HIGHWAY 65

# HIGHWAY 65

## Signal Optimization Project

### Final Report

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## Executive Summary

The following section provides a brief overview and highlights key results obtained as part of the Trunk Highway (TH) 65 Signal Optimization project (Signal Optimization project) completed for the Minnesota Department of Transportation (MnDOT).

## Intersection Summary

The Signal Optimization project included the limits of TH 65 between I-694 in Fridley and 237th Avenue in East Bethel, MN. This segment of TH 65 has a total of 24 signalized intersections. For the purposes of this report TH 65 will be divided into three segments; the south segment (old Zone 181) between I-694 South Ramps to 81st Avenue, the middle segment (old Zone 182) between 85th Avenue to 117th Avenue and the north segment (old Zone 184) from Bunker Lake Boulevard to 237th Avenue.

## Project Description and Purpose

The Minnesota Department of Transportation (MnDOT) received federal funding through the Congestion Mitigation and Air Quality program (CMAQ) to install cameras along each corridor and to replace the existing copper interconnect cable (master controller/local controller closed loop system) with fiber optic cable. The fiber cable network was connected directly to the MnDOT's Regional Traffic Management Center (RTMC) and the traffic signal systems are communicated to through their I2 zone management software. As part of the camera and fiber optic communication network improvements, signal optimization for TH 65 was completed.

The study corridor is a principal north/south arterial linking the northern suburbs to Minneapolis and carries regional significance to the transportation system. This corridor encompasses a very large geographic travelshed, with its only comparable alternatives being I-35W to the east and TH 47 to the west. TH 65 is a major commuter roadway and is also a major recreational route serving as a primary link to northern Minnesota destinations. Within the study corridor, TH 65 provides connections to TH 10, County Road 10, I-694, and east/west County Highways as well as local roads. MnDOT has identified a need to maintain a high level of service for mainline and cross-street traffic flow and to ensure optimal performance. To provide optimal performance, these roadways are scheduled to receive new optimized signal coordination plans once every three to five years. The TH 65 corridor was last re-timed by MnDOT in 2009.

The objective of the Signal Optimization project was to review the existing conditions, optimize the signal system timing, implement and fine-tune the new timing plans. Specific goals of the project include:

- Improve progression and reduce delays for mainline movements.
- Conduct a cycle length analysis to develop a range of off-peak timing plans appropriate for the daily volume variations.

- Provide flexibility in the cross-street and left turn movement green times to account for demand variability and to minimize adverse impacts (reduce delay where possible).

Seven new timing plans were developed, implemented and field fine tuned on a time of day (TOD) schedule. As part of the project, "before" and "after" measures of effectiveness (MOE) data were collected to estimate the benefits of the signal optimization.

## Elements of Study

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of intersection and traffic volume characteristics, signal timing characteristics, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness. The Synchro7.0 and SimTraffic7.0 models developed in evaluation of the existing conditions were used to create optimized signal timing plans. The traffic signal optimization included developing TOD timing plans consisting of new cycle lengths, intersection splits and offsets for each of the signalized corridors and intersections.

After implementation of the timing plans, Alliant Engineering and MnDOT staff conducted field reviews during the months of April and May 2012. During the field reviews, minor adjustments were made to the optimized timing plans to further improve traffic flow and minimize cross-street delays. Following the completed implementation of the signal timing plans, field studies were conducted for the "after" condition and compared to the "before" conditions. A benefit/cost analysis was also completed to evaluate the overall cost-effectiveness of the implemented signal timing plans.

The purpose of this document is to present the results of the Signal Optimization project, which will be discussed in the following sections:

- Introduction (Section1.0)
- Existing Conditions (Section 2.0)
- Signal Timing Optimization and Implementation (Section 3.0)
- Project Benefit Analysis (Section 4.0)
- Potential Improvement Measures (Section 5.0)

## Before/After Travel Time Results

A comparison of the "before" and "after" travel time field studies was made. Table ES-1 and Table ES-2 provide an overall summary of the travel time runs and percent improvement found during the a.m. and p.m. peak periods, respectively.

As shown, the comparison of the "before" and "after" field collected travel times found the following:

- Most routes and directions field measured were found to experience a travel time improvement during both the a.m. and p.m. peak hour and overall three-hour peak periods.
- The peak direction of the peak period (e.g., southbound TH 65 a.m. and northbound TH 65 p.m.) found negligible improvement.
- The performance of the off peak direction of the peak period (e.g., northbound TH 65 a.m. and southbound TH 65 p.m.) were found improved. The a.m. peak hour off peak direction was improved by 7 percent and the p.m. peak hour off-peak direction was found improved by 12 percent.

It should be noted that at the time of the after travel time studies, 35E was under construction (single lane) and Snelling Avenue was closed. These construction projects are resulting in additional traffic pressure to 35W, which in turn is likely resulting in additional traffic volume using TH 65 between Main Street and I-694.

**Table ES - 1. Before/After Travel Time Comparison – A.M. Peak Period**

Northbound

| | Free Flow | AM Peak Hour (700 - 815) | | | AM Overall (600 - 900) | | | Peak Hour Average Speed (mph) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Before | After | Percent Improvement | Before | After | Percent Improvement | Before | After | Percent Improvement |
| | Min Sec | Min Sec | Min Sec | | Min Sec | Min Sec | | | | |
| TH 65 at I-694 South Ramp to 237th Avenue | 23 17 | 28 6 | 26 7 | 7% | 27 13 | 26 3 | 4% | 50 | 53 | 7% |

Southbound

| | Free Flow | AM Peak Hour (700 - 815) | | | AM Overall (600 - 900) | | | Peak Hour Average Speed (mph) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Before | After | Percent Improvement | Before | After | Percent Improvement | Before | After | Percent Improvement |
| | Min Sec | Min Sec | Min Sec | | Min Sec | Min Sec | | | | |
| TH 65 at 237th Avenue to I-694 South Ramp | 23 23 | 33 19 | 33 6 | 1% | 30 52 | 30 14 | 2% | 42 | 43 | 1% |

1. Alliant Engineering field collected travel time runs in October of 2011 (before) and May of 2012 (after).
Note: 35E under construction (single lane) and Snelling Avenue closed in May 2012. Traffic diversion to 35W and TH 65 (Main Street to I-694)

### Table ES - 2. Before/After Travel Time Comparison – P.M. Peak Period

Northbound

| | Free Flow | PM Peak Hour (430-545) | | | PM Overall (300 - 600) | | | Peak Hour Average Speed (mph) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Before | After | Percent Improvement | Before | After | Percent Improvement | Before | After | Percent Improvement |
| | Min Sec | Min Sec | Min Sec | | Min Sec | Min Sec | | | | |
| TH 65 at I-694 South Ramp to 237th Avenue | 23 17 | 32 12 | 31 42 | 2% | 30 26 | 31 3 | -2% | 43 | 44 | 2% |

Southbound

| | Free Flow | PM Peak Hour (430-545) | | | PM Overall (300 - 600) | | | Peak Hour Average Speed (mph) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Before | After | Percent Improvement | Before | After | Percent Improvement | Before | After | Percent Improvement |
| | Min Sec | Min Sec | Min Sec | | Min Sec | Min Sec | | | | |
| TH 65 at 237th Avenue to I-694 South Ramp | 23 23 | 31 28 | 27 48 | 12% | 31 24 | 28 7 | 10% | 45 | 51 | 12% |

1. Alliant Engineering field collected travel time runs in October of 2011 (before) and May of 2012 (after).
Note: 35E under construction (single lane) and Snelling Avenue closed in May 2012. Traffic diversion to 35W and TH 65 (Main Street to I-694)

## Project Benefit

A benefit/cost analysis was completed to establish the annual economic savings incurred as a result of the Signal Optimization project. Typical measures of effectiveness (MOE) used in estimating the benefit of signal optimization projects include approach vehicle delay, vehicle stops and fuel consumption. Table ES-3 illustrates the overall daily and annual "before" and "after" network MOE comparison and percent improvement.

### Table ES - 3. Measures of Effectiveness – Network Performance Comparison

| MOE | Weekday (Daily) | | | | Annual Reduction |
|---|---|---|---|---|---|
| | Before | After | Net Reduction | Percent Improvement | |
| Stops (no. of veh) | 698,904 | 646,651 | **52,253** | **7.5%** | **13,115,566** |
| Delay (hr) | 12,899 | 12,214 | **685** | **5.3%** | **171,910** |
| Fuel Consumption (gal) | 47,358 | 46,326 | **1,032** | **2.2%** | **259,019** |

Based on the study results, an annual benefit is estimated at approximately 4.5 million dollars, which includes an estimated annual savings of 259,000 gallons of gasoline. The benefit/cost ratio is computed based on the comparison between the annual net benefit and the total project cost. As shown in Table ES-4, the Signal Optimization project resulted in a benefit/cost ratio of approximately **69:1** considering only one year of benefit.

**Table ES - 4. Project Benefit to Cost Ratio**

| Segment | Number of Intersections | Cost / Zone ($) | Benefit ($) | Benefit-Cost Ratio |
|---|---|---|---|---|
| TH 65 (I-694 S Ramp to 237th Avenue) | 24 | $66,000 | $4,545,582 | **69** |

## Key Project Highlights

Based on the traffic operation, safety and project benefit analysis, the following key statistics and project conclusions are found:

- The results of the traffic operation analysis found several of the intersections along TH 65 to be deficient under both the existing and newly implemented signal timing plans. The TH 65 does not currently have the geometric or intersection capacity to accommodate the regional demand trying to use corridor. Deficient and over-capacity intersections along TH 65 include: 81st Avenue; 99th Avenue; 105th Avenue; 109th Avenue; Bunker Lake Boulevard; Constance Boulevard; and Viking Boulevard.
- It is also interesting to note the traffic volumes along TH 65 have increased by an average of 20 percent overall since the corridor was last studied in 2008/2009. The middle segment intersections (85th Avenue to 117th Avenue) experienced a 30 percent increase in traffic volume. The volume increase is likely a reflection of both a generally higher regional demand for the corridor, and also an increase in corridor throughput capacity that was made with the 2009 Signal Optimization project.
- The safety analysis made a comparison between the 2008-2010 and 2005-2007 reporting periods to provide an estimated measurement of the safety benefit resulting from the previous corridor re-timing effort in early 2009. The overall number of crashes was found reduced by 12 percent, while the overall traffic volume (crash exposure) increased by over 20 percent in this same period. Thus, a significant reduction in overall and individual intersection crash rates were found. While this is not a perfect comparison, since there are many other factors and variables, corridor signal timing may be a key contributing factor.
- The peak direction of the peak period (e.g., southbound TH 65 a.m. and northbound TH 65 p.m.) found negligible improvement. This is due to the corridor being at capacity and the maximum cycle length (250 seconds) in operation. There is little opportunity to increase performance, other than accommodating a bit more throughput.
- The performance of the off peak direction of the peak period (e.g., northbound TH 65 a.m. and southbound TH 65 p.m.) were found improved, approximately 7 percent in the a.m. and 12 percent in the p.m. peak periods, respectively.
- The off peak hour plans found the greatest operational improvement. This improvement is achieved by better matching the cycle length and intersection splits with the traffic volume demand. As a result, progression was found much

improved in both directions. Significant delay reductions were found at the 694 South Ramp intersection, TH 10 South Ramp and Viking Boulevard intersections.

- On a daily basis, the overall network delay is estimated to be reduced by 5.3 percent.
- Overall an estimated 7.5 percent reduction in total vehicle stops was found on TH 65, which saves both time and fuel.

## Potential Improvement Measures

As part of the Signal Optimization project a comprehensive operation review of TH 65 was completed. During the field implementation and signal timing review process, a few signal operation or roadway improvements were identified for further review and/or consideration. The purpose of the following sections is to document low cost signal operation or geometric modifications to improve intersection efficiency.

### Recommended Future Improvements

Table ES-6 documents potential future improvement measures for the TH 65, which range from low cost signal operation efficiency measures to low cost geometric revisions. The improvement measures identified are generally low cost and do not include major infrastructure investment. Ultimately this is needed; however, it is recommended MnDOT conduct a corridor study to identify the appropriate major geometric improvements

### Flashing Yellow Arrow

As MnDOT investigates and determines the future funding program and implementation policy for flashing yellow arrow (FYA), it would be appropriate to ultimately consider all intersections currently containing protected left turn phasing be retrofitted for installation. However, some will benefit sooner than others if not all retrofitted at the same time. Table ES-6 prioritizes the FYA installations by high, medium and low, in accordance with the following general considerations:

- Locations that have mainline or cross-street left turn movements that would benefit from converting to protected/permissive, leading protected/permissive in one direction or permissive only operation immediately, during all or some time periods, were rated high priority.
- Split phased signals should initially be considered high priority, since there could be an immediate benefit by operating these intersection as either leading protected/permissive or permissive only during the off peak time periods. However, each location must be reviewed case-by-case to determine the left turning vehicle path. If left turning vehicle paths overlap, than permissive or protected/permissive operation may not be feasible. In this case, flashing yellow arrow these locations would be considered a lower priority.
- Traffic signals on the mainline that have good sightlines and feel long with higher cycles were rated high priority.

- The medium priority are signals with single left turn lanes on the mainline, where it is conceivable that protected/permissive could be easily placed in operation during the off peak periods. It may be likely that many of these signals would operate protected only during the a.m. and p.m. peak hours.
- The lower priority rankings are locations that have dual left turn lanes and are most likely to operate protected only during the peak hours or off peak periods until permissive dual left turn movements become more accepted.

In addition to providing improved intersection efficiency and signal phasing flexibility during both the off peak and peak periods, FYA will also provide significant benefit to signal operations during the overnight hours. Traditionally, arterial corridors will operate in free mode, due to the low volumes and inherit inefficiencies of signal coordination under light traffic conditions. FYA will allow the flexibility to omit left turn arrows and to operate a corridor of signals under a short cycle two-phase coordination.

## Corridor Management Study

As documented in this report, TH 65 operates well over capacity during both the a.m. and p.m. peak periods. TH 65 attracts traffic demand from a considerable geographic travelshed. In large part this is due to the lack of convenient north/south county or trunk highways that provide access into the inner metro area. Only two other major north/south roadways exist – 35W and TH 47 – and one north/south county roadway – Lexington Avenue – that may serve as a reliever. Contributing to motorist's choice of using TH 65 may be that 35W is congested, TH 47 is difficult to access due limited Rum River bridge crossings plus is not a convenient route, and Lexington Avenue is a two-lane undivided roadway along much of its length. As a result, significant congestion exists along much of the TH 65 corridor. It is recommended MnDOT undertake a major corridor study to help:

- Determine the actual unconstrained existing and future traffic demand for TH 65.
- Understand to what extent the congestion along 35W, I-694 and TH 252 contribute to motorist demand along TH 65.
- Identify the long term roadway capacity needs (i.e., freeway versus arterial, supporting roadway network needs, frontage roads and interchange locations).
- Begin the process of programming major corridor management and roadway/intersection improvement infrastructure.

# Table ES - 5. Intersection Improvement Summary

| Node No. | Intersection | System ID | Responsible Agency (Signal Owner) | Potential Geometric Improvements | Lane Use/Pavement Marking or Signing Improvements | Signal Phasing or Signal Operation Improvements | Flashing Yellow Arrow Operation Priority (Determine Left Turn Operation by TOD) |
|---|---|---|---|---|---|---|---|
| 1 | TH 65 at I-694 South Ramp | 22210 | MnDOT | | | | Low |
| 2 | TH 65 at I-694 North Ramp | 22211 | MnDOT | | | | Low |
| 3 | TH 65 at Medtronic Parkway/Central Avenue | 21158 | MnDOT | | | | Low |
| 4 | TH 65 at Moore Lake Drive | 21159 | MnDOT | 1. Extend SB Turn Lanes for 50 mph Design and Storage | | | Medium |
| 5 | TH 65 at Mississippi Street | 21160 | MnDOT | 1. Convert Mississippi to 3-Lane Roadway and Provide (1-LT, 1-TH, 1-RT) EB/WB at TH 65 | | 1. Install FYA to Remove Split Phase During Off Peak Periods | High |
| 6 | TH 65 at 73rd Avenue | 21162 | MnDOT | | | | Medium |
| 7 | TH 65 at Osborne Road | 21163 | MnDOT | | | | Low |
| 8 | TH 65 at 81st Avenue | 21164 | MnDOT | 1. Extend NB Turn Lanes for Storage | 1. Remove SB No Turn on Red Sign | | High |
| 9 | TH 65 at 85th Avenue | 21165 | MnDOT | 1. Extend NB/SB Turn Lanes for 60 mph Design (2017 MnDOT Project) | | 1. Install EB/WB FYA to Remove Split Phase Operation | High |
| 10 | TH 65 at 89th Avenue | 21166 | MnDOT | 1. Lengthen NB Left Turn Lane for 55 mph Design and Storage (2017 MnDOT Project) | | | Medium |
| 11 | TH 65 at TH 10 South Ramp | 22209 | MnDOT | | | | Low |
| 12 | TH 65 at TH 10 North Ramp | 21167 | MnDOT | 1. Construct WB Dual Left Turn Lane | | | Low |
| 13 | TH 65 at 93rd Lane/Cloverleaf Parkway | 21169 | MnDOT | 1. Extend NB/SB Turn Lanes for 60 mph Design (2017 MnDOT Project) | 1. Reassign EB approach Lanes to be 1-LT, 1-LT/TH, 1-RT Lane | | High |
| 14 | TH 65 at 99th Avenue | 21170 | MnDOT | 1. Extend NB/SB Turn Lanes for 60 mph Design (2017 MnDOT Project)<br>2. Move U-Haul Access to be Across from Ulysses; and Extend EB Left Turn Lane.<br>3. Extend WB Left Turn Lane | | 1. Convert EB/WB to Protected/Permissive Operatio | High |
| 15 | TH 65 at 105th Avenue | 21171 | MnDOT | 1. Extend NB Turn Lanes for 60 mph Design (2017 MnDOT Project) | | 1. Install EB/WB FYA to Remove Split Phase Operation and Allow WB Leading LT or Permissive | High |
| 16 | TH 65 at 109th Avenue | 21172 | MnDOT | 1. Extend NB/SB Turn Lanes for 60 mph Design (2017 MnDOT Project)<br>2. Construct EB Right Turn Lane<br>3. Construct Dual EB Left Turn Lane | | | Low |
| 17 | TH 65 at 117th Avenue | 25568 | MnDOT | 1. Extend SB Turn Lanes for 60 mph Design (2017 MnDOT Project) | | | Medium |

## Table ES - 6. Intersection Improvement Summary Cont'd

| Node No. | Intersection | System ID | Responsible Agency (Signal Owner) | Potential Geometric Improvements | Lane Use/Pavement Marking or Signing Improvements | Signal Phasing or Signal Operation Improvements | Flashing Yellow Arrow Operation Priority (Determine Left Turn Operation by TOD) |
|---|---|---|---|---|---|---|---|
| 18 | TH 65 at Bunker Lake Boulevard | 21180 | MnDOT | 1. Construct NB Dual LT Lane (Anoka Co. 2012 Project)<br>2. Extend NB/SB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | 1. Install EB Right Turn Overlap<br>2. EB/WB Protected/Permissive Operation | High |
| 19 | TH 65 at Andover Boulevard | 38245 | MnDOT | 1. Extend NB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | | Medium |
| 20 | TH 65 at Constance Boulevard | 21183 | MnDOT | 1. Reconstruct EB/WB Approaches to Consist of 3 Lanes (LT, TH, RT)<br>2. Extend NB/SB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | 1. Remove Split Phase Operation with Improved EB/WB Lane Geometrics | High |
| 21 | TH 65 at Crosstown Boulevard | 21186 | MnDOT | 1. Extend NB/SB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | | Medium |
| 22 | TH 65 at Vikings Boulevard | 21189 | MnDOT | 1. Reconstruct EB/WB Approaches to Consist of 3 Lanes (LT, TH, RT)<br>2. Extend NB/SB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | 1. Remove Split Phase Operation with Improved EB/WB Lane Geometrics | Medium |
| 23 | TH 65 at 213th Avenue/Sims Road | 22208 | MnDOT | 1. Extend NB/SB Turn Lanes for 65 mph Design (2017 MnDOT Project) | | | Medium |
| 24 | TH 65 at 237th Avenue | 22207 | MnDOT | 1. Pull Back Median Noses to Improve Turning Radii<br>2. Extend NB/SB Turn Lanes for 65 mph Design (2012 MnDOT Project) | 1. Provide EB/WB Yellow Cat-Track for Left Turn in Front Operation | 1. Remove Advanced Warning Flasher<br>2. Consider Shared FYA Heads for Peak Hour EB/WB Split Phase Operation | Medium |
| -- | TH 65 Corridor Management | | MnDOT<br>Anoka County<br>Local Cities | 1. Conduct Corridor Study | 1. Provide EB/WB Yellow Cat-Track for Left Turn in Front Operation | 1. Consider Interconnect along 109th Avenue and 105th Avenue to Cross-Coordinate with Anoka Co Signals | NA |