STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

CAROLANN WICKS, P.E.
SECRETARY

March 4, 2010

Ms. Sarah Keifer
Director of Planning
Department of Planning Services
Kent County Administrative Complex
555 Bay Road
Dover, DE 19901

Dear Ms. Keifer:

The attached Traffic Impact Study (TIS) review letter for the **Twin Willows Shopping Center** development has been completed under the responsible charge of a registered professional engineer whose firm is authorized to work in the State of Delaware. They have found the TIS to conform to DelDOT's Rules and Regulations for Subdivision Streets and other accepted practices and procedures for such studies. DelDOT accepts this TIS review and concurs with the recommendations. We are providing it to you in fulfillment of our joint agreement regarding the review of TIS. If you have any questions concerning this letter or the attached review letter, please contact me at (302) 760-2134.

Sincerely,

Todd Sammons
Project Engineer

TS:tsm
Enclosures
cc with enclosures: DelDOT Distribution
Ms. Constance C. Holland, Office of State Planning Coordination
Mr. Mark Keeley, Traffic Concepts, Inc.
Mr. Mir Wahed, Johnson, Mirmiran, & Thompson
Mr. Andrew Parker, McCormick Taylor
Mr. Brad Herb, Johnson, Mirmiran & Thompson

DelDOT

DelDOT Distribution

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Lisa Collins, Service Development Planner, Delaware Transit Corporation
Marc Coté, Subdivision Engineer, Development Coordination
T. William Brockenbrough, Jr., County Coordinator, Development Coordination
Julio Seneus, Subdivision Manager, Development Coordination
Anthony Aglio, Bicycle Coordinator, Statewide & Regional Planning
Troy Brestel, Project Engineer, Development Coordination

JOHNSON, MIRMIRAN & THOMPSON
Engineering A Brighter Future®

March 4, 2010

Mr. Todd Sammons, P.E.
Project Engineer
DelDOT Division of Planning
P O Box 778
Dover, DE 19903

RE: Agreement No. 1406
Traffic Impact Study Services
Task 225A-Twin Willows Shopping Center

Dear Mr. Sammons:

Johnson, Mirmiran and Thompson (JMT) has completed the review of the Traffic Impact Study for the Twin Willows Shopping Center, prepared by Traffic Concepts, Inc. dated November, 2009. This review was assigned Task Number 225A. Traffic Concepts, Inc. prepared the report in a manner generally consistent with DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*.

The TIS evaluates the impacts of the Twin Willows Shopping Center, which is proposed on the southeast corner of the intersection of US Route 13 (DuPont Highway/Kent Road 2) and Twin Willows Road (Kent Road 84) in Kent County. The development would consist of a 10,100 square foot shopping center and a 1,800 square foot fast-food restaurant on an approximately 1.68 acre assemblage of parcels. The parcels are currently zoned BG (General Business) and will be developed under the same zoning. The developer is proposing one full access point on Twin Willows Road. Construction is anticipated to be completed by 2011.

Section 5.3.k.2 of the Kent County Adequate Public Facilities Ordinance (APFO) states: "The specific traffic mitigation measures shall be chosen based on their ability to reduce the impact of traffic generated by the proposed subdivision or land development, in order to achieve and maintain the Level of Service standards for a minimum of two (2) years for roadway segments and intersections within the area of influence." Based on an April 14, 2008 meeting between DelDOT and Kent County Planning regarding the interpretation of the APFO, JMT has been instructed to perform the future two-year Level of Service maintenance analysis, for a date two years from when construction of the development is anticipated to be complete. The two-year Level of Service maintenance analysis results (referred to as Case 4) are contained in this final TIS letter.

DelDOT currently has one relevant project in the study area. DelDOT completed the US Route 13 Corridor Access study between the Delaware Route 1 ramps in Smyrna and Scarborough Road (Kent Road 294) in Dover in August 2004. The primary objective of the study was to determine the optimal locations of new traffic signals along US Route 13 between Dover and Smyrna. This would allow US Route 13 to function as a coordinated arterial and facilitate

platoon progression along the corridor. The study also evaluated additional capacity improvements that would be required to provide acceptable operating conditions along the US Route 13 corridor. The order of improvements are likely to be dictated by the location and order of future developments along the corridor. The study also noted that significant efforts should be made to provide access to new developments onto existing side streets (particularly those expected to be signalized) rather than creating any new access points along US Route 13. As per the results of this study, the proposed traffic signals within the Twin Willows Shopping Center TIS study area include the intersections of US Route 13/Twin Willows Road, US Route 13/Hickory Ridge Road and US Route 13/North Messina Hill Road.

Some of study area intersections were evaluated under DelDOT's 2005 Hazard Elimination Program (HEP f.k.a. HSIP) as part of the Site P and Site R studies. Site P included a 1.69 mile section of US Route 13 from Big Woods Road (Kent Road 448) to 0.28 miles south of Smyrna-Leipsic Road (Kent Road 12). It included the signalized intersection of US Route 13 and Brenford Road/Big Oak Road (Kent Road 42) and the intersection of US Route 13 at Carter Road (Kent Road 137) which was unsignalized at the time of the study. The report noted that a future traffic signal was planned at the intersection of US Route 13 and Carter Road to accommodate the proposed development traffic. This intersection was signalized in February 2008.

Site R included a 0.89 mile section of US Route 13 from 300 feet south of North Messina Hill Road (Kent Road 102) to 300 feet south of Twin Willows Road. In addition to the intersections along US Route 13, the HEP report also studied the geometric deficiencies on US Route 13 related to the curve north of Messina Hill Road. The improvements suggested by the study included the installation of a stop line on eastbound Hickory Ridge Road; the installation of reflectors along the guardrail and the concrete barrier located within the US Route 13 curve north of Messina Hill Road; and the installation of raised pavement markers along northbound and southbound US Route 13 on the approaches to the curve. The HEP report also noted that the level of development proposed along the US Route 13 corridor from Scarborough Road to the Town of Smyrna would continue to change the character of the area. All the recommended improvements from the HEP report have been implemented.

Additionally, developer-funded improvements are currently planned at the intersection of US Route 13 and Brenford Road/Big Oak Road. The improvements include widening the eastbound Brenford Road approach to one left-turn lane, one shared through/left-turn lane and one right-turn lane. The westbound Big Oak Road approach is expected to maintain the current configuration with one shared left-turn/through/right-turn lane due to physical constraints on both sides of the roadway. The developer of the Big Oak Commons development is taking the lead for this project and at least ten other developments are participating in this improvement. In addition, several other developments with site frontage along Brenford Road are expected to improve Brenford Road from east of Massey Millpond Road (Kent Road 148) to US Route 13 in order to meet collector road standards.

Based on our review, we have the following comments and recommendations:

The following intersections exhibit level of service (LOS) deficiencies without the implementation of physical roadway and/or traffic control improvements.

Intersection	***Situations for which deficiencies occur***
US Route 13 and Twin Willows Road	2011 PM and Saturday with and without Twin Willows Shopping Center (Cases 2 and 3), 2013 PM and Saturday with Twin Willows Shopping Center (Case 4)
US Route 13 and Brenford Road/Big Oak Road	2011 PM and Saturday with and without Twin Willows Shopping Center (Cases 2 and 3), 2013 PM and Saturday with Twin Willows Shopping Center (Case 4)
US Route 13 and Hickory Ridge Road	2009 Existing PM (Case 1), 2011 PM and Saturday with and without Twin Willows Shopping Center (Cases 2 and 3), 2013 PM and Saturday with Twin Willows Shopping Center (Case 4)
US Route 13 and North Messina Hill Road	2009 Existing PM (Case 1), 2011 PM with and without Twin Willows Shopping Center (Cases 2 and 3), 2013 PM with Twin Willows Shopping Center (Case 4)

The intersection of US Route 13 and Twin Willows Road would exhibit LOS deficiencies under future conditions even without the development of the Twin Willows Shopping Center. The LOS deficiencies in future conditions would occur on the Twin Willows Road approach. The 95th percentile queue length on the approach during the typical peak hours is expected to be about 375 feet in the PM and 325 feet in the Saturday peak hours, which would extend past the proposed site entrance. To address the LOS deficiency at this intersection we recommend signalizing the intersection of US Route 13 and Twin Willows Road and installing a separate right-turn lane on the westbound Twin Willows Road approach. Also, as discussed earlier, this intersection is recognized as a future signal location in the US Route 13 Corridor Access study. We recommend that this developer fund an equitable portion of the signal improvements at this intersection.

The intersection of US Route 13 and Brenford Road/Big Oak Road exhibits LOS deficiencies under all future conditions. However, as discussed earlier, these LOS deficiencies will be addressed as part of a planned developer-funded project which includes intersection geometric improvements. With the implementation of these planned improvements, this intersection will operate at an acceptable level of service.

The intersection of US Route 13 and Hickory Ridge Road exhibits LOS deficiencies during the existing PM peak hour as well as under all future conditions. The LOS deficiencies in future conditions occur from the minor street approach as well as from the northbound US Route 13 left-turn movement. A new signal has recently been constructed and is currently operational at this location. With the implementation of the signal, this intersection will operate at an acceptable level of service for all future conditions. However, the 95th percentile queues for the northbound left-turn movement would extend beyond the available storage of 380 feet. An additional northbound left-turn lane is needed at the intersection of US Route 13 and Hickory Ridge Road to address the queue deficiency at the northbound left-turn approach. Being how the

new signal is already constructed we do not recommend any additional geometric improvements at this time. We would, however, recommend monitoring the northbound left-turn queue at this intersection. In summary, with the installation of the new signal, we do not recommend any additional improvements be implemented by the developer at this intersection.

The intersection of US Route 13 and North Messina Hill Road exhibits LOS deficiencies during the existing and all future PM peak hour scenarios. The LOS deficiencies would exist only on the North Messina Hill Road approach. The 95th percentile queue length on the approach during the typical peak hour is expected to be less than 80 feet. As discussed earlier this intersection is recognized as a future signal location in the US Route 13 Corridor Access study. With the installation of a traffic signal, this intersection would operate at an acceptable level of service. Other developments, located closer to this intersection are responsible for funding this improvement. We do not recommend that this developer be required to participate.

While the intersection of US Route 13 and Carter Road would operate with acceptable LOS under all future conditions, the eastbound left-turn and the northbound left-turn present a queuing issue. The eastbound left-turn lane currently has approximately 250 feet of storage. Based on the HCS 95th percentile queue analysis, the storage length needs to be extended to 375 feet (excluding taper). The northbound dual left-turn lanes currently have 270 feet of storage and are limited by the striping at the crossover. As per the HCS analyses, the northbound left-turn queue would be 425 feet. We recommend that the northbound left-turn lanes at this intersection be restriped to provide the maximum storage given the limits of the existing crossover. Other developments, located closer to this intersection are responsible for making this improvement. We do not recommend that this developer be required to participate.

Furthermore, the crossover at the intersection of US Route 13 and North Street (Gateway North Boulevard) currently serves as a low volume southbound left-turn movement onto North Street. The northbound U-turns as well as left-turns out of North Street are currently prohibited at this crossover. With the extension of the west leg of Carter Road just north of this crossover, North Street can be accessed through the Carter Road intersection. Thus, all the southbound vehicles that currently turn left into North Street could easily use the signalized left-turn at the intersection of US Route 13 and Carter Road to access North Street. We recommend that DelDOT consider closing this crossover and eliminate the southbound left-turn movement into North Street in order to adequately extend the storage for the dual left-turn lanes at the intersection of US Route 13 and Carter Road. Other developments, located closer to this intersection are responsible for making this improvement. We do not recommend that this developer be required to participate.

Should the County approve the proposed development, the following items should be incorporated into the site design and reflected on the record plan. All applicable agreements (i.e. letter agreements for off-site improvements and traffic signal agreements) should be executed prior to entrance plan approval for the proposed development.

1. The developer should improve Twin Willows Road from the east end of the site frontage to the intersection of Twin Willows Road and US Route 13 to meet DelDOT's local road standards. These standards include, but are not limited to, two eleven-foot travel lanes and two five-foot shoulders. The developer should provide a bituminous concrete overlay to the existing travel lanes, at DelDOT's discretion. DelDOT should analyze the existing lanes' pavement section and recommend an overlay thickness to the developer's engineer if necessary.

2. The developer should construct a full access site entrance on Twin Willows Road as far from US Route 13 as possible to be consistent with the proposed lane configuration as shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Site Approach	Approach does not exist	One shared left-turn/right-turn lane
Westbound Twin Willows Road	One through lane	One shared through/left-turn lane
Eastbound Twin Willows Road	One through lane	One through lane and one right-turn lane

Based on DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*, the recommended turn-lane length (excluding taper) is 170 feet for the eastbound right-turn lane. However, due to physical constraints DelDOT's Subdivision Section may determine that a shorter eastbound right-turn lane is acceptable. The storage length based on the HCS analysis provides a shorter queue length than what is recommended in the *Standards and Regulations for Subdivision Streets and State Highway Access.*

3. The developer should construct a right-turn lane on the westbound Twin Willows Road approach at the intersection of US Route 13 and Twin Willows Road. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound US Route 13	One U-turn lane, two through lanes and one right-turn lane	No Change
Southbound US Route 13	One left-turn lane and two through lanes	No Change
Westbound Twin Willows Road	One shared left-turn/right-turn lane	One left-turn lane and one right-turn lane

Based on DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*, the recommended turn-lane length (excluding taper) is 290 feet for the westbound right-turn lane. The storage length based on the HCS analysis provides a

shorter queue length than what is recommended in the *Standards and Regulations for Subdivision Streets and State Highway Access*.

4. The developer should enter into a traffic signal agreement with DelDOT for the intersection of US Route 13 and Twin Willows Road. The agreement should include pedestrian signals, crosswalks, interconnection and ITS equipment such as CCTV cameras at DelDOT's discretion. The developer will be required to perform a peak hour and a four-hour signal warrant analysis at DelDOT's discretion. The developer should coordinate with DelDOT on the implementation and equitable cost sharing of the traffic signal.

5. The following bicycle, pedestrian, and transit improvements should be included:

    a. A minimum permanent easement of fifteen-feet from the edge of the right-of-way should be dedicated to DelDOT within the site frontage along Twin Willows Road. Within this easement, a ten-foot wide multi-use path that meets current AASHTO and ADA standards should be constructed and should connect to the existing multimodal path located to the east of this property. A five-foot minimum setback should be maintained from the edge of the pavement to the multi-use path.
    b. Where right-turn lanes are added on Twin Willows Road a bicycle lane should also be provided through the right-turn lane. A Right-Turn Yield to Bikes sign (MUTCD R4-4) should be added at the start of each right-turn lane.
    c. ADA compliant curb ramps and marked crosswalks should be provided at the site entrance. The use of Type 3 curb ramp is discouraged.
    d. Where internal sidewalks are located alongside of parking spaces, a buffer, physical barrier or signage should be added to eliminate vehicular overhang onto the sidewalk.
    e. Covered bike parking racks should be provided near the building entrances.
    f. Bicycle Warning signs (W11-1) should be placed on both the eastbound and westbound approaches on Twin Willows Road.
    g. An 8' x 8' ADA compliant concrete pad should be provided along the site frontage on US Route 13 for DTC Route 120. The internal and frontage sidewalks should connect to this stop. Parking facilities for bicyclists should be included.

Please note that this review generally focuses on capacity and level of service issues; additional safety and operational issues will be further addressed through DelDOT's subdivision review process.

Improvements in this TIS may be considered "significant" under DelDOT's *Work Zone Safety and Mobility Procedures and Guidelines*. These guidelines are available on DelDOT's website at http://www.deldot.gov/information/pubs_forms/manuals/de_mutcd/index.shtml. For any additional information regarding the work zone impact and mitigation procedures during

construction please contact Mr. Adam Weiser of DelDOT's Traffic Section. Mr. Weiser can be reached at (302) 659-4073 or by email at Adam.Weiser@state.de.us.

Additional details on our review of the TIS are attached. Please contact me at (302) 266-9600 if you have any questions concerning this review.

Sincerely,
Johnson, Mirmiran, and Thompson, Inc.

David DuPlessis, P.E.
cc: Mir Wahed, P.E., PTOE

Enclosure

General Information

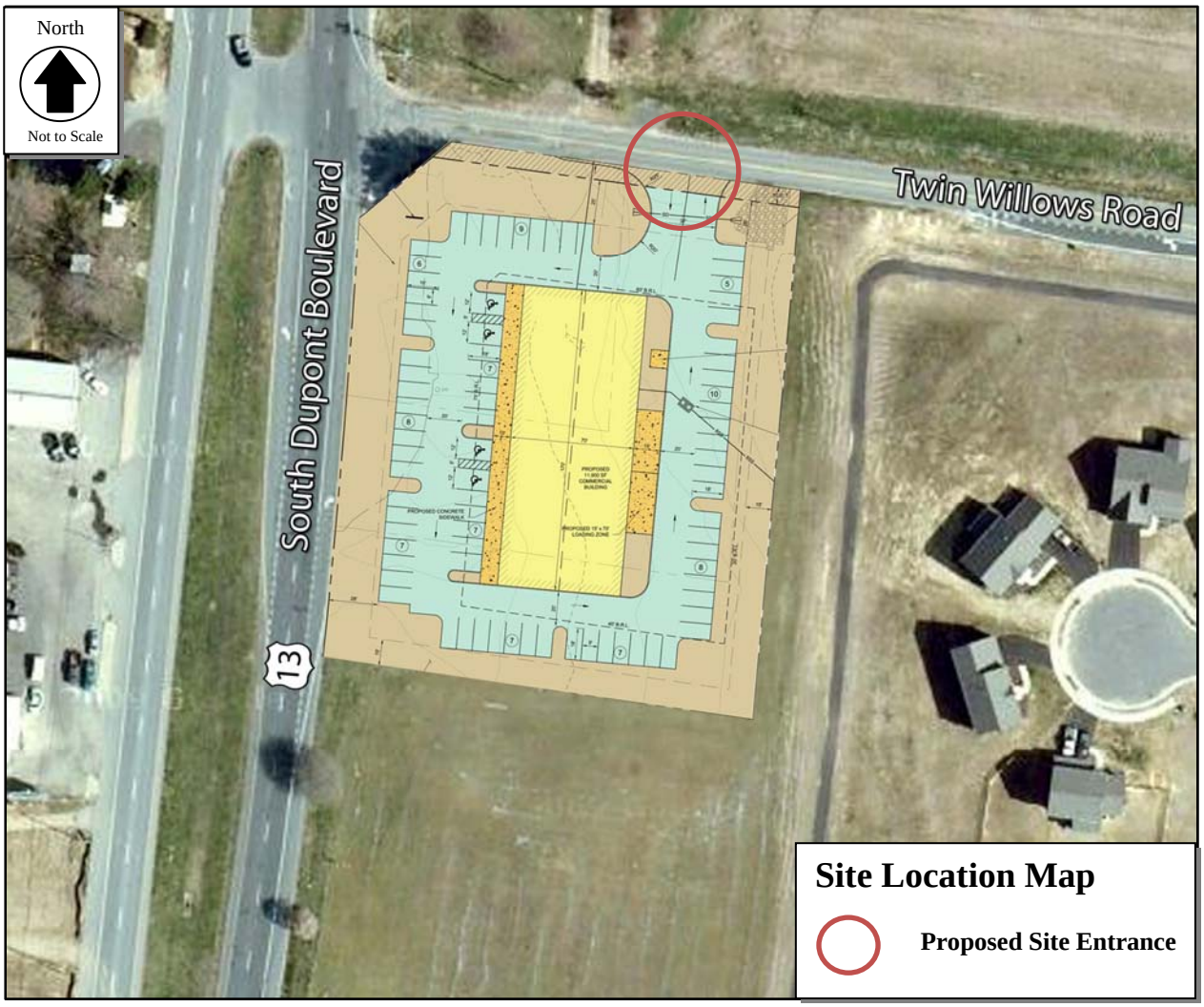
Report date: November, 2009.
Prepared by: Traffic Concepts, Inc.
Prepared for: Twin Willows Shopping Center.
Tax Parcels: 1-00-028.00-02-51.00, 52.00 and 54.01.
Generally consistent with DelDOT's *Rules and Regulations for Subdivision Streets*: Yes.

Project Description and Background

Description: A 10,100 square foot shopping center and a 1,800 square foot fast food restaurant.
Location: The project is proposed on the southeast corner of the intersection of US Route 13 (DuPont Highway/Kent Road 2) and Twin Willows Road (Kent Road 84) in Kent County.
Amount of Land to be developed: Approximately 1.68 acres of land.
Land Use approval(s) needed: Commercial Entrance Approval.
Proposed completion date: 2011.
Proposed access locations: One access point is proposed on Twin Willows Road.
Daily Traffic Volumes:

- 2008 Average Annual Daily Traffic on Twin Willows Road: 1,107 vehicles per day.
- 2008 Average Annual Daily Traffic on US Route 13: 36,455 vehicles per day.

Site Map



**Graphic is an approximation based on the site plan received from Traffic Concepts, Inc on December 2, 2009*

Relevant and On-going Projects

DelDOT currently has one relevant project in the study area. DelDOT completed the US Route 13 corridor access study between the Delaware Route 1 ramps in Smyrna and Scarborough Road (Kent Road 294) in Dover in August 2004. The primary objective of the study was to determine the optimal locations of new traffic signals along US Route 13 between Dover and Smyrna. This would allow US Route 13 to function as a coordinated arterial and facilitate platoon progression along the corridor. The study also evaluated additional capacity improvements that would be required to provide acceptable operating conditions along the US Route 13 corridor. The order of improvements are likely to be dictated by the location and order of future developments along the corridor. The study also noted that significant efforts should be made to provide access to new developments onto existing side streets (particularly those expected to be signalized) rather

than creating any new access points along US Route 13. As per the results of this study, the proposed traffic signals within the Twin Willows Shopping Center TIS study area includes the intersections of US Route 13/Twin Willows Road, US Route 13/Hickory Ridge Road and US Route 13/North Messina Hill Road. DelDOT's Traffic Section has recently completed the installation of a new traffic signal at the intersection of US Route 13 and Hickory Ridge Road and the signal is currently operational.

Livable Delaware
(Source: Delaware Strategies for State Policies and Spending, July 2004)

Location with respect to the Strategies for State Policies and Spending Map of Delaware: The proposed development is located within Investment Level 2.

Investment Level 2

These areas, generally adjacent to Investment Level 1 Areas, include less developed areas within municipalities, rapidly growing areas that have or will have public water and wastewater services, and may include smaller towns, rural villages, and suburban areas. These areas typically include single-family detached housing developments, commercial and office uses serving primarily local residents, and a limited range of entertainment, parks and recreation, cultural and institutional facilities.

In Investment Level 2 Areas, state investments and policies should be based on available infrastructure to accommodate orderly growth, encourage departure from the typical single-family dwelling developments and promote a broader mix of housing types and commercial sites, and encourage development that is consistent with the character of the area. Transportation projects should expand or provide roadways, public transportation, pedestrian walkways, bicycle paths, and other transportation modes that manage flow, support economic development efforts, and encourage connections between communities and the use of local streets for local trips.

Proposed Development's Compatibility with Livable Delaware:

The proposed Twin Willows Shopping Center development falls within Investment Level 2 and is to be developed as a commercial center and in a manner consistent with the character of the other existing commercial developments in the area. As such, this development appears to be generally consistent with the 2004 update of the Livable Delaware "Strategies for State Policies and Spending."

Comprehensive Plans

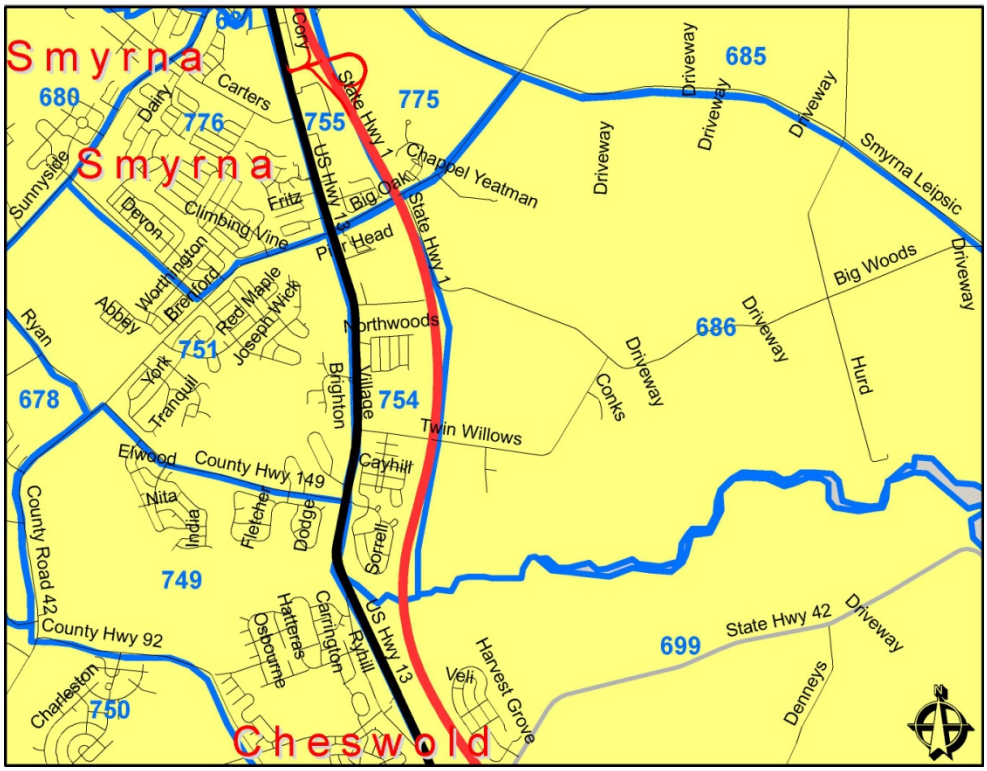
Kent County Comprehensive Plan:
According to the Kent County future land use map, these parcels are located in the Growth Zone Overlay and are designated as Highway Commercial which is consistent with the current General Business (BG) zoning. The Comprehensive Plan states that the strategic placement of neighborhood scale retail establishments strengthens the communities within the County. This type of development provides local access to goods and services to area residents.

Proposed Development's Compatibility with the County Comprehensive Plan:
The proposed Twin Willows Shopping Center development is consistent with the Highway Commercial land use reflected for these parcels in the Comprehensive Plan. By providing a restaurant and specialty retail services to serve the local neighborhoods, the development would presumably reduce longer trips. As such, the development is generally compatible with Kent County's Comprehensive Plan.

Transportation Analysis Zones (TAZ)

Transportation Analysis Zones (TAZ) where development would be located: 754

TAZ Boundaries:



Current employment estimate for TAZ: 0 in 2005
Future employment estimate for TAZ: 0 in 2030

Current Population estimate for TAZ: 664 in 2005
Future Population estimate for TAZ: 2373 in 2030
Current household estimate for TAZ: 261 in 2005
Future household estimate for TAZ: 960 in 2030
Relevant committed developments in the TAZ: Warren Property, Ridgewood Manor, Twin Willows and Spring Meadows.
Would the addition of committed developments to current estimates exceed future projections: No.
Would the addition of committed developments and the proposed development to current estimates exceed future projections: Yes.

Trip Generation

Trip generation for the proposed development was computed using comparable land uses and equations contained in the *Trip Generation, 8th Edition: An ITE Informational Report*, published by the Institute of Transportation Engineers (ITE). The following land uses were utilized to estimate the amount of new traffic generated for this development.

- 1,800 square foot High Turnover Restaurant - (ITE Land Use code 932)
- 10,100 square feet of Specialty Retail - (ITE Land Use code 814)

The peak period trip generation for Twin Willows Shopping Center development is included in Table 1.

Table 1
TWIN WILLOWS SHOPPING CENTER TRIP GENERATION

Land Use	**ADT**	**PM Peak Hour**			**SAT Midday Peak Hour**		
		In	Out	Total	In	Out	Total
1,800 square foot High Turnover Restaurant	**229**	12	8	20	13	12	25
Pass-By Trips		5	3	8	6	5	11
Net New Trips		**7**	**5**	**12**	**7**	**7**	**14**
10,100 square feet Specialty Retail	**448**	20	26	46	20	26	46
Pass-By Trips		0	0	0	0	0	0
Net New Trips		**20**	**26**	**46**	**20**	**26**	**46**
Total Trips	**677**	**27**	**31**	**58**	**27**	**33**	**60**

Overview of TIS

Intersections examined:

1. Twin Willows Road and Site Entrance
2. Twin Willows Road and Big Woods Road
3. Big Woods Road and Hurd Road (Kent Road 326)
4. Big Woods Road and Smyrna-Leipsic Road
5. US Route 13 and Twin Willows Road
6. US Route 13 and Brenford Road/Big Oak Road
7. US Route 13 and Carter Road
8. US Route 13 and Hickory Ridge Road
9. US Route 13 and North Messina Hill Road

Conditions examined:

1. Case 1 - 2009 Existing conditions
2. Case 2 - 2011 No Build conditions without Twin Willows Shopping Center
3. Case 3 - 2011 Build conditions with Twin Willows Shopping Center
4. Case 4 - 2013 Post Build conditions with Twin Willows Shopping Center (Kent County APFO Compliance)

Peak hours evaluated: Weekday evening and Saturday mid-day peak hours

Committed Developments considered:

1. Big Oak Commercial (80,254 square feet of commercial space, 3 commercial outparcels)
2. Big Oak Residential (48 single-family detached houses)
3. Willowwood (498 single-family detached houses)
4. Simon's Corner Shopping Center (324,410 square foot shopping center)
5. Liborio III Shopping Center (92,000 square foot shopping center, expanded to 399,000 square foot shopping center)
6. Worthington (579 single-family detached houses)
7. Centerville and Graceville (856 single-family detached houses)
8. Cambria Village (280 townhouses, 260 unbuilt)
9. Christiana Apartments (188 apartments)
10. Hickory Hollow (325 single-family detached houses)
11. Brenford Woods (111 single-family detached houses, 15 unbuilt)
12. Auburn Meadows (106 single-family detached houses, 366 townhouses)
13. Greenhill Estates (139 single-family detached houses)
14. Villages of Eastridge (374 single-family detached houses)
15. Garrison Lake Green (313 single-family detached houses)
16. Brenford Station, Phase I (195 single-family detached houses, 84 unbuilt)
17. Brenford Station, Phase II (231 single-family detached houses)
18. Hidden Brook (325 single-family detached houses)
19. Ashland (160 single-family detached houses)
20. Wicksfield (202 single-family detached houses, 153 unbuilt)
21. Masseys Mill (60 single-family detached houses)
22. Warren Property (120 apartments)
23. Heritage Trace (236 single-family detached houses)

24. Southern View (100 single-family detached houses)
25. Bon Ayre (404 single-family detached houses, 202 unbuilt)
26. Sunnyside Village (255 single-family detached houses, 117 unbuilt; 132 townhouses, 60 unbuilt; 235 apartments, 108 unbuilt)
27. Twin Willows (158 single-family detached houses; 69 unbuilt)
28. Spring Meadows (152 single-family detached houses, 31 unbuilt; 94 townhouses, 32 unbuilt)
29. Rite Aid (16,032 square foot pharmacy)
30. Willow Creek (213 single-family detached houses)
31. Ridgewood Manor (50 mobile home units)

Note: *The Rite Aid was excluded from calculations as this was fully developed at the time of this TIS.*

Intersection Descriptions

1. **Twin Willows Road and Site Entrance**
   Type of Control: Proposed stop-controlled intersection (T-Intersection)
   Eastbound Approach: (Twin Willows Road) existing one through lane, proposed one through lane and one right-turn lane
   Westbound Approach: (Twin Willows Road) existing one through lane, proposed one shared through/left-turn lane
   Northbound Approach: (Site Entrance) proposed one shared left-turn/right-turn lane, stop-controlled

2. **Twin Willows Road and Big Woods Road**
   Type of Control: stop-controlled intersection (T-Intersection)
   Eastbound Approach: (Big Woods Road) one shared through/right-turn lane
   Westbound Approach: (Big Woods Road) one shared through/left-turn lane
   Northbound Approach: (Twin Willows Road) one shared left-turn/right-turn lane, stop-controlled

3. **Big Woods Road and Hurd Road**
   Type of Control: stop-controlled intersection
   Eastbound Approach: (Big Woods Road) one shared through/left-turn/right-turn lane
   Westbound Approach: (Big Woods Road) one shared through/left-turn/right-turn lane
   Northbound Approach: (Hurd Road) one shared through/left-turn/right-turn lane, stop-controlled
   Southbound Approach: (Hurd Road) one shared through/left-turn/right-turn lane, stop-controlled

4. **Big Woods Road and Smyrna-Leipsic Road**
   Type of Control: stop-controlled intersection
   Eastbound Approach: (Big Woods Road) one shared through/left-turn/right-turn lane, stop-controlled
   Westbound Approach: (Big Woods Road) one shared through/left-turn/right-turn lane, stop-controlled

Northbound Approach: (Smyrna-Leipsic Road) one shared through/left-turn/right-turn lane
Southbound Approach: (Smyrna-Leipsic Road) one shared through/left-turn/right-turn lane

5. **US Route 13 and Twin Willows Road**
   Type of Control: stop-controlled intersection (T-Intersection)
   Westbound Approach: (Twin Willows Road) one shared left-turn/right-turn lane, stop-controlled
   Northbound Approach: (Northbound US Route 13) one shared U-turn/left-turn lane, two through lanes and one right-turn lane
   Southbound Approach: (Southbound US Route 13) one left-turn lane and two through lanes

6. **US Route 13 and Brenford Road/Big Oak Road**
   Type of Control: signalized four-legged intersection
   Eastbound Approach: (Brenford Road) existing one shared through/left-turn/right-turn lane, proposed one left-turn lane, one shared through/left-turn lane and one right-turn lane
   Westbound Approach: (Big Oak Road) one shared through/left-turn/right-turn lane
   Northbound Approach: (Northbound US Route 13) one left-turn lane, two through lanes and one right-turn lane
   Southbound Approach: (Southbound US Route 13) one left-turn lane, two through lanes and one right-turn lane
   Note: The proposed improvements at this intersection are developer funded improvements.

7. **US Route 13 and Carter Road**
   Type of Control: signalized four-legged intersection
   Eastbound Approach: (Carter Road) one left-turn lane, one through lane and one channelized right-turn lane
   Westbound Approach: (Carter Road) one left-turn lane, one through lane and one right-turn lane
   Northbound Approach: (Northbound US Route 13) two left-turn lanes, two through lanes and one right-turn lane
   Southbound Approach: (Southbound US Route 13) one left-turn lane, two through lanes and one right-turn lane
   Note: The eastbound right-turn from Carter Road operates as a free right-turn and has a 350 feet acceleration lane onto southbound US Route 13.

8. **US Route 13 and Hickory Ridge Road**
   Type of Control: stop-controlled four-legged intersection
   Eastbound Approach: (Hickory Ridge Road) one shared through/left-turn lane and one right-turn lane, stop-controlled
   Westbound Approach: (Spring Meadows Drive) one shared through/left-turn/right-turn lane, stop-controlled
   Northbound Approach: (Northbound US Route 13) one left-turn lane, two through lanes and one right-turn lane

Southbound Approach: (Southbound US Route 13) one left-turn lane, two through lanes and one right-turn lane
Note: This intersection is proposed to be signalized. The signal design and construction has recently been completed and the signal is currently operational.

9. **US Route 13 and North Messina Hill Road**
   Type of Control: stop-controlled intersection (T-Intersection)
   Eastbound Approach: (North Messina Hill Road) one shared left-turn/right-turn lane, stop-controlled
   Northbound Approach: (Northbound US Route 13) one left-turn lane and two through lanes
   Southbound Approach: (Southbound US Route 13) one U-turn lane, two through lanes and one right- turn lane

Transit, Pedestrian, and Bicycle Facilities

Existing transit service: The Smyrna Park and Ride is located near US Route 13 and the Delaware Route 1 ramps intersection to the north of the study area. Starting December 4, 2009 DTC started a new local service between Dover and Smyrna. The new Route 120 currently operates Monday through Friday from 5:30 am to 6:30 pm with 17 trips daily and has timed connections to Route 301 at the Smyrna Park and Ride and in Dover.

Planned transit service: JMT contacted Lisa Collins, Service Development Planner of DTC. In an email dated December 16, 2009, she noted that DTC could serve the property directly with a bus stop located on US Route 13. She requested an 8' x 8' concrete pad be installed on the site frontage on US Route 13.

Existing bicycle and pedestrian facilities: According to DelDOT's *Delaware Bicycle Facility Master Plan* (October 2005), US Route 13 is designated as a Recreational Connector.

The *Delaware Bicycle Touring Map* designates US Route 13 as having above average cycling conditions with high traffic volumes (greater than 10,000 vehicles per day). In the vicinity of the site, Twin Willows Road, Brenford Road, Big Oak Road, Big Woods Road, North Messina Hill Road, Smyrna-Leipsic Road and Hurd Road, all have above average cycling conditions with low traffic volumes (less than 2,000 vehicles per day). Hickory Ridge Road is designated as having average cycling conditions with low traffic volumes (less than 2,000 vehicles per day) and Carter Road is designated as having average cycling conditions with moderate traffic volumes (between 2,000 and 10,000 vehicles per day).

Planned bicycle and pedestrian facilities: Traffic Concepts, Inc contacted Mr. Anthony Aglio, DelDOT's Bicycle Coordinator. In an email dated September 9, 2009 he requested the following bicycle improvements:

- A minimum of fifteen-foot wide permanent easement from the edge of the right-of-way should be dedicated to DelDOT within the site frontage along Twin Willows Road. Within this easement, a ten-foot wide multi use path that meets current AASHTO and ADA standards should be constructed and should connect to the existing multimodal path

located to the east of this property. A minimum of five-foot setback should be maintained from the edge of the pavement to the multi use path.

- ADA compliant curb ramps and crosswalks should be provided at the site entrance.
- Where internal sidewalks are located alongside of parking spaces, a buffer, physical barrier or signage should be added to eliminate vehicular overhang onto the sidewalk.
- Covered bike parking should be included near the entrances of commercial locations.
- Bicycle Warning signs (W11-1) should be placed on both the eastbound and westbound approaches on Twin Willows Road.
- The developer of this project should contact DTC regarding the addition of transit service and transit facilities at this location. Internal sidewalks should connect to this stop. This bus stop should include parking facilities for bicyclists (A bus stop on US Route 13 was recommended).
- Any intersection improvements planned on other study intersections including Carter Road and Smyrna-Leipsic Road should include pedestrian and bicycle facilities.

Previous Comments

All comments from the preliminary TIS have been addressed in the final TIS.

General HCS/Synchro Analysis Comments

(See table footnotes on the following pages for specific comments)

1) JMT performed analysis for Case 4 (2013 post build scenario) as per Kent County APFO requirement. The TIS did not conduct this analysis.

2) The TIS sometimes used incorrect peak hour factors. JMT applied the peak hour factor as per lane groups for existing conditions as customary DelDOT TIS Review methodology.

3) The TIS analysis sometimes used peak hour factors of 0.92 for future conditions even if volumes remain unchanged. JMT used existing peak hour factors if volumes remained unchanged.

4) The TIS did not perform heavy vehicle count during the turning movement counts and used heavy vehicle percentages based on the ATR counts. JMT used heavy vehicle percentages from a recently completed TIS in the area.

Table 2
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[1] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
Twin Willows Road & Site Entrance [2,3]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2011 with Twin Willows Shopping Center (Case 3)				
Westbound Twin Willows Road Approach	A (7.8)	A (7.7)	A (7.8)	A (7.7)
Northbound Site Approach	B (11.5)	B (11.1)	B (11.3)	B (11.0)
2013 with Twin Willows Shopping Center (Case 4)				
Westbound Twin Willows Road Approach	-	-	A (7.8)	A (7.7)
Northbound Site Approach	-	-	B (11.4)	B (11.0)

[1] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[2] TIS analyzed the proposed site entrance as a shared left-turn/right-turn lane approach.
[3] TIS analyzed eastbound Twin Willows Road approach as a shared through/right-turn lane. JMT analyzed this approach with a through lane and a separate right-turn lane as shown in the site plan.

Table 3
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[4] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
Twin Willows Road & Big Woods Road	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Westbound Big Woods Road Approach	A (7.3)	A (7.3)	A (7.2)	A (7.3)
Northbound Twin Willows Approach	A (8.5)	A (8.6)	A (8.5)	A (8.6)
2011 without Twin Willows Shopping Center (Case 2)				
Westbound Big Woods Road Approach	A (7.3)	A (7.3)	A (7.2)	A (7.3)
Northbound Twin Willows Approach	A (8.5)	A (8.6)	A (8.5)	A (8.6)
2011 with Twin Willows Shopping Center (Case 3)[5]				
Westbound Big Woods Road Approach	A (7.3)	A (7.3)	A (7.2)	A (7.3)
Northbound Twin Willows Approach	A (8.5)	A (8.6)	A (8.5)	A (8.6)

[4] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[5] There is no change in volumes between Case 3 (2011) and Case 4 (2013) analyses at this intersection.

Table 4
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[6] Two-Way Stop Control	**LOS per TIS**		**LOS per JMT**	
Big Woods Road & Hurd Road[7]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Eastbound Big Woods Road Approach	A (7.2)	A (7.2)	A (7.2)	A (7.2)
Westbound Big Woods Road Approach	A (7.2)	A (7.3)	A (7.2)	A (7.3)
Northbound Hurd Road Approach	A (8.4)	A (8.6)	A (8.4)	A (8.6)
Southbound Hurd Road Approach	-	A (8.8)	-	A (8.8)
2011 without Twin Willows Shopping Center (Case 2)				
Eastbound Big Woods Road Approach	A (7.2)	A (7.2)	A (7.2)	A (7.2)
Westbound Big Woods Road Approach	A (7.2)	A (7.3)	A (7.2)	A (7.3)
Northbound Hurd Road Approach	A (8.4)	A (8.6)	A (8.4)	A (8.6)
Southbound Hurd Road Approach	-	A (8.8)	-	A (8.8)
2011 with Twin Willows Shopping Center (Case 3)[8]				
Eastbound Big Woods Road Approach	A (7.2)	A (7.2)	A (7.2)	A (7.2)
Westbound Big Woods Road Approach	A (7.2)	A (7.3)	A (7.2)	A (7.3)
Northbound Hurd Road Approach	A (8.4)	A (8.6)	A (8.4)	A (8.6)
Southbound Hurd Road Approach	-	A (8.8)	-	A (8.8)

[6] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[7] There were no traffic volumes on southbound Hurd Road in the PM peak hour. Hence, no LOS results are provided for this approach.
[8] There is no change in volumes between Case 3 (2011) and Case 4 (2013) analyses at this intersection.

Table 5
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[9] Two-Way Stop Control	**LOS per TIS**		**LOS per JMT**	
Big Woods Road & Smyrna-Leipsic Road	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Northbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Southbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Westbound Big Woods Road Approach	A (8.6)	A (9.7)	A (8.6)	A (9.7)
Eastbound Big Woods Road Approach	A (8.6)	A (9.0)	A (8.5)	A (8.9)
2011 without Twin Willows Shopping Center (Case 2)				
Northbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Southbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Westbound Big Woods Road Approach	A (8.6)	A (9.8)	A (8.6)	A (9.7)
Eastbound Big Woods Road Approach	A (8.6)	A (9.0)	A (8.6)	A (9.0)
2011 with Twin Willows Shopping Center (Case 3)				
Northbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Southbound Smyrna-Leipsic Road Approach	A (7.3)	A (7.3)	A (7.3)	A (7.3)
Westbound Big Woods Road Approach	A (8.6)	A (9.8)	A (8.6)	A (9.7)
Eastbound Big Woods Road Approach	A (8.6)	A (9.0)	A (8.6)	A (9.0)

[9] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.

Table 5 (Continued)
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[10] Two-Way Stop Control	**LOS per TIS**		**LOS per JMT**	
Big Woods Road & Smyrna-Leipsic Road	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2013 with Twin Willows Shopping Center (Case 4)				
Northbound Smyrna-Leipsic Road Approach	-	-	A (7.3)	A (7.3)
Southbound Smyrna-Leipsic Road Approach	-	-	A (7.3)	A (7.3)
Westbound Big Woods Road Approach	-	-	A (8.6)	A (9.7)
Eastbound Big Woods Road Approach	-	-	A (8.6)	A (9.0)

[10] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.

Table 6
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[11] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Twin Willows Road[12]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Northbound US Route 13-Left	B (11.9)	B (12.2)	B (11.9)	B (12.2)
Southbound US Route 13-Left	B (11.7)	A (9.9)	B (11.7)	A (9.9)
Westbound Twin Willows Road Approach	C (19.6)	B (15.0)	C (22.3)	C (17.1)
2011 without Twin Willows Shopping Center (Case 2)				
Northbound US Route 13-Left	C (15.3)	C (17.4)	C (15.3)	C (17.0)
Southbound US Route 13-Left	D (25.9)	C (16.3)	D (25.9)	C (16.7)
Westbound Twin Willows Road Approach	F (173.7)	F (86.4)	F (312.6)	F (168.3)
2011 with Twin Willows Shopping Center (Case 3)				
Northbound US Route 13-Left	C (15.3)	C (17.4)	C (15.3)	C (17.0)
Southbound US Route 13-Left	D (28.0)	C (17.0)	D (28.0)	C (17.5)
Westbound Twin Willows Road Approach	F (284.8)	F (143.0)	F (468.8)	F (265.0)

[11] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[12] TIS analyzed this intersection with two car storage in the median, while JMT analyzed this intersection with one car storage in the median.

Table 6 (Continued)
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[13] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Twin Willows Road	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2013 with Twin Willows Shopping Center (Case 4)				
Northbound US Route 13-Left	-	-	C (15.5)	C (17.3)
Southbound US Route 13-Left	-	-	D (29.1)	C (17.8)
Westbound Twin Willows Road Approach	-	-	F (503.4)	F (282.1)
2011 with Twin Willows Shopping Center (Case 3 With Proposed Improvement)[14]				
Northbound US Route 13-Left	-	-	C (15.3)	C (17.0)
Southbound US Route 13-Left	-	-	D (28.0)	C (17.5)
Westbound Twin Willows Road Approach	-	-	F (205.1)	F (108.3)
2013 with Twin Willows Shopping Center (Case 4 With Proposed Improvement)[14]				
Northbound US Route 13-Left	-	-	C (15.5)	C (17.3)
Southbound US Route 13-Left	-	-	D (29.1)	C (17.8)
Westbound Twin Willows Road Approach	-	-	F (218.1)	F (113.8)

[13] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[14] Proposed Improvement consists of adding a separate right-turn lane to the westbound Twin Willows Road approach.

Table 7
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Signalized Intersection[15] (HCS Analysis)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Twin Willows Road[16,17]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2011 with Twin Willows Shopping Center (Case 3 With Proposed Improvement)[18]	-	-	B (16.2)	B (15.1)
2013 with Twin Willows Shopping Center (Case 4 With Proposed Improvement)[18]	-	-	B (17.1)	B (15.2)

[15] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[16] This intersection is proposed as a future signal location as per the US Route 13 access study. Hence, JMT performed signalized intersection analysis at this location. TIS did not perform these analyses.
[17] JMT assumed a 120 second cycle length with protected-only phasing for the southbound left-turn movement.
[18] Proposed Improvement consists of adding a separate right-turn lane to the westbound Twin Willows Road approach.

Table 8
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Signalized Intersection[19] (HCS Analysis)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Brenford Road/Big Oak Road[20,21]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing Conditions[22] (Case 1)	B (17.6)	B (11.4)	B (15.7)	B (17.4)
2011 without Twin Willows Shopping Center (Case 2)	F (142.8)	E (56.4)	F (94.7)	F (97.0)
2011 with Twin Willows Shopping Center (Case 3)	-	-	F (95.9)	F (98.0)
2011 with Twin Willows Shopping Center (Case 3 with Proposed Improvements)[23, 24]	D (44.7)	E (58.6)	D (40.0)	D (35.7)
2013 with Twin Willows Shopping Center (Case 4 with Proposed Improvements)[23, 24]	-	-	D (41.0)	D (36.6)

[19] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[20] TIS used incorrect phasing showing permitted left-turns instead of split phasing. JMT used split phasing as seen in the field.
[21] TIS used incorrect red times on US Route 13 approaches. JMT used red times as per DelDOT signal timing plans.
[22] TIS used 120 second cycle length for PM peak hour and 100 second cycle length for SAT peak hour. JMT used 120 second cycle length for both PM and SAT peak hour analyses.
[23] Intersection configuration is based on the proposed improvements from other committed developments (Big Oak Commons, Auburn Meadows, etc.) and consists of modifying the eastbound Brenford Road approach to one left-turn, one shared through/left-turn and one right-turn lane.
[24] TIS used 150 second cycle length for PM peak hour and 100 second cycle length for SAT peak hour. JMT used 150 second cycle length for both PM and SAT peak hour analyses.

Table 9
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Signalized Intersection[25] (HCS Analysis)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Carter Road[26]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2007 Existing Conditions (Case 1) [27,28]	D (42.9)	F (88.9)	B (18.9)	B (17.3)
2011 without Twin Willows Shopping Center (Case 2)[29]	F (201.5)	F (137.9)	C (31.3)	B (19.7)
2011 with Twin Willows Shopping Center (Case 3)[30]	D (40.7)	D (37.5)	C (31.6)	B (19.8)
2013 with Twin Willows Shopping Center (Case 4)[30]	-	-	C (33.0)	C (20.4)

[25] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[26] TIS did not incorporate the pedestrian phases in the signalized analyses. JMT incorporated these as per timing received from DelDOT and pedestrian counts from the TIS.
[27] Both TIS and JMT analyzed the eastbound right-turn as free movement as a full length acceleration lane is provided for this approach.
[28] JMT and TIS used an existing cycle length of 120 seconds.
[29] TIS used cycle length of 120 seconds for PM peak hour and 100 seconds for Sat Peak Hour. JMT used 130 seconds during both peak hours. Arrival type 4 was used for the through traffic on US Route 13 to account for signal coordination.
[30] TIS used cycle length of 150 seconds for PM peak hour and 100 seconds for Sat Peak Hour. JMT used 130 seconds cycle length.

Table 10
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[31] Two-Way Stop Control	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Hickory Ridge Road[32]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Northbound US Route 13-Left	B (14.6)	B (13.6)	B (14.6)	B (13.6)
Southbound US Route 13-Left	B (11.5)	A (9.6)	B (11.4)	A (9.6)
Westbound Hickory Ridge Road Approach	E (46.6)	D (25.7)	F (50.4)	D (27.7)
Eastbound Hickory Ridge Road Approach	D (29.3)	C (22.0)	E (37.9)	D (26.0)
2011 without Twin Willows Shopping Center (Case 2)				
Northbound US Route 13-Left	F (274.0)	F (138.6)	F (274.0)	F (138.6)
Southbound US Route 13-Left	C (19.2)	B (13.9)	C (19.2)	B (13.9)
Westbound Hickory Ridge Road Approach	F (*)	F (*)	F (*)	F (*)
Eastbound Hickory Ridge Road Approach	F (*)	F (*)	F (*)	F (*)
2011 with Twin Willows Shopping Center (Case 3)				
Northbound US Route 13-Left	F (282.3)	F (142.9)	F (282.3)	F (142.9)
Southbound US Route 13-Left	C (19.3)	B (14.0)	C (19.3)	B (14.0)
Westbound Hickory Ridge Road Approach	F (*)	F (*)	F (*)	F (*)
Eastbound Hickory Ridge Road Approach	F (*)	F (*)	F (*)	F (*)

* HCS+ did not generate a result due to excessive delay.

[31] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[32] TIS analyzed this intersection with two car storage in the median, while JMT analyzed this intersection with one car storage in the median. At the time of TIS study this intersection was unsignalized.

Table 10 (Continued)
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[33] Two-Way Stop Control	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Hickory Ridge Road[34]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2013 with Twin Willows Shopping Center (Case 4)				
Northbound US Route 13-Left	-	-	F (302.3)	F (158.6)
Southbound US Route 13-Left	-	-	C (19.7)	B (14.2)
Westbound Hickory Ridge Road Approach	-	-	F (*)	F (*)
Eastbound Hickory Ridge Road Approach	-	-	F (*)	F (*)

* HCS+ did not generate a result due to excessive delay.

[33] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[34] TIS analyzed this intersection with two car storage in the median, while JMT analyzed this intersection with one car storage in the median. At the time of TIS study this intersection was unsignalized.

Table 11
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Signalized Intersection[35] (HCS Analysis)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & Hickory Ridge Road[36,37]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2011 without Twin Willows Shopping Center (Case 2)	-	-	D (40.3)	D (39.5)
2011 with Twin Willows Shopping Center (Case 3)	-	-	D (41.7)	D (39.6)
2013 with Twin Willows Shopping Center (Case 4)	-	-	D (43.4)	D (40.8)

[35] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[36] This intersection has recently been converted to a signal. Hence, JMT performed signalized intersection analyses for Cases 2, 3 and 4. TIS did not perform these analyses.
[37] JMT assumed 150 second cycle length with phasing as per signal plan dated September 23, 2009, with split phasing on the eastbound and westbound approaches and protected-only phasing for the northbound and southbound left-turn movements.

Table 12
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[38] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & North Messina Hill Road[39]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2009 Existing (Case 1)				
Northbound US Route 13-Left	B (12.4)	B (13.6)	B (12.5)	B (13.6)
Southbound US Route 13-Left	B (11.4)	A (9.9)	B (11.4)	A (9.9)
Eastbound North Messina Hill Road Approach	D (29.0)	C (15.5)	E (35.3)	C (15.5)
2013 without Twin Willows Shopping Center (Case 2)				
Northbound US Route 13-Left	C (20.0)	D (31.1)	C (20.4)	D (29.0)
Southbound US Route 13-Left	C (22.8)	C (17.1)	C (22.8)	C (17.1)
Eastbound North Messina Hill Road Approach	F (89.6)	D (31.7)	F (138.0)	D (29.6)
2011 with Twin Willows Shopping Center (Case 3)				
Northbound US Route 13-Left	C (20.1)	D (31.3)	C (20.5)	D (29.1)
Southbound US Route 13-Left	C (23.0)	C (17.2)	C (23.0)	C (17.2)
Eastbound North Messina Hill Road Approach	F (89.6)	D (31.9)	F (142.0)	D (29.8)

[38] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[39] TIS analyzed this intersection with two car storage in the median, while JMT analyzed this intersection with one car storage in the median.

Table 12 (Continued)
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
Prepared by Traffic Concepts, Inc.

Unsignalized Intersection[40] One-Way Stop Control (T-intersection)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & North Messina Hill Road[41]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2013 with Twin Willows Shopping Center (Case 4)				
Northbound US Route 13-Left	-	-	C (21.0)	D (30.4)
Southbound US Route 13-Left	-	-	C (23.4)	C (17.5)
Eastbound North Messina Hill Road Approach	-	-	F (153.3)	D (30.8)

[40] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[41] TIS analyzed this intersection with two car storage in the median, while JMT analyzed this intersection with one car storage in the median.

Table 13
PEAK HOUR LEVELS OF SERVICE (LOS)
Based on Traffic Impact Study for Twin Willows Shopping Center
Report dated November, 2009
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Signalized Intersection[42] (HCS Analysis)	**LOS per TIS**		**LOS per JMT**	
US Route 13 & North Messina Hill Road[43,44]	Weekday PM	Saturday Mid-day	Weekday PM	Saturday Mid-day
2011 with Twin Willows Shopping Center (Case 3)	-	-	B (10.8)	B (17.7)
2013 with Twin Willows Shopping Center (Case 4)	-	-	B (11.1)	B (18.5)

[42] For signalized and unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds.
[43] This intersection is proposed as a future signal location in conjunction with three other subdivision developments (Hidden Brook, Saratoga and Stonington) and is consistent with the US Route 13 access study. Hence, JMT performed signalized intersection analysis at this location. The TIS did not include these analyses.
[44] JMT assumed a 120 second cycle length with protected-permitted phasing on the northbound and southbound left-turn movements.