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Memorandum

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From: Chris Rhodes, P.E.
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Date: December 4, 2009

Subject: Traffic Study (three intersections)
Tyne Boulevard / Granny White Pike
Tyne Boulevard / Lealand Lane
Tyne Boulevard / Franklin Pike
KHA Project Number: 118028000

This memorandum documents the traffic analysis performed at the intersections of Tyne Boulevard / Granny White Pike, Tyne Boulevard / Lealand Lane, and Tyne Boulevard / Franklin Pike in the City of Oak Hill, Tennessee. This study was performed to determine whether or not operational and/or geometric improvements are needed at each intersection to improve traffic conditions.

Traffic Data Collection

The first step of the analysis consisted of obtaining eight-hour turning movement counts (TMC) at the unsignalized intersections of Tyne Boulevard / Granny White Pike and Tyne Boulevard / Lealand Lane. This effort was performed by Kimley-Horn and Associates, Inc. (KHA) staff and Tennessee Transportation Assistance Program (TTAP) staff from the University of Tennessee on November 10, 2009 from 7:00 a.m. – 9:00 a.m., 11:00 a.m. – 1:00 p.m., and 2:00 p.m. – 6:00 p.m. A six-hour TMC was performed by KHA staff at the signalized intersection of Tyne Boulevard / Franklin Pike on November 12, 2009 from 7:00 a.m. – 9:00 a.m., 11:00 a.m. – 1:00 p.m., and 4:00 p.m. – 6:00 p.m. The TMCs can be found in **Attachment A** of this memorandum.

Level of Service Analysis

Levels of service (LOS) determinations were made for the weekday AM, MD, and PM peak hours at each of the study intersections using *Synchro*. This software uses methodologies contained in the *2000 Highway Capacity Manual (HCM)* to determine the operating characteristics of the proposed intersections. Level of service (LOS) is the industry standard used to describe the operating

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characteristics of a road segment or intersection in relation to its capacity. LOS is defined as a qualitative measure that describes operational conditions and motorists' perceptions within a traffic stream. The *HCM* defines six levels of service based on the average amount of delay incurred on a vehicle at a given intersection, LOS A through LOS F, with A being the best and F being the worst. Typically, a minimum goal for acceptable roadway service is LOS D, and a goal of LOS E is acceptable for left-turn and side street approaches at unsignalized intersections.

Intersection #1: Tyne Boulevard / Granny White Pike
Currently, the intersection of Tyne Boulevard / Granny White Pike operates as a four-way stop, with single-lane approaches for all directions. **Table 1** depicts the LOS results, the seconds of delay experienced per vehicle, and traffic volume to capacity ratios for the existing conditions at this intersection.

Table 1
Unsignalized Intersection Level of Service and Delay (seconds/vehicle) and Volume to Capacity Ratio [v/c]
Intersection of Tyne Boulevard / Granny White Pike

Weekday Peak Hour Scenario			
Vehicle Movement	**Existing 2009 Traffic Conditions**		
	AM Peak	**MD Peak**	**PM Peak**
Eastbound Approach:	F (104.8) [1.07]	B (10.1) [0.23]	E (40.4) [0.80]
Westbound Approach:	F (148.1) [1.20]	B (10.7) [0.28]	F (114.2) [1.13]
Northbound Approach:	F (232.5) [1.39]	B (12.7) [0.51]	F (157.4) [1.23]
Southbound Approach:	F (111.0) [1.08]	B (12.4) [0.47]	F (217.7) [1.36]

As summarized in **Table 1**, this intersection fails in most directions during both the AM and PM peak periods, but operates at acceptable levels of service during the mid-day (MD) peak period. Copies of each *Synchro HCM* capacity analysis can be found in **Attachment B** of this memorandum.

Traffic Signal Warrant Analysis
A traffic signal warrant analysis was performed based on the conditions set forth in the *Manual on Uniform Traffic Control Devices* (*MUTCD)*. The three traffic signal warrants relating to traffic volumes are Warrant 1 (Eight-Hour Vehicular Volume), Warrant 2 (Four-Hour Vehicular Volume), and Warrant 3 (Peak Hour). These warrants were the basis for the analysis of whether or not a traffic signal is necessary at the intersection of Tyne Boulevard / Granny White Pike.

Warrant 1 is the eight-hour vehicular volume warrant and contains two conditions, A and B. Condition A is the Minimum Vehicular Volume and Condition B is the Interruption of Continuous Traffic. A traffic signal is warranted if the criteria of either Condition A or Condition B are satisfied. If

neither condition is satisfied, the combination of 80 percent of Condition A and 80 percent of Condition B can be used in some cases to determine if a traffic signal is warranted. Warrant 2 is the four-hour vehicular volume warrant. A traffic signal is warranted if the criteria set forth in the *MUTCD* are met for at least four hours of the day. Warrant 3 is the peak-hour warrant. A traffic signal is warranted if the criteria set forth in the *MUTCD* are met during any one hour during the day. **Table 2** summarizes the results of the study.

Table 2
Warrant Analysis Summary
Tyne Boulevard / Granny White Pike

Warrant	Description	Hours Met	Warrant Met?
1A	Minimum Vehicular Volume (8-hour)	6	No
1B	Interruption of Continuous Traffic (8-hour)	2	No
1A	80% of Warrant 1A (8-hour)	6	No
1B	80% of Warrant 1B (8-hour)	6	
2	Four Hour Volume (4-hour)	5	Yes
3	Peak Hour Volume (1-hour)	2	Yes

As depicted above, this intersection meets the requirements for the 4-hour and 1-hour warrants (Warrants 2 and 3) and meets six of the eight hours for Warrant 1. Warrant 1 results indicate that the two hours not meeting the minimum volume requirements are close to meeting the warranting thresholds for the side street approach (Tyne Boulevard). The two hours from 11:00 a.m. – 1:00 p.m. for side street volumes are within approximately 10 – 20 percent (i.e. approximately 10-20 vehicles per hour) of meeting the minimum volume requirements; hence these two hours are approaching the warranting thresholds. Based on the results of this warrant analysis, a traffic signal is warranted at this intersection. A copy of the signal warrant analysis can be found in **Attachment C** of this memorandum.

In addition to the need for a traffic signal, the need for exclusive left-turn lanes were analyzed. Based on analyses using the Tennessee Department of Transportation's *Roadway Design Guidelines (August 2008)*, exclusive left-turn lanes are warranted on all approaches of the intersection, with the exception of the eastbound approach. However, an eastbound left-turn lane is recommended as well (as the widening needed for the westbound left-turn lane would introduce additional pavement width on the eastbound approach which would otherwise be marked out and wasted pavement if not marked as a left-turn lane). The results of this analysis can be found in **Attachment D** of this memorandum. With the installation of exclusive left-turn lanes on all approaches, the intersection still meets the 4-hour warrant (Warrant 2). A copy of the signal warrant analysis, including the left-turn lanes, can be found in **Attachment C** of this memorandum.

The installation of a traffic signal at the intersection of Tyne Boulevard / Granny White Pike with the addition of exclusive left-turn lanes on all approaches is

warranted and recommended. However, the installation of a traffic signal without left-turn lanes is not recommended as the traffic signal will only marginally reduce delay without having the ability to separate left-turning traffic from the through traffic streams on each approach.

Table 3 depicts the LOS results, average vehicle delay, and volume to capacity ratios if a traffic signal were installed at the intersection, with exclusive left-turn lanes on all approaches with permissive only left-turn signal phasing.

Table 3
Signalized Intersection Level of Service and Delay (seconds/vehicle) and Volume to Capacity Ratio [v/c]
Intersection of Tyne Boulevard / Granny White Pike

Weekday Peak Hour Scenario			
Vehicle Movement	**Existing 2009 Traffic Conditions**		
	AM Peak	**MD Peak**	**PM Peak**
Eastbound Left:	A (10.0) [0.33]	B (14.9) [0.09]	A (8.9) [0.16]
Eastbound Through/Right:	B (12.6) [0.63]	B (15.4) [0.21]	B (10.2) [0.47]
Eastbound Approach:	*B (12.1)*	*B (15.3)*	*B (10.0)*
Westbound Left:	B (11.1) [0.48]	B (15.5) [0.21]	B (10.4) [0.44]
Westbound Through/Right:	B (11.3) [0.56]	B (15.6) [0.25]	B (11.8) [0.59]
Westbound Approach:	*B (11.2)*	*B (15.5)*	*B (11.4)*
Northbound Left:	A (4.4) [0.04]	A (2.9) [0.04]	A (4.7) [0.12]
Northbound Through/Right:	A (7.0) [0.59]	A (3.5) [0.25]	A (6.1) [0.50]
Northbound Approach:	*A (6.9)*	*A (3.4)*	*A (6.0)*
Southbound Left:	A (4.8) [0.13]	A (3.0) [0.07]	A (5.6) [0.33]
Southbound Through/Right:	A (5.7) [0.42]	A (3.4) [0.22]	A (6.0) [0.48]
Southbound Approach:	*A (5.6)*	*A (3.3)*	*A (5.9)*
Overall Intersection:	***A (8.9) [0.60]***	***A (7.1) [0.25]***	***A (8.0) [0.54]***

With the installation of a traffic signal and exclusive left-turn lanes on all approaches, it is evident from the results presented in **Table 3** that the operation of the intersection significantly improves. The intersection would operate at acceptable levels of service for all movements on each approach during all peak periods of the day. Copies of each *Synchro HCM* capacity analysis can be found in **Attachment B** of this memorandum.

Roundabout Analysis
City of Oak Hill staff requested that KHA staff perform a roundabout analysis at the intersection of Tyne Boulevard / Granny White Pike. An initial analysis, using *Synchro*, has been performed. **Table 4** depicts the results of the roundabout analysis.

Table 4
Roundabout Volume to Capacity Ratio [v/c]
Intersection of Tyne Boulevard / Granny White Pike

Weekday Peak Hour Scenario			
Vehicle Movement	**Existing 2009 Traffic Conditions**		
	AM Peak	**MD Peak**	**PM Peak**
Eastbound Approach:	[0.55]	[0.14]	[0.46]
Westbound Approach:	[0.64]	[0.17]	[0.58]
Northbound Approach:	[0.65]	[0.32]	[0.59]
Southbound Approach:	[0.48]	[0.30]	[0.69]

Based on the results in **Table 4**, a roundabout could potentially operate at acceptable volume to capacity (v/c) ratios. However, prior to considering the installation of a roundabout at this location, there are factors outside of an operational analysis to be considered. Additional right-of-way acquisition and the costs associated with those acquisitions should be considered. Furthermore, a more detailed analysis utilizing software specifically designed for roundabout analysis should be performed as well to confirm the roundabout's capacity and potential operation. Copies of each *Synchro HCM* capacity analysis can be found in **Attachment B** of this memorandum. Further analysis will be required to determine if a roundabout is a feasible alternative to improve the operation of this intersection. KHA staff can perform this analysis, if desired by City of Oak Hill staff.

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Intersection #2: Tyne Boulevard / Lealand Lane
Currently, the intersection of Tyne Boulevard / Lealand Lane operates as a four-way stop, with single-lane approaches for all directions. **Table 5** depicts the LOS results, the seconds of delay experienced per vehicle, and traffic volume to capacity ratios for the existing conditions at this intersection.

Table 5
Unsignalized Intersection Level of Service and Delay (seconds/vehicle) and Volume to Capacity Ratio [v/c]
Intersection of Tyne Boulevard / Lealand Lane

Weekday Peak Hour Scenario			
Vehicle Movement	**Existing 2009 Traffic Conditions**		
	AM Peak	**MD Peak**	**PM Peak**
Eastbound Approach:	D (25.7) [0.75]	A (8.5) [0.22]	C (18.7) [0.68]
Westbound Approach:	F (80.2) [1.08]	A (8.6) [0.23]	B (14.7) [0.55]
Northbound Approach:	B (14.8) [0.40]	A (8.0) [0.06]	B (10.8) [0.23]
Southbound Approach:	C (17.0) [0.53]	A (8.1) [0.11]	B (14.3) [0.50]

As summarized in **Table 5**, this intersection operates at an acceptable LOS during all peaks of the day in most directions. However, the westbound approach during the AM peak operates at failing conditions, which is not an uncommon occurrence for stop-controlled intersections during peak hours. Copies of each *Synchro HCM* capacity analysis can be found in **Attachment B** of this memorandum.

Traffic Signal Warrant Analysis
A traffic signal warrant analysis was performed based on the conditions set forth in the *MUTCD*. The three traffic signal warrants relating to traffic volumes are Warrant 1 (Eight-Hour Vehicular Volume), Warrant 2 (Four-Hour Vehicular Volume), and Warrant 3 (Peak Hour). These warrants were the basis for the analysis of whether or not a traffic signal is necessary at the Tyne Boulevard / Lealand Lane. **Table 6** summarizes the results of the traffic signal warrant study at this intersection.

Table 6 Warrant Analysis Summary Tyne Boulevard / Lealand Lane			
Warrant	**Description**	**Hours Met**	**Warrant Met?**
1A	Minimum Vehicular Volume (8-hour)	2	No
1B	Interruption of Continuous Traffic (8-hour)	1	No
1A	80% of Warrant 1A (8-hour)	4	No
1B	80% of Warrant 1B (8-hour)	1	
2	Four Hour Volume (4-hour)	1	No
3	Peak Hour Volume (1-hour)	0	No

Based on this analysis, a traffic signal is not warranted at the intersection of Tyne Boulevard / Lealand Lane in the City of Oak Hill, Tennessee. A copy of the signal warrant analysis can be found in **Attachment C** of this memorandum.

Multi-way Stop Analysis

In addition to performing a signal warrant analysis, KHA staff analyzed whether or not a multi-way stop at the intersection of Tyne Boulevard / Lealand Lane is warranted. According to conditions set forth in the *MUTCD*, the intersection does not warrant a multi-way stop, unless there is a historical crash-problem, which KHA staff did not investigate. Conversion to two-way stop control with Tyne Boulevard changing to free flow movements and maintaining stop control on Lealand Lane could be implemented, if desired, by City staff as traffic volumes do support two-way stop control. However, if the multi-way stop control is functioning satisfactorily and the City is not receiving public complaints, then maintaining multi-way stop control is feasible.

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Intersection #3: Tyne Boulevard / Franklin Pike

Currently, the intersection of Tyne Boulevard / Franklin Pike operates as a signalized intersection running in free operation. City of Oak Hill staff requested that KHA staff analyze whether or not installing an additional eastbound lane would improve the operation of the signal. Based upon a review of the traffic volumes, the installation of an exclusive right-turn lane could improve operations on the eastbound approach, thereby improving the operation of the overall intersection. The analysis was performed using *Synchro* with the existing laneage at the intersection, as well as with a proposed eastbound exclusive right-turn lane. **Table 7** depicts the existing and proposed LOS results for this intersection.

Table 7
Signalized Intersection Level of Service and Delay (seconds/vehicle) and Volume to Capacity Ratio [v/c]
Intersection of Tyne Boulevard / Franklin Pike

Weekday Peak Hour Scenario						
Vehicle Movement	**Existing Conditions**			**Proposed Conditions (Add EB Right-turn Lane)**		
	AM Peak	**MD Peak**	**PM Peak**	**AM Peak**	**MD Peak**	**PM Peak**
Eastbound Left/Through/Right:	F (88.3) [1.05]	C (30.7) [0.51]	F (140.3) [1.20]	--	--	--
Eastbound Left/Through:	--	--	--	D (42.7) [0.76]	C (34.6) [0.42]	D (42.2) [0.78]
Eastbound Right:	--	--	--	C (27.1) [0.15]	C (31.6) [0.07]	C (26.8) [0.22]
Eastbound Approach:	*F (88.3)*	*C (30.7)*	*F (140.3)*	*C (34.0)*	*C (33.0)*	*D (33.3)*
Westbound Left/ Through:	D (35.4) [0.32]	D (35.7) [0.07]	D (36.6) [0.08]	D (35.4) [0.32]	D (38.6) [0.07]	D (36.4) [0.08]
Westbound Right:	C (32.1) [0.00]	C (34.9) [0.00]	--[1]	C (32.1) [0.00]	D (37.8) [0.00]	--[1]
Westbound Approach:	*C (35.0)*	*D (35.3)*	*D (36.6)*	*C (35.0)*	*D (38.2)*	*D (36.4)*
Northbound Left/Through:	D (36.8) [0.92]	A (5.1) [0.14]	B (13.1) [0.43]	B (14.9) [0.78]	A (4.1) [0.13]	B (10.5) [0.43]
Northbound Through/Right:	C (26.9) [0.91]	A (6.4) [0.32]	B (11.9) [0.50]	B (15.7) [0.81]	A (5.1) [0.30]	A (8.4) [0.44]
Northbound Approach:	*C (29.9)*	*A (6.2)*	*B (12.1)*	*B (15.4)*	*A (5.0)*	*A (8.8)*
Southbound Left/Through & Southbound Through/Right:	C (21.7) [0.60]	B (11.5) [0.28]	C (31.3) [0.89]	B (18.5) [0.53]	B (10.0) [0.25]	C (20.6) [0.75]
Southbound Approach:	*C (21.7)*	*B (11.5)*	*C (31.3)*	*B (18.5)*	*B (10.0)*	*C (20.6)*
Overall Intersection:	***D (37.5) [0.92]***	***B (12.8) [0.35]***	***D (51.8) [0.91]***	***B (19.7) [0.77]***	***B (12.0) [0.30]***	***C (20.4) [0.70]***

[1] During the PM peak hour, the westbound right-turn traffic volume was zero; therefore, LOS, delay, and v/c ratios are not applicable.

Based on the results in **Table 7**, it is evident that installing an exclusive right-turn lane for the eastbound approach would improve the operation of the signalized intersection at Tyne Boulevard / Franklin Pike, especially during the AM and PM peak periods. The eastbound approach delay is significantly decreased, as well as the volume to capacity ratios. The installation of an eastbound exclusive right-turn lane is recommended at this intersection. Copies of each *Synchro HCM* capacity analysis can be found in **Attachment B** of this memorandum.

Conclusions

As discussed above, two of the three intersections analyzed warrant either geometric improvements, operational improvements, or both (as is the case for Tyne Boulevard / Granny White Pike). We plan to sit down and discuss each of these intersections with you and your staff during the next meeting with staff. Copies of all data collection and analysis performed at each of the intersections are included as attachments to this memorandum. If there are questions prior to the staff meeting, please do not hesitate to call.

Attachments: A: Turning Movement Counts
B: *Synchro* HCM Capacity Analysis Output
C: *MUTCD* Traffic Signal Warrant Analysis
D: Warrant for Left-Turn Storage Lanes Figures

c: File