EXHIBIT B

BURGESS & NIPLE

Robert E. Rice, City Engineer
City of Powell
47 Hall Street
Powell, OH 43065

Re: SR 750/Bennett Parkway
Traffic Signal Warrant Study

August 27, 2002

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Dear Mr. Rice:

Attached are the results of the traffic signal study that was conducted by Burgess & Niple at the intersection of E. Olentangy Street (SR 750) and Bennett Parkway/Cressingham Lane. The study consists of conducting 24-hour approach counts, peak hour turning movement counts, speed studies, gap analysis, signal warrant analysis, peak hour delay studies, traffic crash analysis, and a cost analysis. The results were used to determine the need and justification for signal installation at this location.

We appreciate the opportunity to work with the City of Powell and hope the information resulting from our analysis will assist the City in its efforts to promote safe and efficient traffic flow on its streets.

Sincerely,

William J. Bielek, PE
Project Manager
Burgess & Niple, Limited

SR 750/Bennett Parkway
Traffic Signal Warrant Analysis

Introduction

Various traffic studies were conducted during the week of July 29th, 2002 to determine the need and justification for traffic signal installation at the intersection of E. Olentangy Street (SR 750) & Bennett Parkway/Cressingham Lane. The procedures and results of these studies are described below. They provided the basis for the conclusions and recommendations contained in this summary document. Data summary sheets for these studies are included in the Appendix.

24-Hour Mechanical Traffic Volume Counts

Hourly traffic count data was collected on Wednesday July 31st through Friday August 2nd 2002. Traffic was counted as it approached on each leg of the intersection. Volume data over the 2-3 day period was averaged for use in the signal warrant analysis. Due to the variability of each day's count and the mixed-use nature of the traffic (work-based and recreational), ODOT seasonal adjustment factors were not considered to be relevant and were not applied to the count data.

Speed Study

Because the minimum volume requirements of the signal warrant procedures are dependent on the approach speed of major street traffic, vehicle speed data was collected for all SR 750 traffic over the data collection period. The data shows that the 85th percentile speed[1] is in excess of 43 mph.

Gap Analysis

During the AM peak hour, there are 125 right turns from NB Bennett Parkway to EB SR 750. This represents nearly 90% of the total side street traffic demand. The minimum acceptable gap in EB SR 750 traffic flow, required for traffic to safely turn right, is approximately 6 seconds. During the AM peak hour, there are over 200 gaps in EB traffic greater than 7 seconds. The results are similar during the PM peak hour.

Given the number of available gaps and the minimal delay encountered by the right turn traffic from Bennett Parkway (as discussed later in this report) we agree with the decision reached in a recent report - the *Olentangy Street Comprehensive Traffic Study, March 2000* - to discount the Bennett Parkway right turn traffic demand from the traffic signal warrant analysis.

Existing Intersection Delay

An intersection delay study was conducted to determine the actual amount of time that side street traffic needs to turn onto, or cross SR 750 under existing conditions. The results show that the average control delay per vehicle during the AM peak period (7:00 – 8:15) is 16.3 seconds for Bennett Parkway traffic and 20.9 seconds for Cressingham Lane traffic. PM peak period (4:15 – 5:45) delay is 21.8 seconds and 30.3 seconds for Bennett and Cressingham traffic, respectively. For comparison purposes, this corresponds to a Level of Service for signalized intersections ranging from LOS B to LOS C. ("Level of Service" is described in the Appendix.)

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[1] The 85th percentile speed is considered to be the "prevailing speed", or the highest safe speed that can be traveled on a particular section of roadway. It is the speed that is exceeded by 15% of all traffic under free flow conditions.

Traffic Signal Warrant Analysis

The *Ohio Manual of Uniform Traffic Control Devices* (OMUTCD) describes various traffic characteristics including volume, vehicle delay, speed, pedestrian activity, and crash history that could justify or "warrant" the installation of a traffic signal. There are 11 "warrants" contained in the OMUTCD, summarized in the table below, that define the minimum conditions under which traffic signals can legally be installed in Ohio. Satisfying any one of the warrants could justify signalization.

Traffic Signal Warrant		Description
1	Minimum Vehicular Volume	8-hour combined major/minor street traffic volume
2	Interruption of Continuous Traffic	8-hour, high-volume, major street traffic
3	Minimum Pedestrian Volume	High pedestrian activity without adequate gaps in traffic
4	School Crossing	School crossing without adequate gaps in traffic
5	Progressive Movement	Grouping of vehicles for coordinated traffic flow
6	Accident Experience	High number of angle, pedestrian, or left-turn accidents
7	Systems Warrant	Intersection of major routes
8	Combination of Warrants	Traffic meeting reduced requirements of Warrants #1 & #2
9	Four Hour Volumes	High traffic volume during four hours
10	Peak Hour Delay	High side street delay during peak hour of major street
11	Peak Hour Volume	High combined major/minor street peak hour volume

The existing traffic conditions at the intersection of SR 750 & Bennett Parkway/Cressingham Lane were analyzed and compared to the minimum requirements of each of the above described warrants. The results of each warrant analysis is described below and summarized on the Signal Warrant Analysis Sheets:

Warrant #1 – Minimum Vehicular Volume
Warrant #2 – Interruption of Continuous Traffic
Warrant #8 – Combination of Warrants
Warrant #9 – Four Hour Volume
Warrant #11 – Peak Hour Volume

- After discounting the right turn traffic from Bennett Parkway, side street traffic volume was insufficient to satisfy Warrants #1, #2, #8. #9, and #11.

Warrant #3 – Minimum Pedestrian Volume

- There was very little pedestrian activity at the time of the morning and afternoon peak traffic period traffic counts. Although pedestrians currently crossing SR 750 at the Thornbury intersection would likely cross at Bennett if a traffic signal were present, the increased pedestrian traffic would still be insufficient to satisfy the minimum required pedestrian volume of 100 per hour for 4 hours or 190 for one hour.
- The proposed park to be located in the southwest quadrant of the intersection, would also increase the total number of pedestrian crossings. However, until this demand can be quantified and compared to the requirements of Warrant #3, signalization could not be warranted.
- In the meantime, we recommend that the existing pedestrian-actuated flasher at Thornbury be put into full-time operation to avoid giving pedestrians a false sense of security while crossing the intersection, since vehicles would, technically, still have the right-of-way.

Warrant #4 – School Crossing

- This warrant does not apply since the intersection is not an "Established School Crossing" used routinely by school children following a "school route plan".

Warrant #5 – Progressive Movement

- This warrant does not apply since there exists no coordinated signal system along SR 750 that would benefit from an additional signal at Bennett Parkway.

Warrant #6 – Accident Experience

- This warrant does not apply since there exists no accident problem susceptible to correction by a signal.

Warrant #7 – Systems Warrant

- This warrant does not apply since Bennett Parkway is not part of a "highway system that serves as the principal network for through traffic flow".

Warrant #10 – Peak Hour Delay

- Combined minor street stopped delay during the morning **and** afternoon peak hours is approximately 2.2 vehicle-hours. In order to satisfy Warrant #10, delay on **one** minor street approach, during **either** the morning or afternoon peak hour must exceed four vehicle-hours. Therefore Warrant #10 is not satisfied.

Further investigation, beyond an analysis of the signal warrants, was also done to determine the overall impact of installing a new signal. Issues involving signalized intersection delay, accident hazard, and cost were therefore evaluated as described below.

Signalized Intersection Delay

AM and PM peak hour turning movement counts were conducted and used in a *Synchro* analysis to determine the theoretical intersection delay and total number of vehicle-stops that would occur if a traffic signal were to be installed. These values could then be compared to the amount of delay and stops actually measured at the intersection under existing, unsignalized conditions.

Under signalized conditions, the delay for right turns from Bennett Parkway would remain virtually unchanged, assuming right-turn-on-red would be permitted. Cressingham traffic would experience delays of 26.5 and 26.1 sec/veh during the AM and PM peak hours, respectively. Therefore, the total **side street** delay would not be reduced under signalized conditions.

However, signalization would require over 30% of the SR 750 traffic to stop. The resulting delay to major street traffic would result in peak period intersection delay of 3.5 vehicle-hours, or an **increase** of 60% over existing conditions.

Accident Analysis

Under certain conditions, installation of a traffic signal can reduce overall accident occurrence at an intersection. Traffic signals can greatly reduce the incidence of right angle type crashes. Unfortunately, signals also cause increases in rear-end and sideswipe type crashes – accidents caused by increasing the number of stops and lane-changing.

An investigation of accidents occurring at the SR 750/Bennett Parkway intersection over the past two years shows only three crashes, none of which would have been prevented had a signal been in operation.

Traffic volume at the SR 750/Bennett Parkway intersection totals approximately 15,000 veh/day, or over 5 million vehicles per year. Accident rates at signalized intersections typically range between 0.8 and 1.0 accidents per million vehicles. At this rate, it would not be surprising to see 4-5 accidents per year, 2-3 of which would be rear end type crashes involving vehicles on SR 750, if a signal were to be installed.

Cost

The cost of signal installation is not limited to its design and construction cost, which is typically $60-80,000. Annual operation and maintenance costs amount to at least $3,000 per year. Increased accident costs amount to over $10, 000 per property damage accident – much more for injury accidents. Unneeded signals also increase vehicle operating costs and driver delay costs, in this case amounting to nearly $50,000 and 3000 hours per year.

Conclusions and Recommendations

Traffic signals are installed to improve safety and reduce excessive side street delay. As has been shown in the various studies and analyses described in this report, neither will be accomplished by installing a traffic signal at the intersection of SR 750 and Bennett Parkway/Cressingham Lane.

There exists no hazardous condition at the intersection, certainly not one that can be corrected with a signal. In fact, crash occurrence can be expected to increase if a signal is installed.

Existing side street delay is low, averaging less than 20 seconds per vehicle during the peak traffic periods of the day. Signalization would actually increase overall intersection delay by 60%. Also, because a signal at the Bennett/Cressingham intersection would interrupt traffic flow on SR 750 and tend to group this major street traffic into platoons, side street traffic at adjacent intersections, e.g., Thornbury and Olentangy Ridge may, at times, experience longer delays than under existing conditions.

Based on these findings, it is recommended that the existing stop sign control at the intersection of SR 750 and Bennett Parkway/Cressingham Lane be retained.

LEVEL OF SERVICE DESCRIPTION

Level of service (LOS) for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to type of intersection control, geometrics, traffic, and incidents. **Total** delay is the difference between the travel time actually experienced by the driver and the travel time that would result in the absence of traffic control, geometric delay, any incidents, and any other vehicles. Specifically, LOS criteria for traffic signals are stated in terms of the average **control** delay per vehicle. Control delay is a complex measure and depends on a number of variables, including the quality of signal coordination, the cycle length, the green ratio, and the volume/capacity (v/c) ratio for a particular approach.

Levels of service are defined to represent reasonable ranges in control delay.

LOS A describes operations with low control delay, up to 10 sec/veh. This LOS occurs when signal coordination is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

LOS B describes operations with control delay greater than 10 and up to 20 sec/veh. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of delay.

LOS C describes operations with control delay greater than 20 and up to 35 sec/veh. These higher delays may result from only fair coordination, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. Cycle failure occurs when a given green phase does not serve queued vehicles, and overflows occur. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with control delay greater than 35 and up to 55 sec/veh. At LOS D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable coordination, long cycle lengths, and high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes operations with control delay greater than 55 and up to 80 sec/veh. These high delay values generally indicate poor coordination, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

LOS F describes operations with control delay in excess of 80 sec/veh. This level, considered unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of lane groups. It may also occur at high v/c ratios with many individual cycle failures. Poor signal corrdination and long cycle lengths may also contribute significantly to high delay levels.

Delays in the range of LOS F (unacceptable) can occur while the v/c ratio is below 1.0. Very high delays can occur at such v/c ratios when some combination of the following conditions exists: the cycle length is long, the lane group in question is disadvantaged by the signal timing (has a long red time), and the signal coordination for the subject movements is poor. The reverse is also possible (for a limited duration): a saturated lane group (i.e., v/c ratio grater than 1.0) may have low delays if the cycle length is short or the signal coordination is favorable, or both.

Thus, the designation LOS F does not automatically imply that the intersection, approach, or lane group is over capacity, nor does an LOS better than E automatically imply that unused capacity is available.

Source: *Highway Capacity Manual*; Transportation Research Board; National Research Council; 2000