cSH	1191	1700	1136	1700	284	82	404
Volume to Capacity	0.09	0.25	0.07	0.21	0.69	0.55	0.59
Queue Length 95th (ft)	7	0	6	0	116	60	91
Control Delay (s)	8.3	0.0	8.4	0.0	41.6	93.4	25.8
Lane LOS	A		A		E	F	D
Approach Delay (s)	1.7		1.6		41.6	36.6	
Approach LOS					E	E	

Intersection Summary			
Average Delay	13.8		
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	80	305	30	100	315	55	15	80	135	85	75	160
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	87	332	33	109	342	60	17	93	157	113	100	213
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	402			364			1345	1141	348	1299	1128	372
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	402			364			1345	1141	348	1299	1128	372
tC, single (s)	4.1			4.1			7.2	6.6	6.3	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.6	4.1	3.4	3.5	4.0	3.3
p0 queue free %	92			91			58	44	77	0	42	68
cM capacity (veh/h)	1156			1194			41	166	686	53	172	674

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	87	364	109	402	267	113	313
Volume Left	87	0	109	0	17	113	0
Volume Right	0	33	0	60	157	0	213
cSH	1156	1700	1194	1700	221	53	349
Volume to Capacity	0.08	0.21	0.09	0.24	1.21	2.15	0.90
Queue Length 95th (ft)	6	0	7	0	334	283	221
Control Delay (s)	8.4	0.0	8.3	0.0	174.9	694.4	61.1
Lane LOS	A		A		F	F	F
Approach Delay (s)	1.6		1.8		174.9	229.3	
Approach LOS					F	F	

Intersection Summary			
Average Delay	88.3		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	50	255	25	60	235	90	5	40	80	45	25	110
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	71	364	36	66	258	99	6	49	98	58	32	141

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	71	400	66	357	152	58	173
Volume Left (vph)	71	0	66	0	6	58	0
Volume Right (vph)	0	36	0	99	98	0	141
Hadj (s)	0.58	0.02	0.52	-0.18	-0.34	0.67	-0.40
Departure Headway (s)	7.2	6.6	7.2	6.5	7.2	8.1	7.0
Degree Utilization, x	0.14	0.73	0.13	0.64	0.30	0.13	0.34
Capacity (veh/h)	478	527	477	530	447	405	459
Control Delay (s)	10.2	24.4	10.1	19.3	13.3	11.1	12.3
Approach Delay (s)	22.3		17.9		13.3	12.0	
Approach LOS	C		C		B	B	

Intersection Summary			
Delay	17.9		
Level of Service	C		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	40	295	10	100	295	85	10	55	85	115	60	100
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	43	321	11	109	321	92	12	64	99	153	80	133

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	43	332	109	413	174	153	213
Volume Left (vph)	43	0	109	0	12	153	0
Volume Right (vph)	0	11	0	92	99	0	133
Hadj (s)	0.53	0.01	0.53	-0.12	-0.22	0.53	-0.40
Departure Headway (s)	8.0	7.5	7.8	7.1	7.9	8.3	7.3
Degree Utilization, x	0.10	0.69	0.24	0.82	0.38	0.35	0.44
Capacity (veh/h)	425	459	445	493	412	407	451
Control Delay (s)	10.7	24.4	12.0	33.5	15.6	14.6	14.7
Approach Delay (s)	22.8		29.0		15.6	14.6	
Approach LOS	C		D		C	B	

Intersection Summary			
Delay	22.1		
Level of Service	C		
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	75	225	75	75	230	90	5	65	90	35	45	140
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	107	321	107	82	253	99	6	79	110	45	58	179

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	107	429	82	352	195	45	237
Volume Left (vph)	107	0	82	0	6	45	0
Volume Right (vph)	0	107	0	99	110	0	179
Hadj (s)	0.58	-0.09	0.52	-0.18	-0.30	0.67	-0.36
Departure Headway (s)	7.8	7.1	7.9	7.2	7.7	8.6	7.6
Degree Utilization, x	0.23	0.84	0.18	0.70	0.42	0.11	0.50
Capacity (veh/h)	444	496	435	479	426	391	436
Control Delay (s)	11.9	36.6	11.4	24.2	16.2	11.4	16.7
Approach Delay (s)	31.6		21.8		16.2	15.8	
Approach LOS	D		C		C	C	

Intersection Summary			
Delay	23.5		
Level of Service	C		
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

5/12/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	80	305	30	100	315	55	15	80	135	85	75	160
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	87	332	33	109	342	60	17	93	157	113	100	213

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total (vph)	87	364	109	402	267	113	313
Volume Left (vph)	87	0	109	0	17	113	0
Volume Right (vph)	0	33	0	60	157	0	213
Hadj (s)	0.53	-0.03	0.53	-0.07	-0.24	0.53	-0.44
Departure Headway (s)	9.1	8.5	9.0	8.4	8.7	9.3	8.3
Degree Utilization, x	0.22	0.86	0.27	0.94	0.65	0.29	0.72
Capacity (veh/h)	380	412	388	416	397	377	417
Control Delay (s)	13.5	45.1	14.2	57.2	26.2	14.9	28.9
Approach Delay (s)	39.0		48.1		26.2	25.1	
Approach LOS	E		E		D	D	

Intersection Summary			
Delay	36.2		
Level of Service	E		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

7/6/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	255	25	60	235	90	5	40	80	45	25	110
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	71	364	36	66	258	99	6	49	98	58	32	141
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								893				
pX, platoon unblocked												
vC, conflicting volume	556	376	103	546	398	98	173			146		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	556	376	103	546	398	98	173			146		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	69	31	96	64	50	90	100			96		
cM capacity (veh/h)	230	525	944	184	516	961	1404			1388		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	71	400	66	357	152	231
Volume Left	71	0	66	0	6	58
Volume Right	0	36	0	99	98	141
cSH	230	547	184	592	1404	1388
Volume to Capacity	0.31	0.73	0.36	0.60	0.00	0.04
Queue Length 95th (ft)	32	153	38	100	0	3
Control Delay (s)	27.5	27.5	35.0	19.9	0.3	2.2
Lane LOS	D	D	E	C	A	A
Approach Delay (s)	27.5		22.2		0.3	2.2
Approach LOS	D		C			

Intersection Summary			
Average Delay	17.9		
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

7/6/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	40	295	10	100	295	85	10	55	85	115	60	100
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	43	321	11	109	321	92	12	64	99	153	80	133
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								893				
pX, platoon unblocked												
vC, conflicting volume	843	639	147	761	657	113	213			163		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	843	639	147	761	657	113	213			163		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	0	8	99	0	6	90	99			89		
cM capacity (veh/h)	39	348	900	57	340	939	1333			1416		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	43	332	109	413	174	367
Volume Left	43	0	109	0	12	153
Volume Right	0	11	0	92	99	133
cSH	39	355	57	397	1333	1416
Volume to Capacity	1.12	0.93	1.89	1.04	0.01	0.11
Queue Length 95th (ft)	109	244	259	338	1	9
Control Delay (s)	343.8	67.1	574.1	89.1	0.6	3.8
Lane LOS	F	F	F	F	A	A
Approach Delay (s)	99.2		190.2		0.6	3.8
Approach LOS	F		F			

Intersection Summary			
Average Delay	95.9		
Intersection Capacity Utilization	61.7%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

7/6/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	75	225	75	75	230	90	5	65	90	35	45	140
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	107	321	107	82	253	99	6	79	110	45	58	179
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								893				
pX, platoon unblocked												
vC, conflicting volume	609	438	147	651	473	134	237			189		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	609	438	147	651	473	134	237			189		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.2		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.3		
p0 queue free %	47	34	88	47	46	89	100			97		
cM capacity (veh/h)	202	488	892	155	472	918	1330			1338		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	107	429	82	352	195	282
Volume Left	107	0	82	0	6	45
Volume Right	0	107	0	99	110	179
cSH	202	551	155	547	1330	1338
Volume to Capacity	0.53	0.78	0.53	0.64	0.00	0.03
Queue Length 95th (ft)	69	179	66	114	0	3
Control Delay (s)	41.3	30.8	52.2	22.7	0.3	1.5
Lane LOS	E	D	F	C	A	A
Approach Delay (s)	32.9		28.3		0.3	1.5
Approach LOS	D		D			

Intersection Summary			
Average Delay	21.0		
Intersection Capacity Utilization	57.2%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Lower Welden St & Lemnah Dr/Allen St

7/6/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	80	305	30	100	315	55	15	80	135	85	75	160
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	87	332	33	109	342	60	17	93	157	113	100	213
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								893				
pX, platoon unblocked												
vC, conflicting volume	871	718	207	838	746	172	313			250		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	871	718	207	838	746	172	313			250		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	0	0	96	0	0	93	99			91		
cM capacity (veh/h)	0	320	834	0	308	872	1225			1316		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	87	364	109	402	267	427
Volume Left	87	0	109	0	17	113
Volume Right	0	33	0	60	157	213
cSH	0	338	0	341	1225	1316
Volume to Capacity	Err	1.08	Err	1.18	0.01	0.09
Queue Length 95th (ft)	Err	335	Err	418	1	7
Control Delay (s)	Err	106.7	Err	141.6	0.6	2.7
Lane LOS	F	F	F	F	A	A
Approach Delay (s)	Err		Err		0.6	2.7
Approach LOS	F		F			

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		

Intersection	
Intersection Delay, s/veh	19.5
Intersection LOS	C

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	50	255	25	0	60	235	90	0	5	40	80
Peak Hour Factor	0.92	0.70	0.70	0.70	0.92	0.91	0.91	0.91	0.92	0.82	0.82	0.82
Heavy Vehicles, %	2	5	5	5	2	1	1	1	2	2	2	2
Mvmt Flow	0	71	364	36	0	66	258	99	0	6	49	98
Number of Lanes	0	1	1	0	0	1	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	2	2
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	2	1	2
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	2	2
HCM Control Delay	24.2	19.5	14
HCM LOS	C	C	B

Lane	NBLn1	EBLn1	EBLn2	WBLn1	WBLn2	SBLn1	SBLn2
Vol Left, %	4%	100%	0%	100%	0%	100%	0%
Vol Thru, %	32%	0%	91%	0%	72%	0%	19%
Vol Right, %	64%	0%	9%	0%	28%	0%	81%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	125	50	280	60	325	45	135
LT Vol	40	0	255	0	235	0	25
Through Vol	80	0	25	0	90	0	110
RT Vol	5	50	0	60	0	45	0
Lane Flow Rate	152	71	400	66	357	58	173
Geometry Grp	6	7	7	7	7	7	7
Degree of Util (X)	0.317	0.144	0.744	0.134	0.654	0.132	0.344
Departure Headway (Hd)	7.476	7.273	6.698	7.303	6.594	8.256	7.158
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	480	493	540	491	546	434	502
Service Time	5.536	5.02	4.445	5.052	4.341	6.01	4.911
HCM Lane V/C Ratio	0.317	0.144	0.741	0.134	0.654	0.134	0.345
HCM Control Delay	14	11.2	26.5	11.2	21	12.3	13.6
HCM Lane LOS	B	B	D	B	C	B	B
HCM 95th-tile Q	1.3	0.5	6.4	0.5	4.7	0.5	1.5

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	45	25	110
Peak Hour Factor	0.92	0.78	0.78	0.78
Heavy Vehicles, %	2	10	10	10
Mvmt Flow	0	58	32	141
Number of Lanes	0	1	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	2
HCM Control Delay	13.3
HCM LOS	B

Lane

Intersection	
Intersection Delay, s/veh	24.1
Intersection LOS	C

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	40	295	10	0	100	295	85	0	10	55	85
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	6	6	6
Mvmt Flow	0	43	321	11	0	109	321	92	0	12	64	99
Number of Lanes	0	1	1	0	0	1	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	2	2
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	2	1	2
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	2	2
HCM Control Delay	24.8	31.7	16.9
HCM LOS	C	D	C

Lane	NBLn1	EBLn1	EBLn2	WBLn1	WBLn2	SBLn1	SBLn2
Vol Left, %	7%	100%	0%	100%	0%	100%	0%
Vol Thru, %	37%	0%	97%	0%	78%	0%	38%
Vol Right, %	57%	0%	3%	0%	22%	0%	62%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	150	40	305	100	380	115	160
LT Vol	55	0	295	0	295	0	60
Through Vol	85	0	10	0	85	0	100
RT Vol	10	40	0	100	0	115	0
Lane Flow Rate	174	43	332	109	413	153	213
Geometry Grp	6	7	7	7	7	7	7
Degree of Util (X)	0.405	0.098	0.701	0.239	0.83	0.36	0.444
Departure Headway (Hd)	8.356	8.152	7.613	7.912	7.236	8.459	7.494
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	434	437	471	451	496	423	478
Service Time	6.356	5.949	5.409	5.703	5.027	6.255	5.289
HCM Lane V/C Ratio	0.401	0.098	0.705	0.242	0.833	0.362	0.446
HCM Control Delay	16.9	11.8	26.5	13.2	36.6	16	16.2
HCM Lane LOS	C	B	D	B	E	C	C
HCM 95th-tile Q	1.9	0.3	5.4	0.9	8.2	1.6	2.2

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	115	60	100
Peak Hour Factor	0.92	0.75	0.75	0.75
Heavy Vehicles, %	2	2	2	2
Mvmt Flow	0	153	80	133
Number of Lanes	0	1	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	2
HCM Control Delay	16.1
HCM LOS	C

Lane

Intersection	
Intersection Delay, s/veh	25.7
Intersection LOS	D

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	75	225	75	0	75	230	90	0	5	65	90
Peak Hour Factor	0.92	0.70	0.70	0.70	0.92	0.91	0.91	0.91	0.92	0.82	0.82	0.82
Heavy Vehicles, %	2	5	5	5	2	1	1	1	2	2	2	2
Mvmt Flow	0	107	321	107	0	82	253	99	0	6	79	110
Number of Lanes	0	1	1	0	0	1	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	2	2
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	2	1	2
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	2	2
HCM Control Delay	34.6	23.8	17.7
HCM LOS	D	C	C

Lane	NBLn1	EBLn1	EBLn2	WBLn1	WBLn2	SBLn1	SBLn2
Vol Left, %	3%	100%	0%	100%	0%	100%	0%
Vol Thru, %	41%	0%	75%	0%	72%	0%	24%
Vol Right, %	56%	0%	25%	0%	28%	0%	76%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	160	75	300	75	320	35	185
LT Vol	65	0	225	0	230	0	45
Through Vol	90	0	75	0	90	0	140
RT Vol	5	75	0	75	0	35	0
Lane Flow Rate	195	107	429	82	352	45	237
Geometry Grp	6	7	7	7	7	7	7
Degree of Util (X)	0.446	0.235	0.858	0.184	0.713	0.109	0.508
Departure Headway (Hd)	8.22	8.002	7.307	8.128	7.409	8.887	7.823
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	441	451	497	444	492	406	465
Service Time	6.22	5.702	5.007	5.828	5.109	6.587	5.523
HCM Lane V/C Ratio	0.442	0.237	0.863	0.185	0.715	0.111	0.51
HCM Control Delay	17.7	13.1	40	12.7	26.4	12.7	18.3
HCM Lane LOS	C	B	E	B	D	B	C
HCM 95th-tile Q	2.2	0.9	9	0.7	5.6	0.4	2.8

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	35	45	140
Peak Hour Factor	0.92	0.78	0.78	0.78
Heavy Vehicles, %	2	10	10	10
Mvmt Flow	0	45	58	179
Number of Lanes	0	1	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	2
HCM Control Delay	17.4
HCM LOS	C

Lane

Intersection	
Intersection Delay, s/veh	41.2
Intersection LOS	E

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	80	305	30	0	100	315	55	0	15	80	135
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	6	6	6
Mvmt Flow	0	87	332	33	0	109	342	60	0	17	93	157
Number of Lanes	0	1	1	0	0	1	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	2	2
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	2	1	2
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	2	2
HCM Control Delay	44.1	54.4	31.7
HCM LOS	E	F	D

Lane	NBLn1	EBLn1	EBLn2	WBLn1	WBLn2	SBLn1	SBLn2
Vol Left, %	7%	100%	0%	100%	0%	100%	0%
Vol Thru, %	35%	0%	91%	0%	85%	0%	32%
Vol Right, %	59%	0%	9%	0%	15%	0%	68%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	230	80	335	100	370	85	235
LT Vol	80	0	305	0	315	0	75
Through Vol	135	0	30	0	55	0	160
RT Vol	15	80	0	100	0	85	0
Lane Flow Rate	267	87	364	109	402	113	313
Geometry Grp	6	7	7	7	7	7	7
Degree of Util (X)	0.7	0.226	0.888	0.279	0.962	0.301	0.744
Departure Headway (Hd)	9.422	9.473	8.885	9.354	8.723	9.677	8.658
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	385	382	411	387	418	374	420
Service Time	7.422	7.173	6.585	7.054	6.423	7.377	6.358
HCM Lane V/C Ratio	0.694	0.228	0.886	0.282	0.962	0.302	0.745
HCM Control Delay	31.7	14.9	51.1	15.6	64.9	16.5	32.6
HCM Lane LOS	D	B	F	C	F	C	D
HCM 95th-tile Q	5.1	0.9	9.1	1.1	11.3	1.2	6

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	85	75	160
Peak Hour Factor	0.92	0.75	0.75	0.75
Heavy Vehicles, %	2	2	2	2
Mvmt Flow	0	113	100	213
Number of Lanes	0	1	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	2
HCM Control Delay	28.3
HCM LOS	D

Lane

Roundabout Capacity Analysis

Federal Street EA Update
NCHRP 572 Roundabout Analysis

Lower Welden St at Allen Street/Lemnah Dr

Input Worksheet

Time	Approach	Raw turning volumes				PHF	Adjusted turning volumes				Roundabout volumes		
		U-turn	Left	Through	Right		U-turn	Left	Through	Right	Circ	Enter	Exit*
2010 AM	NB approach	1	50	255	25	.7	1	71	364	36	159	473	266
	SB approach	1	60	235	90	.91	1	66	258	99	130	424	521
	EB approach	1	45	25	0	.78	1	58	32	0	334	91	220
	WB approach	1	5	40	80	.82	1	6	49	98	497	154	135
2010 PM	NB approach	1	40	295	10	.92	1	43	321	11	346	376	333
	SB approach	1	100	295	85	.92	1	109	321	92	123	523	574
	EB approach	1	115	60	0	.75	1	153	80	0	444	235	201
	WB approach	1	10	55	85	.86	1	12	64	99	521	176	201
2030 AM	NB approach	1	75	225	75	.7	1	107	321	107	189	537	260
	SB approach	1	75	230	75	.91	1	82	253	82	196	419	477
	EB approach	1	35	45	0	.78	1	45	58	0	345	104	270
	WB approach	1	5	65	90	.82	1	6	79	110	477	196	248
2030 PM	NB approach	1	80	305	30	.92	1	87	332	33	326	452	361
	SB approach	1	100	315	55	.92	1	109	342	60	201	512	603
	EB approach	1	85	75	0	.75	1	113	100	0	472	215	241
	WB approach	1	15	80	135	.86	1	17	93	157	535	269	242

* For information only; volume is not used in computations.

Output Worksheet

Time	Approach	Single lane roundabout					Double lane roundabout				
		Capacity (veh/hr)[1]	v/c	Control Delay (sec)[2]	LOS[3]	95th Percentile Queue (veh)[4]	Critical Lane Capacity (veh/hr)[6]	Critical Lane v/c	Control Delay (sec)[2]	LOS[3]	95th Percentile Queue (veh)[4]
2010 AM	NB approach	964	0.49	7	A	2.8	1011	0.23	5	A	0.9
	SB approach	992	0.43	6	A	2.2	1032	0.21	4	A	0.8
	EB approach	809	0.11	5	A	0.4	894	0.07	4	A	0.2
	WB approach	687	0.22	7	A	0.9	798	0.12	5	A	0.4
	Intersection[5]			7	A						
2010 PM	NB approach	800	0.47	8	A	2.5	887	0.21	5	A	0.8
	SB approach	1000	0.52	7	A	3.1	1037	0.25	5	A	1.0
	EB approach	725	0.32	7	A	1.4	888	0.19	5	A	0.7
	WB approach	671	0.26	7	A	1.0	785	0.13	5	A	0.4
	Intersection[5]			8	A						
2030 AM	NB approach	936	0.57	9	A	3.8	990	0.27	5	A	1.1
	SB approach	928	0.45	7	A	2.4	985	0.21	5	A	0.8
	EB approach	800	0.13	5	A	0.4	888	0.06	4	A	0.2
	WB approach	701	0.28	7	A	1.1	809	0.14	5	A	0.5
	Intersection[5]			8	A						
2030 PM	NB approach	816	0.55	10	A	3.5	900	0.25	5	A	1.0
	SB approach	924	0.55	9	A	3.5	982	0.26	5	A	1.0
	EB approach	705	0.30	7	A	1.3	812	0.14	5	A	0.5
	WB approach	662	0.41	9	A	2.0	777	0.20	6	A	0.8
	Intersection[5]			9	A						

Notes

1. NCHRP 572, Eq. 4-3
2. HCM 2000, Equation 17-38 (recommend adding 5 sec/veh delay in saturated conditions)
3. HCM 2000, Exhibit 17-2
4. HCM 2000, Equation 17-37
5. Weighted average of approach volume and delay; for comparison only
6. NCHRP 572, Eq. 4-4

Intersection	
Intersection Delay, s/veh	9.2
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	471	423	153	90
Demand Flow Rate, veh/h	495	428	156	99
Vehicles Circulating, veh/h	166	131	521	334
Vehicles Exiting, veh/h	267	546	140	225
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	10.7	8.6	8.3	6.2
Approach LOS	B	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LT
Assumed Moves	LTR	LTR	LTR	LT
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	495	428	156	99
Cap Entry Lane, veh/h	957	991	671	809
Entry HV Adj Factor	0.951	0.989	0.981	0.907
Flow Entry, veh/h	471	423	153	90
Cap Entry, veh/h	910	981	658	734
V/C Ratio	0.517	0.432	0.232	0.122
Control Delay, s/veh	10.7	8.6	8.3	6.2
LOS	B	A	A	A
95th %tile Queue, veh	3	2	1	0

4: Lower Welden St & Lemnah Dr/Allen St

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	50	255	25	60	235	90	5	40	80	45	25	0
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	71	364	36	66	258	99	6	49	98	58	32	0
Approach Volume (veh/h)		471			423			152			90	
Crossing Volume (veh/h)		156			126			493			330	
High Capacity (veh/h)		1226			1255			938			1068	
High v/c (veh/h)		0.38			0.34			0.16			0.08	
Low Capacity (veh/h)		1017			1043			759			875	
Low v/c (veh/h)		0.46			0.41			0.20			0.10	

Intersection Summary			
Maximum v/c High	0.38		
Maximum v/c Low	0.46		
Intersection Capacity Utilization	45.7%	ICU Level of Service	A

Intersection	
Intersection Delay, s/veh	10.3
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	375	522	175	233
Demand Flow Rate, veh/h	382	532	186	238
Vehicles Circulating, veh/h	349	125	527	451
Vehicles Exiting, veh/h	340	588	204	206
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	11.2	10.5	9.3	9.3
Approach LOS	B	B	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LT
Assumed Moves	LTR	LTR	LTR	LT
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	382	532	186	238
Cap Entry Lane, veh/h	797	997	667	720
Entry HV Adj Factor	0.981	0.980	0.942	0.981
Flow Entry, veh/h	375	522	175	233
Cap Entry, veh/h	782	978	628	706
V/C Ratio	0.479	0.534	0.279	0.331
Control Delay, s/veh	11.2	10.5	9.3	9.3
LOS	B	B	A	A
95th %tile Queue, veh	3	3	1	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	40	295	10	100	295	85	10	55	85	115	60	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	43	321	11	109	321	92	12	64	99	153	80	0
Approach Volume (veh/h)		375			522			174			233	
Crossing Volume (veh/h)		342			119			517			441	
High Capacity (veh/h)		1059			1262			920			978	
High v/c (veh/h)		0.35			0.41			0.19			0.24	
Low Capacity (veh/h)		866			1049			743			794	
Low v/c (veh/h)		0.43			0.50			0.23			0.29	

Intersection Summary				
Maximum v/c High	0.41			
Maximum v/c Low	0.50			
Intersection Capacity Utilization	71.8%	ICU Level of Service	C	

Intersection	
Intersection Delay, s/veh	10.8
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	535	434	195	103
Demand Flow Rate, veh/h	561	439	199	114
Vehicles Circulating, veh/h	196	199	498	345
Vehicles Exiting, veh/h	262	498	259	293
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.1	9.8	9.0	6.5
Approach LOS	B	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LT
Assumed Moves	LTR	LTR	LTR	LT
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	561	439	199	114
Cap Entry Lane, veh/h	929	926	687	800
Entry HV Adj Factor	0.954	0.990	0.982	0.905
Flow Entry, veh/h	535	434	195	103
Cap Entry, veh/h	886	916	674	724
V/C Ratio	0.604	0.474	0.290	0.142
Control Delay, s/veh	13.1	9.8	9.0	6.5
LOS	B	A	A	A
95th %tile Queue, veh	4	3	1	0

4: Lower Welden St & Lemnah Dr/Allen St

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	75	225	75	75	230	90	5	65	90	35	45	0
Peak Hour Factor	0.70	0.70	0.70	0.91	0.91	0.91	0.82	0.82	0.82	0.78	0.78	0.78
Hourly flow rate (vph)	107	321	107	82	253	99	6	79	110	45	58	0
Approach Volume (veh/h)		536			434			195			103	
Crossing Volume (veh/h)		185			193			473			341	
High Capacity (veh/h)		1198			1191			953			1059	
High v/c (veh/h)		0.45			0.36			0.20			0.10	
Low Capacity (veh/h)		992			985			772			867	
Low v/c (veh/h)		0.54			0.44			0.25			0.12	

Intersection Summary				
Maximum v/c High	0.45			
Maximum v/c Low	0.54			
Intersection Capacity Utilization	52.2%	ICU Level of Service	A	

Intersection	
Intersection Delay, s/veh	11.9
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	452	511	267	213
Demand Flow Rate, veh/h	462	521	283	217
Vehicles Circulating, veh/h	328	206	543	478
Vehicles Exiting, veh/h	367	620	247	249
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	13.1	11.9	12.3	9.1
Approach LOS	B	B	B	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LT
Assumed Moves	LTR	LTR	LTR	LT
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	462	521	283	217
Cap Entry Lane, veh/h	814	920	657	701
Entry HV Adj Factor	0.979	0.981	0.945	0.982
Flow Entry, veh/h	452	511	267	213
Cap Entry, veh/h	797	902	620	688
V/C Ratio	0.568	0.567	0.431	0.310
Control Delay, s/veh	13.1	11.9	12.3	9.1
LOS	B	B	B	A
95th %tile Queue, veh	4	4	2	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	80	305	30	100	315	55	15	80	135	85	75	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.86	0.86	0.86	0.75	0.75	0.75
Hourly flow rate (vph)	87	332	33	109	342	60	17	93	157	113	100	0
Approach Volume (veh/h)		451			511			267			213	
Crossing Volume (veh/h)		322			197			532			469	
High Capacity (veh/h)		1075			1187			910			957	
High v/c (veh/h)		0.42			0.43			0.29			0.22	
Low Capacity (veh/h)		881			981			734			776	
Low v/c (veh/h)		0.51			0.52			0.36			0.28	

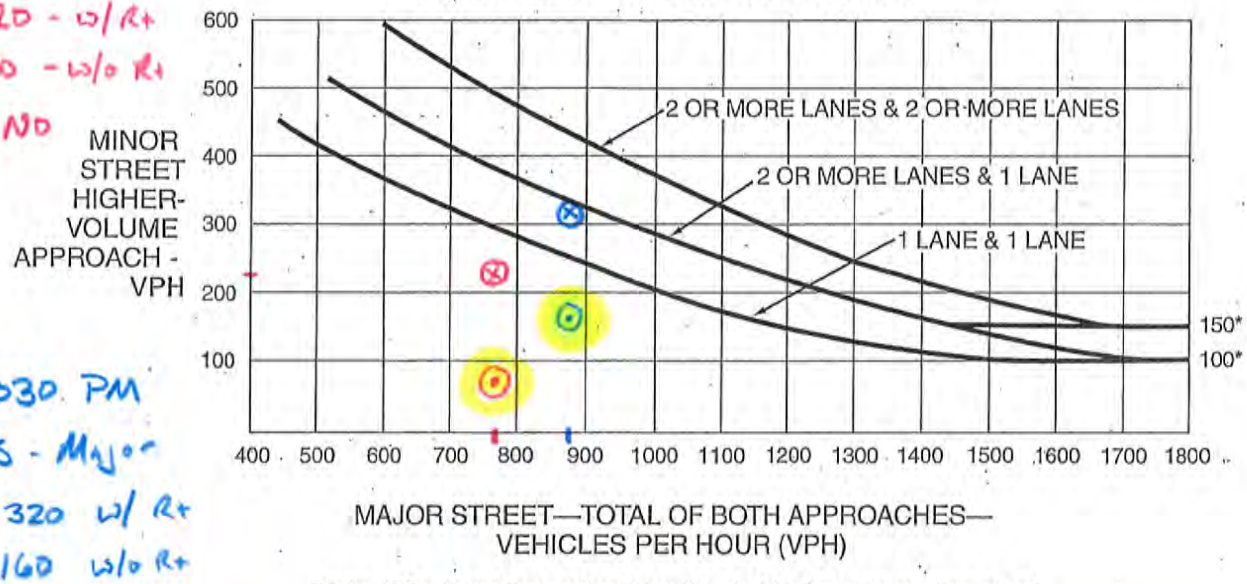
Intersection Summary			
Maximum v/c High	0.43		
Maximum v/c Low	0.52		
Intersection Capacity Utilization	67.2%	ICU Level of Service	C

MUTCD Warrant Evaluation

LEMNAH DR. / LOWER WELDEN / ALLEN ST

2030 AM
770 - Major
⊗ 220 - w/ Rt
⊙ 80 - w/o Rt
→ NO

Figure 4C-3. Warrant 3, Peak Hour



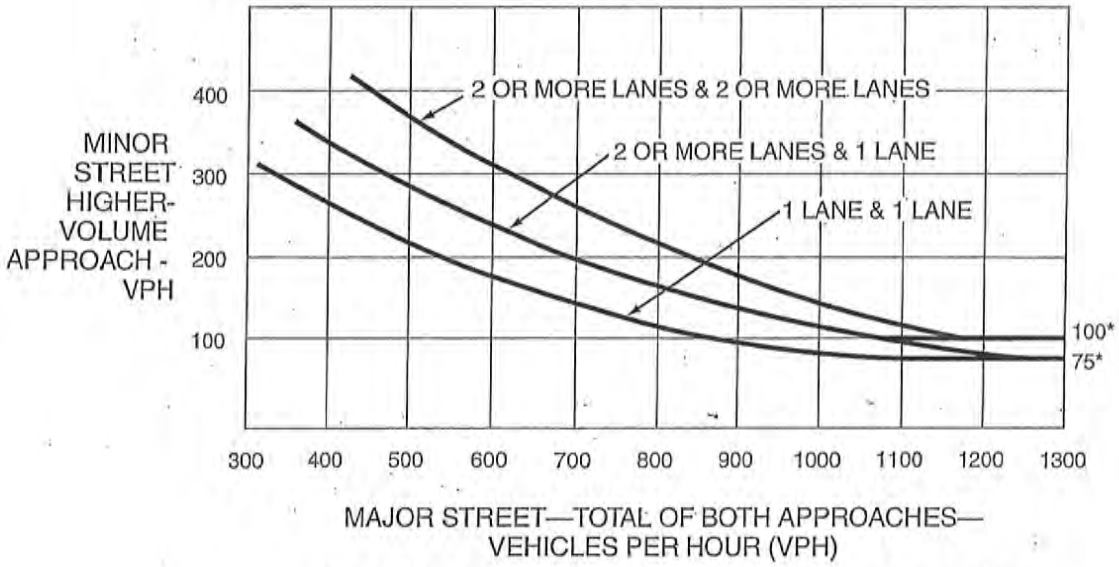
2030 PM
885 - Major
⊗ 320 w/ Rt
⊙ 160 w/o Rt

*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.

↳ No, No w/o RIGHT TURN VOLUME FROM MINOR ST.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Section 2B.06 STOP Sign Applications

Guidance:

01 *At intersections where a full stop is not necessary at all times, consideration should first be given to using less restrictive measures such as YIELD signs (see Sections 2B.08 and 2B.09).*

02 *The use of STOP signs on the minor-street approaches should be considered if engineering judgment indicates that a stop is always required because of one or more of the following conditions:*

A. *The vehicular traffic volumes on the through street or highway exceed 6,000 vehicles per day;*
B. *A restricted view exists that requires road users to stop in order to adequately observe conflicting traffic on the through street or highway; and/or*
C. *Crash records indicate that three or more crashes that are susceptible to correction by the installation of a STOP sign have been reported within a 12-month period, or that five or more such crashes have been reported within a 2-year period. Such crashes include right-angle collisions involving road users on the minor-street approach failing to yield the right-of-way to traffic on the through street or highway.*

Support:

03 The use of STOP signs at grade crossings is described in Sections 8B.04 and 8B.05.

Section 2B.07 Multi-Way Stop Applications

Support:

01 Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal. ABOUT 1/2

02 The restrictions on the use of STOP signs described in Section 2B.04 also apply to multi-way stop applications.

Guidance:

03 *The decision to install multi-way stop control should be based on an engineering study.*

04 *The following criteria should be considered in the engineering study for a multi-way STOP sign installation:*

(5) Likely NOT WARRANTED

A. *Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.*

Low Engineering CRASH RISK

B. *Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions.*

C. *Minimum volumes:*

PEAK Hour VOLUMES WELL ABOVE THRESHOLDS

1. *The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and* 2010 AM = 715 2010 PM = 825
2. *The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but* 2010 AM = 305 2010 PM = 425
3. *If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.*

YES

D. *Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.*

Option:

05 Other criteria that may be considered in an engineering study include:

NO A. The need to control left-turn conflicts;
Unlikely? B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;
Unlikely C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop; and
possible case D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.

MUTCD - Multi-Way Stop Volume Warrant Analysis
Lower Weldon / Lemnah /Allen

2015 Existing Average Month Volumes --- Lake / Federal / Catherine St									
Hour				Minor	% of AM Peak	% of PM Peak	Major	% of AM Peak	% of PM Peak
6:00	-	7:00	AM	161			170		
7:00	**-**	**8:00**	**AM**	**276**	100%	93%	**414**	100%	58%
8:00	-	9:00	AM	342	124%	116%	483	117%	68%
9:00	-	10:00	AM	218	79%	74%	434	105%	61%
10:00	-	11:00	AM	223	81%	75%	506	122%	71%
11:00	-	12:00	AM	301	109%	102%	671	162%	94%
12:00	-	1:00	PM	346	125%	117%	616	149%	86%
1:00	-	2:00	PM	280	101%	95%	543	131%	76%
2:00	-	3:00	PM	290	105%	98%	653	158%	92%
3:00	-	4:00	PM	295	107%	100%	711	172%	100%
4:00	**-**	**5:00**	**PM**	**296**	107%	100%	**713**	172%	100%
5:00	-	6:00	PM	286	104%	97%	674	163%	95%
6:00	-	7:00	PM	0			0		

2010 Build Average Month Volumes --- Lower Weldon / Lemnah /Allen									
Hour				Minor	% of AM Peak	% of PM Peak	Major	% of AM Peak	% of PM Peak
6:00	-	7:00	AM						
7:00	**-**	**8:00**	**AM**	**299**	299	388	**701**	701	469
8:00	-	9:00	AM	426	370	481	683	817	548
9:00	-	10:00	AM	271	236	307	613	735	492
10:00	-	11:00	AM	278	242	314	715	856	574
11:00	-	12:00	AM	375	326	424	948	1136	761
12:00	-	1:00	PM	431	375	487	871	1043	699
1:00	-	2:00	PM	349	303	394	767	919	616
2:00	-	3:00	PM	361	314	408	923	1105	740
3:00	-	4:00	PM	367	319	415	1005	1203	806
4:00	**-**	**5:00**	**PM**	**417**	321	417	**809**	1207	809
5:00	-	6:00	PM	356	310	402	953	1141	764
6:00	-	7:00	PM						

DHV > Average Month =	0.98
> 200 on Minor Street approach	
> 300 on Major Street approach	

Multi-Way Stop Minimum Volumes are Satisfied.

2009 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Lake Street at Federal Street

Major Street Direction: Eastbound-Westbound

Year: 2015 **Condition:** Existing

Operating speed on major roadway: 25 mph

Number of approaches: 4

			Required approach volumes Minimum*	Adjusted Minimum**
Warrant 1	**EIGHT-HOUR VEHICULAR VOLUME**			
Warrant 1A	MINIMUM VEHICULAR VOLUME (8 hours of day)			
	Major Street :	1 Lane(s) on each approach	500	500
	Minor Street :	2 Lane(s) on each approach	200	200
Warrant 1B	INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)			
	Major Street :	1 Lane(s) on each approach	750	750
	Minor Street :	2 Lane(s) on each approach	100	100
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B			Warrant 1A	Warrant 1B
	Major Street :	1 Lane(s) on each approach	400	600
	Minor Street :	2 Lane(s) on each approach	160	80

Warrant 2 **FOUR HOUR VEHICULAR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 2 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 **PEAK HOUR VOLUME**

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 2 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road Westbound	Entering Vol. on Major Road Eastbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	161	80	90	170	No	No	No	No	No
7:00 - 8:00 AM	276	191	223	414	No	No	No	No	No
8:00 - 9:00 AM	342	233	250	483	No	No	No	Verify	No
9:00 - 10:00 AM	218	210	224	434	No	No	No	No	No
10:00 - 11:00 AM	223	244	262	506	Yes	No	No	No	No
11:00 - 12:00 AM	301	321	350	671	Yes	No	Yes	Yes	No
12:00 - 1:00 PM	346	287	329	616	Yes	No	Yes	Yes	No
1:00 - 2:00 PM	280	270	273	543	Yes	No	No	No	No
2:00 - 3:00 PM	290	271	382	653	Yes	No	Yes	Verify	No
3:00 - 4:00 PM	295	306	405	711	Yes	No	Yes	Yes	No
4:00 - 5:00 PM	296	280	433	713	Yes	No	Yes	Yes	No
5:00 - 6:00 PM	286	307	367	674	Yes	No	Yes	Yes	No
6:00 - 7:00 PM	0	0	0	0	No	No	No	No	No
					Yes	No	No	Yes	No
				Warrants Met?	1			2	3
					Yes			Yes	No

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

Peak Four Hour Pedestrian Volumes: (non-concurrent) 95, 79, 78, 70

Warrant 5, School Crossing:

See MUTCD for details.

Warrant 6, Coordinated Signal System:

See MUTCD for details.

Warrant 7, Crash Experience: No

Not Evaluated

# of accidents "correctable by signalization" occuring in the last 12 months: 0

Warrant 8, Roadway Network:

See MUTCD for details.

Source: *Manual on Uniform Traffic Control Devices* (MUTCD); 2009 Edition [2009]

last updated: 08/05/05 [version]