CBB Crawford, Bunte, Brammeier
Traffic and Transportation Engineers

Since 1973

MEMORANDUM

Date: August 16, 2006

To: Mr. Pat Kelly
City Administrator
Village of Twin Oaks
1190 Meramec Station Rd.
Suite 204
Twin Oaks, Missouri 63021

From: Lee Cannon, P.E., PTOE

Project: CBB Job No. 162-06
Autumn Leaf Drive at Boly Lane Traffic Calming Study
Village of Twin Oaks, Missouri

In accordance with your request, Crawford, Bunte, Brammeier has completed a traffic engineering assessment related to traffic operations along Autumn Leaf Drive near Boly Lane in the Village of Twin Oaks, Missouri. It is our understanding that a few vehicles have left the roadway traveling northbound on Autumn Leaf Drive at the turn to the west near Boly Lane, and local residents are concerned about the safety and operations of the road and intersection. You indicated that several residents have requested the installation of speed bumps on Autumn Leaf Drive to control travel speeds.

The purpose of this assessment was to review the location and provide recommendations for improvement, as deemed appropriate by our experience in dealing with similar traffic situations. As part of our evaluation, the advantages and disadvantages of several alternative traffic calming measures, safety device installations and/or traffic control modifications including the residents' request for speed bumps were considered. It should be acknowledged that this assessment does not represent a detailed traffic operations and safety study, but rather an abbreviated evaluation of an appropriate roadway and intersection configuration. The Village of Twin Oaks has provided crash history reports and speed data for Autumn Leaf Drive obtained from the Saint Louis County Police Department who provides police services under contract.

All recommendations in this assessment are intended to be compliant with the Manual on Uniform Traffic Control Devices (MUTCD) last updated in 2003 by the US Department of Transportation Federal Highway Administration. The MUTCD is the standard engineering reference and rule of law for design use and placement of all traffic control devices on public roads including regulatory and warning signs, object markers, and pavement markings.

450 Cottonwood Road - Suite B
Glen Carbon, IL 62034
(T) 618-656-2612 (F) 618-659-0650

1830 Craig Park Court - Suite 209
St. Louis, MO 63146
(T) 314-878-6644 (F) 314-878-5876
www.cbbtraffic.com

3261 S. Meadowbrook Road – Suite 300
Springfield, IL 62711
(T) 217-546-6433 (F) 217-546-6467

Statement of the Problem

As stated above, we understand that a few vehicles have left the roadway traveling northbound on Autumn Leaf Drive at the turn to the west near Boly Lane, and local residents are concerned about the safety and operations of the road and intersection. In fact, several residents have requested the installation of speed bumps on Autumn Leaf Drive presumably to control travel speeds.

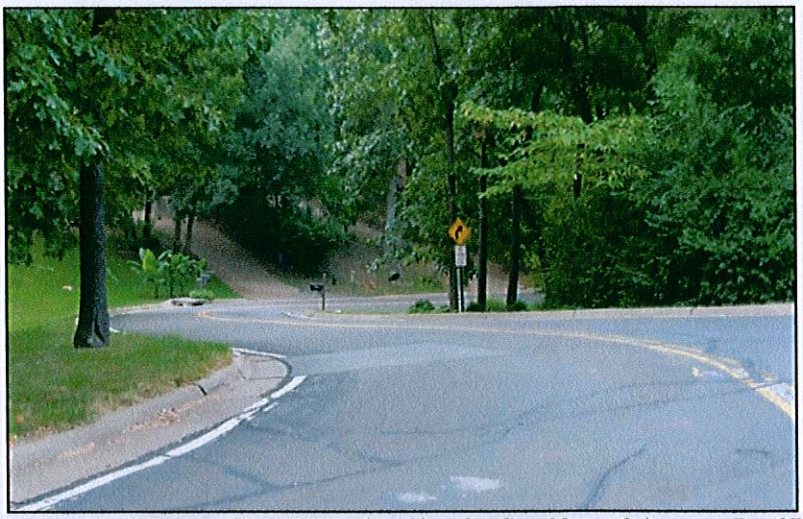
Existing Roadway Conditions

Boly Lane and Autumn Leaf Drive are two-lane residential streets that provide access to 41 single-family homes and 78 condominium units south of Big Bend Road with a posted speed limit of 20 miles per hour (mph) and "no outlet" posted. Boly Lane and Autumn Leaf Drive have on-street parking restrictions along the entire west side of each road and on both sides of both roads through and adjacent to the two turns in Autumn Leaf Drive. Boly Lane also has on-street parking restricted on the east side near Big Bend Road.

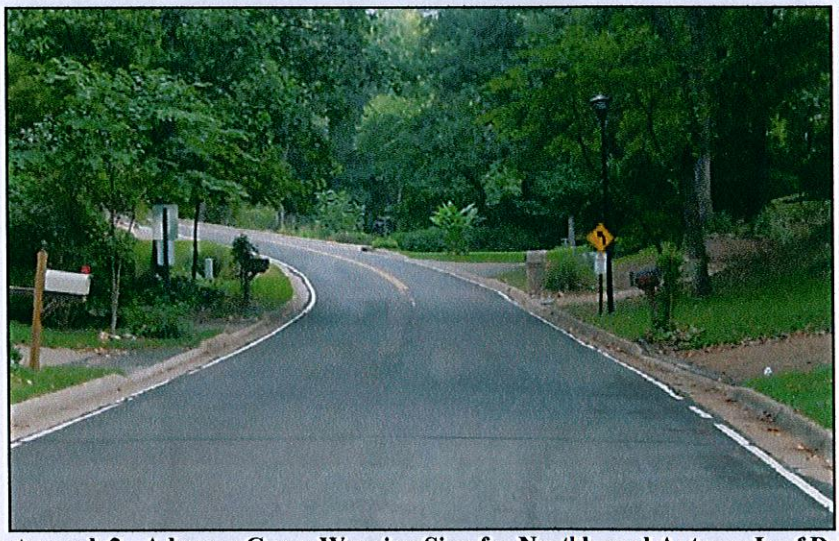
North of Autumn Leaf Drive, Boly Lane is generally 24-feet wide and has white painted edgelines with rolled curb and gutter. South of Autumn Leaf Drive, the pavement width is generally 20-foot wide with white painted edgelines, but has vertical curbs and gutters. Approximately 10 single-family homes have access to Boly Lane north of Autumn Leaf Drive and 7 single-family homes and a pet cemetery have access to Boly Lane south of Autumn Leaf Drive.

A two-way stop is posted with painted stop bars for the northbound and southbound approaches of Boly Lane at the intersection with Autumn Leaf Drive. A double-yellow, centerline pavement marking is painted near the southbound stop bar on Boly Lane and extends along Autumn Leaf Drive down the hill and through the turn indicating the "preference route" for traffic between the north leg of Boly Lane and the southeast leg of Autumn Leaf Drive. Vertical curb and gutter are present along the entire length of Autumn Leaf Drive. White reflectors are installed on top of the curb for motorists traveling northwest up Autumn Leaf Drive to Boly Lane. The reflectors begin near the drainage inlet at 1406 Autumn Leaf Drive and end near the top of the hill at Boly Lane. Approximately 24 single-family homes and 78 condominium units have access via Autumn Leaf Drive, south of Boly Lane. All traffic on Boly Lane and Autumn Leaf Drive is presumably generated by the residents and their visitors since no alternate routes or access connections are provided.

Advance curve warning signs are posted on Autumn Leaf Drive just east of Boly Lane (on the downhill slope as shown in Photograph 1) for the southbound motorists and at the bottom of the hill for northbound motorists, see Photograph 2. No parking sign are also currently mounted below the curve warning sign assemblies. The size of both advance curve warning signs do meet MUTCD minimum size requirements (24 inches), but 30 inch signs are suggested on conventional roads for better visibility. Furthermore, the alignment of Autumn Leaf Drive dictates the use of a slightly different warning sign, the reverse turn type MUTCD W1-3, Left 30 inches.



Photograph 1 - Advance Curve Warning Sign for Southbound Autumn Leaf Drive



Photograph 2 - Advance Curve Warning Sign for Northbound Autumn Leaf Drive

Field Observations

The intersection of Boly Lane and Autumn Leaf Drive is awkward since the northbound and southbound Boly Lane approaches are required to stop while the northbound Autumn Leaf Drive approach (up the hill) is free-flow. Due to the higher traffic volumes using Autumn Leaf Drive and the steep grade of the approach (approximately 15%), it is understandable that westbound Autumn Leaf Drive is allowed to flow free up and around the turn. If westbound Autumn Leaf Drive were required to stop, rollbacks and start-up slippage under slick pavements conditions would likely result. The double yellow centerline and white edgeline pavement markings through the reverse turn as well as the reflectors along the northern curb provide guidance for vehicles through the turn. It was also noted that the northbound stop sign is severely faded and should be replaced (MUTCD R1-1, 30 inches).

More advance warning signs could be provided for motorist traveling southbound on Boly Lane to the southeast on Autumn Leaf Drive to indicate the reverse turn and preference route. An advance curve warning sign is posted, but it is not located far enough in advance of the turn. More appropriate signing is discussed later in this report.

Vegetation restricts the sight distance in the northeast quadrant of the intersection of Boly Lane and Autumn Leaf Drive. The vegetation could be removed to obtain adequate sight distance between the south and west approaches. However, the small number of northbound vehicles that uses Boly Lane south of Autumn Leaf Drive on a daily basis (7 homes) can creep past the stop bar into the intersection to obtain better sight distance to the west (down the hill), which is marginally acceptable due to the fact that the southbound approach of Boly Lane must also stop at the intersection.

Speed Data and Traffic Volume

The Village of Twin Oaks provided CBB with results from a speed survey that was conducted on Autumn Leaf Drive from Monday, June 23, 2003 to Thursday, June 26, 2003. Radar equipment was set up to track traffic traveling up the hill and down the hill from 2:00 p.m. to 10:00 a.m. each day. A computer recorded speed data, number of vehicles, average speed, and maximum speed. It should be noted that the minimum speed that the radar was set-up to record was 20 mph, so any vehicles traveling less than 20 mph were not indicated in the survey.

Table 1 averages the three days of speed data provided from St. Louis County. Based on the data provided, only 15% of the downhill vehicles recorded reached speeds of more than 24.5 mph and 15% of the uphill vehicles recorded reached speeds greater than 27 mph. A maximum speed of 36 mph was recorded for uphill vehicles with a maximum of 32 mph for downhill vehicles. It should be reiterated that the radar study did not include vehicles traveling less than 20 mph (the posted speed limit); therefore, the total volume and the average and 85th percentile speeds listed below only include the vehicles exceeding the posted speed limit (20 mph).

Table 1 - Speed and Volume Data from St. Louis County Radar Study
Three Day Average (2 p.m. to 10 a.m.)
Village of Twin Oaks, Missouri

Direction of Travel on Autumn Leaf Drive	*Total Vehicles Recorded*	*Average Speed**	*85th Percentile**	*Maximum Speed**
Uphill (Westbound)	214	23.1	27	36
Downhill (Eastbound)	190	22.1	24.5	32
Both Directions (Total)	404	22.6	25.8	36

* Minimum speed to record was set at 20 mph (posted speed limit)

It should be noted that speed limits of 25 mph or less are generally reserved for local streets only. It is difficult to travel under 25 mph and also generally difficult to enforce, except within school zones. The significant grade further impacts the ability to maintain a low speed, specifically for southbound motorists. While CBB is not recommending that the speed limit be increased, we would not suggest that the speed limit for the entire road be lowered beyond the existing 20 mph. Consequently, advisory speeds for the reverse turn may be lower than 20 mph and is investigated in further detail below.

The number of trips using Boly Lane and Autumn Leaf Drive was estimated using data provided in the Trip Generation Manual, 7th Edition, published by the Institute of Transportation Engineers (ITE). This nationally accepted manual considers the number of single family homes and condominiums to estimate the trips on a daily and peak hour basis. Table 2 summarizes the trip generation forecast. To validate the forecasted traffic, a 30-minute spot count was performed at the intersection of Boly Lane with Autumn Leaf Drive. Those counts indicate that traffic on Autumn Leaf Drive was slightly lower than the estimates in Table 2, which are based on the national averages.

Table 2
Trip Generation Estimate
Village of Twin Oaks, Missouri

Location	*No. Units*	*Total Daily Trips*	*AM Peak Hour*			*PM Peak Hour*		
			In	*Out*	*Total*	*In*	*Out*	*Total*
Boly Lane North of Autumn Leaf Drive	11 Single-Family Homes	105	2	6	8	7	4	11
Boly Lane South of Autumn Leaf Drive	7 Single-Family Homes	65	2	4	6	5	3	8
Autumn Leaf Drive South of Boly Lane	24 Single-Family Homes 78 Condominium	690	10	42	52	42	22	64
Total		860	14	52	66	54	29	83

Considering the 690 daily trips expected along Autumn Leaf Drive (west of Boly Lane), the 20-foot width of the roadway is adequate to safely accommodate those volumes. The residential trips along Autumn Leaf Drive represent approximately one to one and a half vehicles every minute on average during the peak hours.

Review of Incident Reports

The Village of Twin Oaks provided four incident reports for Autumn Leaf Drive from 2003 to 2006. All four incidents reported were single-vehicle type with property damage only and no fatalities or injury. All incidents reported occurred during the night hours (darkness). Three of the four reports involved vehicles traveling northbound on Autumn Leaf Drive (up the hill) and leaving the roadway to the outside of the first turn before reaching Boly Lane. One report involved a southbound motorist on Autumn Leaf Drive (traveling downhill) scraping the curb and leaving the road. One incident involved a minor under the influence of alcohol.

Based on the review of incident report data, it appears that vehicles are not following the road around the turn and leaving the roadway. This could be a result of poor visibility of the turns and/or warning signs and/or their traveling too fast for the geometric conditions of the road. It appears that improved awareness of the turn (through signing and/or lighting) in combination with lower advisory travel speeds would be very advantageous. Based on the address of the drives listed on the incident reports, it would appear that all four of the incidents involved visitors to the residents south on Autumn Leaf Drive.

Traffic Control Alternatives and Recommendations

It is our understanding that some residents have request that speed bumps be placed along Autumn Leaf Drive to control traffic speeds. Speed Bumps can accomplish their goal of encouraging vehicles to proceed at or below the posted speed limit (usually around 20 mph) at a specific location, but may not reduce overall travel speeds on the roads. Although they provide a low-cost alternative, traffic engineers typically do not favor the use of speed bumps as they are often considered an unacceptable hazard and inconvenience to motorists. They interfere with snow plow operations and emergency vehicle passage. They are difficult to construct accurately as the height and curvature of the bump greatly affect its performance. Research has shown that speed bumps produce the greatest driver discomfort at low speeds; at higher speeds the vehicle suspension is able to absorb much of the impact before the body of the automobile reacts. Speed bumps are now installed predominantly in parking lots where vehicles travel at speeds of 20 mph or less. Furthermore, vehicles that must slow down to cross the speed bumps often accelerate after or between the bumps to make up time.

Based on our evaluation of the incident data and inspection of the roadway conditions, it is our opinion that speed bumps would not be an optimal solution for the problem identified (vehicles leaving the roadway due to lock of awareness of the reverse turn and/or vehicle speeds too high for conditions). Instead, improving the advance warning signs and enhancing the delineation along the turn is preferable to address the problem identified. Several alternatives are identified below that give consideration to implementation timeframe and cost to construct and operate each improvement.

It is recommended that the Village carefully consider the recommendations outlined below and involve the residents of these streets in the process. Regarding traffic calming measures, safety devises, and warning signs a stepwise approach should be employed, beginning with the least expensive and restrictive of the measures, so as to avoid unnecessary expense and impacts that may potentially be perceived as negative by neighbors.

Short Time Frame and Low Cost Improvement Alternatives

1. Re-paint double yellow centerline and white edgelines around the Autumn Leaf Drive reverse turn. It is recommended that the double yellow centerline and white edgelines be repainted and consist of a highly reflective paint (glass/reflex beads or similar) to assist in clear visibility. Wider edgelines and raised pavement markers could provide for increased delineation of the driving path and enhance the ability of the driver to track the roadway, particularly under nighttime, wet-weather, or adverse-weather conditions. It is also recommended that the centerline be extended more into the straight section of the road. This allows a motorist to more clearly recognize that the straight road is turning. An additional 50 to 100 feet north and south of the existing centerline terminus should provide improved delineation. These markings should be re-painted on a routine basis as it becomes worn on the street surface over time.

2. Remove the existing advance curve warning signs as shown in Photographs 1 and 2. The sign assembly shown to the right should be installed approximately 100 feet prior to the beginning of the double yellow centerline on each end. Based on the "preference route" as the movements between Boly Lane north and Autumn Leaf Drive, a reverse turn sign (W1-3 Left, 30 inch) with minor road sign should be installed with an advisory speed plaque (W13-1, 10 mph). The height of the advisory sign should be mounted at least six feet above the level of the nearest level pavement edge. A ball-bank test was performed on Autumn Leaf Drive, and it was determined that <u>the advisory speed should be posted at 10 mph</u>. It should also be noted that 'no parking' signs shall not be attached to this warning signs assembly shown to the right; therefore, additional posts may be necessary to post the parking restrictions.

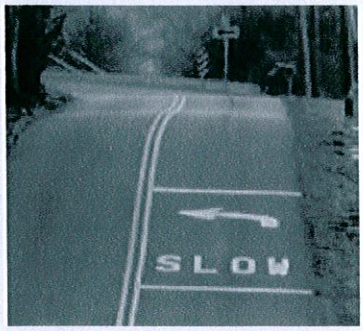
3. To further advise motorists of the exact location of the turns, large arrow signs (W1-6) could be placed on the outsides of the turns (near the drainage inlet for down the hill and between the stop sign and driveway for motorists up the hill) and at a right angle to approaching traffic. The bottom of this sign should be mounted seven feet above the level of the nearest pavement edge.

W1-6

4. Chevrons (W1-8) could be placed around the <u>outside</u> of the turn in addition to or in lieu of the large arrow signs to guide motorists around the turns. Signs could be placed on both sides of one post to guide vehicles both uphill and downhill through the curve. The bottom of this sign should be mounted seven feet above the level of the nearest pavement edge.

W1-8

5. A non-traditional treatment may provide the most distinct reaction from a road user, especially those visitors that may not be aware of the sharp turns ahead. Pavement markings such as a large turning arrow coupled with the word slow and/or the advisory speed recommendation and perpendicular white lines would help to get the attention of motorists. In general, these non-traditional pavement marking treatments have reduced both speeds and crashes at horizontal curves in test cases conducted by a few agencies.[1] CBB would only recommend this treatment as a supplement to the standard warning signs recommended above.



[1] National Cooperative Highway Research Board Program Report 500; Guidance for implementation of the AASHTO Strategic Highway Safety Plan; Volume 7: A Guide for Reducing Collisions on Horizontal Curves

Medium Time Frame and Moderate Cost Improvement Alternatives

Many of the following improvements could be cost prohibitive. First, the Village should consider the signing and marking improvements described above. If incident continue, the village may wish to pursue one or more of the following strategies:

- Provide lighting around the turns

Lighting is expected to improve visibility at the turn, but has moderately construction costs. Roadside lighting also has a continual operating cost. The lighting posts should be located in the least hazardous location to avoid injury to a motorist if their vehicle were to leave the road and still provide adequate lighting of the location. If lighting is installed break-away poles should be considered with placement of the insides of the turns, if possible.

- Provide guardrail along the northeast curve

A guardrail will keep vehicles from leaving the roadway, but increases the probability of causing injuries to the driver. In addition, a guardrail may not be considered aesthetically pleasing, especially in residential neighborhood and especially by the homeowners adjacent to the installation.

- Provide skid-resistant pavement surfaces

Skid resistant pavement surfaces may allow a vehicle to slow down quicker and avoid leaving the roadway. This is a potentially expensive solution that may or may not reduce the number of incidents at this location.

- Provide grooved pavement.

Grooved pavement would alert a motorist if crossing the edgeline or centerline and potentially help obtain/regain control in wet-weather conditions. This alternative would be expensive to implement and the incident data did not specifically indicate a problem with wet-weather conditions.

Long Time Frame and High Cost Improvement Alternatives

If no other alternative proves effective, the horizontal alignment and vertical curvature of Autumn Leaf Drive could be modified to reduce the horizontal and vertical curvature. However, it is highly likely that an improvement of this scale is not financially feasible or practical based on the existing location of residential homes and to the low number and low severity of the single-vehicle incidents leaving the road.

Conclusion and Findings

Based on the review of incident report data, it appears that vehicles are not following the road around the turn and leaving the roadway. This could be a result of poor visibility of the turns and/or warning signs and/or their traveling too fast for the geometric conditions of the road. It appears that improved awareness of the turn (through signing and/or lighting) in combination with lower advisory travel speeds would be very advantageous.

Based on our evaluation of the incident data and inspection of the roadway conditions, it is our opinion that speed bumps would not be an optimal solution for the problem identified (vehicles leaving the roadway due to lock of awareness of the reverse turn and/or vehicle speeds too high for conditions). Instead, improving the advance warning signs and enhancing the delineation along the turn is preferable to address the problem identified. Several alternatives are identified below that give consideration to implementation timeframe and cost to construct and operate each improvement.

1. Re-paint the double yellow centerline and white edgelines around the Autumn Leaf Drive reverse turn with a highly reflective paint (glass/reflex beads or similar)

2. Remove the existing advance curve warning signs as shown in Photographs 1 and 2 and install reverse turn signs (W1-3 Left, 30 inch) with minor road sign should be installed with an advisory speed plaque of 10 mph (W13-1, 10 mph) .

3. Large arrow signs (W1-6) could be placed on the outsides of the turns (near the drainage inlet for down the hill and between the stop sign and driveway for motorists up the hill) and at a right angle to approaching traffic.

4. Chevrons (W1-8) could be placed around the outside of the turn in addition to or in lieu of the large arrow signs to guide motorists around the turns.

5. Non-traditional treatment such as a large turning arrow coupled with the word slow and/or the advisory speed recommendation and perpendicular white line pavement markings would help to get the attention of motorists. CBB would only recommend this treatment as a supplement to the standard warning signs recommended above.

It is recommended that the Village carefully consider the recommendations outlined above and involve the residents of these local streets in the process. Regarding traffic calming measures, traffic safety devices and earning signs, a stepwise approach should be employed, beginning with the least expensive and restrictive of the measures, so as to avoid unnecessary expense and impacts.

I hope that you will find this information useful in assessing the traffic concerns on Autumn Leaf Drive within the Village of Twin Oaks. Please contact our office should you have any questions.

Sincerely,

Lee Cannon

Lee Cannon, P.E.
Associate

RLC:bjr