



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

JENNIFER COHAN
SECRETARY

September 25, 2017

Mr. Michael Maris
Michael Maris Associates, Inc.
156 Ramapo Valley Road
Mahwah, NJ 07430

Dear Mr. Maris:

The enclosed Traffic Impact Study (TIS) review letter for the **Delaware National** (Tax Parcels 07-031.00-001 & 014, 08-027.00-001 & 007) redevelopment 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 Development Coordination Manual and other accepted practices and procedures for such studies. DelDOT accepts this review letter and concurs with the recommendations. If you have any questions concerning this letter or the enclosed review letter, please contact me at (302) 760-2167.

Sincerely,

Troy Brestel
Project Engineer

TEB:km
Enclosures

cc with enclosures: Mr. Larry Tarabicos, Tarabicos Grosso, L.L.P.
Ms. Constance C. Holland, Office of State Planning Coordination
Mr. George Haggerty, New Castle County Department of Land Use
Mr. Owen Robatino, New Castle County Department of Land Use
Mr. Marco Boyce, New Castle County Department of Land Use
Mr. Andrew Parker, McCormick Taylor, Inc.
DelDOT Distribution

DelDOT Distribution

Annie Cordo, Deputy Attorney General
Robert McCleary, Director, Transportation Solutions (DOTS)
Drew Boyce, Director, Planning
Mark Luszcz, Chief Traffic Engineer, Traffic, DOTS
Mark Tudor, Assistant Director, Project Development North, DOTS
J. Marc Côté, Assistant Director, Development Coordination
T. William Brockenbrough, Jr., County Coordinator, Development Coordination
Adam Weiser, Safety Engineer, Traffic, DOTS
Peter Haag, Traffic Studies Manager, Traffic, DOTS
Kevin Canning, Canal District Engineer, North District
Matthew Lichtenstein, Canal District Public Works Engineer, Canal District
David Dooley, Service Development Planner, Delaware Transit Corporation
Erin Osborne, New Castle Subdivision Coordinator, Development Coordination
Pao Lin, New Castle Subdivision Manager, Development Coordination
Mark Galipo, Traffic Engineer, Traffic, DOTS
Anthony Aglio, Planning Supervisor, Statewide & Regional Planning
Claudy Joinville, Project Engineer, Development Coordination



September 25, 2017

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

RE: Agreement No. 1773
Traffic Impact Study Services
Task No. 1A Subtask 5A – Delaware National

Dear Mr. Brestel:

McCormick Taylor has completed its review of the Traffic Impact Study (TIS) for the Delaware National residential development prepared by Michael Maris Associates, Inc. (MMA) dated July 10, 2017. MMA prepared the report in a manner generally consistent with DelDOT's *Development Coordination Manual* [formerly *Standards and Regulations for Subdivision Streets*, incorporated by reference into the New Castle County Unified Development Code 40.11.130].

The TIS evaluates the impacts of the Delaware National residential development, proposed to be located on the south side of Delaware Route 48 (Lancaster Pike / New Castle Road 237), on the east and west sides of Hercules Road (New Castle Road 282) and west of Centerville Road (New Castle Road 272) in New Castle County, Delaware. In total, the proposed development would consist of 158 single-family detached houses and 104 townhouses on approximately 205 acres of land. The Wilmington and Western Railroad runs north and south through the site, and the development would therefore be divided into three parts. The part west of Hercules Road would have 19 single-family detached houses; the part east of Hercules Road but west of the railroad would have 104 single-family detached houses; the part east of the railroad but west of Centerville Road would have 35 single-family detached houses and 104 townhouses. The following access points are proposed: two along Hercules Road (to serve all parts of the site west of the railroad) with additional access via interconnection to the Ashland Research Center and Norman Drive (to serve units east of Hercules Road and west of the railroad), one along Red Clay Drive (to serve the majority of the site east of the railroad), and one along Penn Oak Drive (to serve approximately 18 units). Construction is anticipated to be complete by 2022.

The land is currently zoned as S (Suburban) within New Castle County, and will be developed under that zoning as an open-space planned residential development.

DelDOT currently has one relevant project in the study area, which is the Corridor Capacity Preservation Program (CCPP), a statewide program intended to sustain the capacity of adopted highway corridors by various means such as limiting access points and using service roads for local vehicle trips. The general purpose of the program is to ensure that existing principal arterial roadways, including Delaware Route 48 between Hercules Road and Delaware Route 41 (Newport Gap Pike / New Castle Road 21), are able to efficiently carry regional traffic without

impedance from the effects of local development. As the proposed Delaware National plan has no direct access to Delaware Route 48, DelDOT's CCPP Manager previously indicated no objection to the proposed development.

It is also noted that the TIS assessed future conditions both with and without proposed expansions of the DuPont Experimental Station and AstraZeneca facilities. The DuPont Experimental Station is located along Delaware Route 141, approximately 3.5 miles east of the Delaware National site. As evaluated, expansion of the DuPont site would add 1,069,974 SF of research and development space. The AstraZeneca campus is located near US Route 202, approximately 5.0 miles east of the Delaware National site. As evaluated, expansion of the AstraZeneca campus would add 1,763,746 SF of research and development space. The analyses that include the DuPont and AstraZeneca sites as committed developments were conducted for DelDOT evaluation (analyzed as Case 4) but were not subject to New Castle County regulations.

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

The proposed development will not meet the New Castle County Level of Service (LOS) Standards as stated in Section 40.11.210 of the Unified Development Code (UDC) unless physical roadway and/or traffic control improvements are implemented at the following intersections:

<i>Intersection</i>	<i>Existing Traffic Control</i>	<i>Situations for which deficiencies occur</i>
Centerville Road & Red Clay Drive	Signalized	2022 no-build (case 2) PM 2022 build (case 3) PM 2022 build (case 4) PM
Delaware Route 48 & Centerville Road	Signalized	2022 no-build (case 2) AM & PM 2022 build (case 3) AM & PM 2022 build (case 4) AM & PM

All other intersections included in the New Castle County scope of study for this TIS meet the LOS concurrency requirements of Section 40.11.210 of the New Castle County UDC.

The two intersections listed above are in DelDOT's scope of study for this TIS, and would exhibit LOS deficiencies according to Chapter 2 of DelDOT's *Development Coordination Manual*.

As shown in the table immediately below, three more intersections that are part of DelDOT's scope of study for this TIS would exhibit LOS deficiencies without the implementation of physical roadway and/or traffic control improvements, based on the criteria listed in Chapter 2 of DelDOT's *Development Coordination Manual*. These include two signalized intersections that were not part of New Castle County's scope of study, along with the stop-controlled minor street approaches at one unsignalized intersection. Because the unsignalized intersection is proposed to be controlled only by stop signs on the minor street approaches, the deficiencies pertain to those approaches only, and the intersection is not subject to New Castle County's concurrency requirements.

<i>Intersection</i>	<i>Existing Traffic Control</i>	<i>Situations for which deficiencies occur</i>
Delaware Route 48 & Delaware Route 141	Signalized	2017 existing (case 1) AM & PM 2022 no-build (case 2) AM & PM 2022 build (case 3) AM & PM 2022 build (case 4) AM & PM
Delaware Route 41 & Hercules Road / Mill Creek Road	Signalized	2022 build (case 3) AM 2022 build (case 4) AM
Hercules Road & Proposed Site Entrance	Does not exist; Proposed unsignalized two-way stop control (four-leg intersection)	2022 build (case 3) AM & PM 2022 build (case 4) AM & PM

Finally, the following unsignalized intersections that are in New Castle County's scope of study, but which are excluded from DelDOT's scope of study, have at least one stop-controlled minor street approach that would not meet the DelDOT unsignalized intersection LOS criteria unless physical roadway and/or traffic control improvements are implemented. However, because these unsignalized intersections are controlled only by stop signs on the minor street approaches, the deficiencies would pertain to those approaches only, and the intersections are not subject to New Castle County's concurrency requirements.

<i>Intersection</i>	<i>Existing Traffic Control</i>	<i>Situations for which deficiencies occur</i>
Delaware Route 48 & Stratton Drive	One-way stop control (unsignalized T-intersection)	2017 existing (case 1) AM 2022 no-build (case 2) AM 2022 build (case 3) AM & PM
Delaware Route 48 & Westgate Drive	One-way stop control (unsignalized T-intersection)	2017 existing (case 1) AM & PM 2022 no-build (case 2) AM & PM 2022 build (case 3) AM & PM
Hercules Road & Cheshire Court/ Olympus Place	Two-way stop control (unsignalized four-leg intersection)	2017 existing (case 1) AM 2022 no-build (case 2) AM 2022 build (case 3) AM
Centerville Road & Spice Mill Circle (Little Falls Centre)	One-way stop control (unsignalized T-intersection)	2022 no-build (case 2) AM & PM 2022 ld (case 3) AM & PM

The existing signalized intersection of Centerville Road and Red Clay Drive exhibits LOS deficiencies in the PM peak hour under future conditions. This traffic signal was installed in 2016 with side-street split phasing. The TIS recommends changing the side streets from split phasing to protected/permitted left-turn phasing. This will require changing the recently installed four-section signal heads to five-section signal heads on both side-street mast arms. The proposed change would address the LOS deficiencies as needed to meet concurrency requirements of the New Castle County UDC, but will need to be further evaluated by DelDOT Traffic Section to determine if it is appropriate to install the proposed phasing or if there were other factors (geometric design, safety, operations, etc.) that required the use of split phasing.

The existing signalized intersection of Delaware Route 48 and Centerville Road exhibits LOS deficiencies in the AM and PM peak hours under future conditions. Various options were considered to improve the intersection to satisfactory LOS; however, as the delays are the result of heavy traffic along eastbound Delaware Route 48, the most appropriate improvement is to add an additional third through lane to eastbound Delaware Route 48 through the intersection with Centerville Road. The details of the limits of this through lane are described in Item 7 below.

The existing signalized intersection of Delaware Route 48 and Delaware Route 141 exhibits existing and future operational deficiencies, operating at LOS F during the AM and PM peak hours due to the high traffic volumes traveling through the intersection. Each approach of the intersection currently consists of two exclusive left-turn lanes, two exclusive through lanes, and one exclusive channelized right-turn lane. Mitigation of LOS deficiencies would require the addition of a third exclusive through lane to one or more of the approaches. While adding these lanes would mitigate the poor LOS and improve overall operation, the construction of these lanes would have significant social, economic, and environmental impacts. Given those impacts along with the distance of this intersection from the proposed development and the incremental increase in intersection delay due to Delaware National site traffic, no mitigation by the developer is required at this intersection.

The existing signalized intersection of Delaware Route 41 and Hercules Road / Mill Creek Road exhibits LOS deficiencies in the AM peak hour under future build conditions. This intersection was recently improved in 2015 as part of the Toll Brothers Greenville Overlook residential development. This project added auxiliary thru lanes on both directions of Delaware Route 41 and on westbound Hercules Road. Bicycle lanes were added on Delaware Route 41 and left-turn lanes were extended on all approaches. Considering the recent extensive improvements already completed, we are not recommending any additional improvements be made to this intersection by the developer of Delaware National.

The proposed unsignalized full-access site entrance on Hercules Road exhibits LOS deficiencies under future build conditions. The LOS deficiencies would exist as LOS E on the eastbound minor street approach during the PM peak hour and on the westbound minor street approach during the AM peak hour. The expected 95th percentile queue length on the eastbound approach during the PM peak hour is expected to be less than one vehicle. Thus, no further improvements are recommended for this approach. The expected 95th percentile queue length on the westbound approach during the AM peak hour is expected to be approximately two vehicles. The addition of a 50' right-turn lane is recommended for this approach to allow right-turns to be made without undue delay from left-turn traffic. Additionally, based on the DelDOT auxiliary lane worksheet, right-turn lanes should be constructed on both northbound and southbound Hercules Road at the site entrances. LOS deficiencies are still expected on the minor street approaches even with these improvements; however, 95th percentile queue lengths are expected to be only one or two vehicles long. Furthermore, with the proposed roadway interconnection between Delaware National and the Ashland Research Center property, drivers wanting to make a westbound left from Delaware National onto southbound Hercules Road would have the option of doing so via the signalized intersection of Hercules Road and Ashland Research Center Entrance.

The following are existing unsignalized intersections that each exhibit LOS deficiencies on at least one of the minor street approaches under future conditions, but we do not recommend any improvements be implemented by the developer at any of these intersections:

- Delaware Route 48 and Stratton Drive
- Delaware Route 48 and Westgate Drive
- Hercules Road and Cheshire Court / Olympus Place
- Centerville Road and Spice Mill Circle (Little Falls Centre)

For the Stratton Drive intersection, LOS deficiencies would exist only on the low-volume minor street approach (under the existing and all future scenarios), and the 95th percentile queue lengths on that approach are not expected to exceed one vehicle. Trips generated by Delaware National will not add to volumes turning to or from Stratton Drive. Along the section of Delaware Route 48 west of Hercules Road, Delaware National is expected to add a maximum of 11 vehicles to the thru movements in each direction during each peak hour. The total approach volume on Stratton Drive is expected to be 25 vehicles in the AM peak hour and 12 vehicles in the PM peak hour.

For the Westgate Drive intersection, LOS deficiencies would exist only on the low-volume minor street approach during the AM and PM peak hours (under the existing and all future scenarios), and the 95th percentile queue lengths on that approach are expected to be less than two vehicles. Trips generated by Delaware National will not add to volumes turning to or from Westgate Drive. Along the section of Delaware Route 48 west of Hercules Road, Delaware National is expected to add a maximum of 11 vehicles to the thru movements in each direction during each peak hour. The total approach volume on Westgate Drive is expected to be 27 vehicles in the AM peak hour and 16 vehicles in the PM peak hour.

At the intersection of Hercules Road and Cheshire Court / Olympus Place, LOS deficiencies would occur on the minor street approaches during the AM peak hour (under existing and all future scenarios). On the eastbound Cheshire Court approach, the 95th percentile queue lengths are expected to be less than one vehicle, and the future total approach volumes are projected to be three vehicles in the AM peak hour and zero vehicles in the PM peak hour. On the westbound Olympus Place approach, the 95th percentile queue lengths are expected to be approximately two vehicles.

For the intersection of Centerville Road and Spice Mill Circle, LOS deficiencies would exist only on the minor street approach during the AM and PM peak hours (under all future scenarios). A significant portion of the increase in delay to minor street traffic occurs in the no-build scenario. This is due to the proposed Little Falls Center 1 & 2 development, which is proposed to add 26,550 SF of office space. The TIS states that this development will have access from Penn Oak Drive. However, based on the site plans for Delaware National, the site plans for Little Falls Center Lots 1 & 2, and coordination with DelDOT, McCormick Taylor determined that access for this office development will be via the existing intersection of Centerville Road & Spice Mill Circle. McCormick Taylor re-distributed the trips associated with Little Falls Center Lots 1 & 2

to account for this discrepancy. In both the future no-build and build scenarios, the eastbound Spice Mill Circle left-turn is expected to have 95th percentile queue lengths of 13 vehicles in the PM peak hour; the eastbound right-turn is also expected to have 95th percentile queue lengths of seven vehicles. Potential methods to address the deficiencies (including signalization or prohibiting turning movements) were considered but were determined to be infeasible and/or unjustified. Given that Spice Mill Circle only serves a self-contained office complex (part of Little Falls Centre), there is only a short duration of high-volume exiting traffic during the PM peak hour, with low volumes of exiting traffic the rest of the day. As such, we do not recommend any improvements be implemented by the developer of Delaware National. However, if an internal connection could be negotiated to connect this parcel of Little Falls Centre with the parcel immediately to the north, which has access to Red Clay Drive, that connection could provide some relief for the Spice Mill Circle intersection.

Should the County choose to 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 Hercules Road from Norman Drive (Ashland Research Center driveway) to a point 300 feet south of Delaware Route 48 (just south of former golf cart tunnel) as needed in order to meet DelDOT's major collector road standards. These standards include but are not limited to twelve-foot travel lanes and eight-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 the proposed site entrances (Cobbs Creek Way / Muirfield Way) on Hercules Road as a full-movement access point. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Hercules Road	Two through lanes	One left-turn lane, two through lanes, and one right-turn lane
Southbound Hercules Road	Two through lanes	One left-turn lane, two through lanes, and one right-turn lane
Eastbound Cobbs Creek Way	Approach does not exist	One shared left/through/right-turn lane
Westbound Muirfield Way	Approach does not exist	One shared left-turn/through lane and one right-turn lane

Initial recommended minimum turn-lane lengths (excluding tapers) of the separate turn lanes are listed below. The developer should coordinate with DelDOT's Development Coordination Section to determine final design details, including exact entrance location and final turn-lane lengths, during the site plan review process.

Approach	Left-Turn Lane	Right-Turn Lane
Northbound Hercules Road	120 feet ***	160 feet *
Southbound Hercules Road	120 feet ***	100 feet *
Eastbound Cobbs Creek Way	N/A	N/A
Westbound Muirfield Way	N/A	50 feet **

* initial turn-lane length based on DelDOT's *Auxiliary Lane Worksheet*

** initial turn-lane length based on storage length per queuing analysis

*** The lengths of the proposed left-turn lanes are estimated based on guidance in Section 5.2.9.3 of DelDOT's Development Coordination Manual. However, as noted in the Manual and the *Auxiliary Lane Worksheet*, based on the geometry of the proposed intersection the developer's Engineer shall coordinate further with DelDOT's Development Coordination Section to determine these specific turn lane lengths. Also note that the proposed northbound left-turn lane may require modifications to the existing southbound left-turn lane for Norman Drive (Ashland Research Center).

- The developer should coordinate with DelDOT's Development Coordination Section and New Castle County regarding the proposed interconnection between the proposed Delaware National site and the adjacent Ashland Research Center property (via proposed Spyglass Hill Way, with interconnection located immediately south of the portion of the Delaware National site east of Hercules Road). Such a connection would give the Delaware National property a secondary access point along Hercules Road, via the connection through the Ashland Research Center to the existing signal at the Hercules Road entrance. The developer should coordinate with DelDOT's Development Coordination Section to determine final design details of the interconnection during the site plan review process.
- The developer should construct the proposed site entrance (Phalen Court) on Penn Oak Drive. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Penn Oak Drive	One through lane	One shared through/right-turn lane
Southbound Penn Oak Drive	One through lane	One shared left-turn/through lane
Westbound Phalen Court	Approach does not exist	One shared left-turn/right-turn lane

5. The developer should construct the site entrance (Rolling Oaks Way) on Red Clay Drive. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration*
Northbound Rolling Oaks Way	Approach does not exist	One right-turn only lane
Eastbound Red Clay Drive	One thru lane	One shared through/right-turn lane
Westbound Red Clay Drive	One thru lane, separated from eastbound lane by a raised grass median	One thru lane, separated from eastbound lane by a raised grass median

* Potential issues are noted with the proposed the site entrance (Rolling Oaks Way) on Red Clay Drive. Based on the available site plans, it appears that this site entrance is designed as right-in/right-out with the existing median to remain on Red Clay Drive. This design would require traffic entering from Centerville Road to complete a U-turn around the western end of the median (at Penn Oak Drive) to reach Rolling Oaks Way. This layout may not be appropriate for a residential entrance from a low-volume street. In addition, the site entrance is to be located in close proximity to the existing intersection of Red Clay Drive & Penn Oak Drive. The configuration of this proposed driveway should be confirmed during the site plan review process to verify that adequate sight distance will be available for all proposed movements at this intersection and that road users will be provided with adequate traffic control devices to easily determine who has the right-of-way at the closely spaced intersections. The developer must coordinate with DelDOT's Development Coordination Section to determine final design details including the intersection configuration and location during the site plan review process.

6. The developer should enter into a traffic signal agreement with DelDOT for the intersection of Centerville Road and Red Clay Drive. The agreement will cover signal phasing adjustments needed to meet the LOS concurrency requirements of the New Castle County UDC (i.e. change from side-street split phasing to concurrent phasing with protected/permitted left turns). The agreement should include pedestrian signals, crosswalks, interconnection, and ITS equipment such as CCTV cameras at DelDOT's discretion. The developer should coordinate with DelDOT on the design details and implementation of the traffic signal modifications.
7. The developer should improve the intersection of Delaware Route 48 and Centerville Road by adding a third through lane in the eastbound direction (widening Delaware Route 48 to the south as needed). The limits of the third through lane on Delaware Route 48 should begin approximately 1,600 feet west of the intersection and end approximately 900 feet east of the intersection, where it would lead directly into the existing right-turn lane for Little Falls Drive. The existing separate right-turn lane on the eastbound approach of Delaware Route 48 at Centerville Road should be retained on the outside of the new through lane. The existing acceleration lane on eastbound Delaware Route 48

east of Centerville Road should also be retained on the outside of the new through lane. The developer should coordinate with DelDOT during the site plan review process regarding design details such as lane lengths, signing, striping, channelization islands and other traffic control modifications associated with these intersection improvements.

8. The developer should enter into a traffic signal agreement with DelDOT for the intersection of Delaware Route 48 and Centerville Road. The agreement will cover signal adjustments required by the physical improvements described in Item No. 7. The agreement should include pedestrian signals, crosswalks, interconnection, and ITS equipment such as CCTV cameras at DelDOT's discretion. The developer should coordinate with DelDOT on the design details, implementation and equitable cost sharing of the traffic signal modifications. One or more other developers may enter into a traffic signal agreement for this intersection as well.
9. The following bicycle, pedestrian, and transit improvements should be included:
 - a. A right-turn yield to bikes sign (MUTCD R4-4) should be added at the start of the right-turn lanes added to northbound and southbound Hercules Road at the proposed site entrances (Cobbs Creek Way / Muirfield Way).
 - b. Adjacent to the proposed right-turn lanes on northbound and southbound Hercules Road at the proposed site entrances (Cobbs Creek Way / Muirfield Way), a minimum five-foot wide bicycle lane should be dedicated and striped with appropriate markings for bicyclists through the turn lane in order to facilitate safe and unimpeded bicycle travel.
 - c. Appropriate bicycle symbols, directional arrows, striping (including stop bars), and signing should be included along bicycle facilities and right-turn lanes within the project limits.
 - d. Utility covers should be made flush with the pavement.
 - e. The existing golf cart tunnel under Hercules Road just south of Delaware Route 48 should be improved as needed and retained as a shared-use path.
 - f. The existing pedestrian path tunnel under Red Clay Drive just east of Penn Oak Drive should be improved as needed and retained as a shared-use path.
 - g. The network of proposed shared-use paths shown on the site plan should be constructed throughout the site. The developer should coordinate with DelDOT's Development Coordination Section during the site plan review process to determine design details of the shared-use paths including exact alignments and possible additional pedestrian connections.
 - h. Any shared-use paths being constructed, extended or relocated as described herein (including any existing/former golf cart paths being re-purposed as shared-use paths) should be a minimum of ten feet wide with a minimum of a five-foot buffer from any roadway and should meet current UDC, DelDOT, AASHTO, and ADA standards.
 - i. ADA compliant curb ramps and crosswalks should be provided at all pedestrian crossings, including all site entrances. Type 3 curb ramps are discouraged.



- j. Internal sidewalks for pedestrian safety and to promote walking as a viable transportation alternative should be constructed, on both sides of the street, along all streets within the development. These sidewalks should each be a minimum of five feet wide (with a minimum of a five-foot buffer from the roadway) and should meet current AASHTO and ADA standards. These internal sidewalks should connect each residential area to the previously described network of multi-use paths.
- k. The developer should provide right of way for two future bus stops along the site frontage on both sides of Hercules Road (one stop on each side), at locations agreeable to the Delaware Transit Corporation (DTC).
- l. The developer should relocate the existing bus stop along eastbound Delaware Route 48 east of Hercules Road so that it is closer to Hercules Road. A multi-use path should be built to provide a pedestrian connection between this relocated bus stop and the proposed development. Parking facilities for bicyclists should be included at the bus stop.
- m. The nearest Park & Ride facility is located at the intersection of Kennett Pike & DuPont Road. The developer should contribute a one-time fee of \$1,000 towards the ongoing maintenance of this facility.
- n. The developer should coordinate with the DTC and DelDOT regarding the details and implementation of all transit-related improvements.

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://deldot.gov/Publications/manuals/de_muted/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.

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.

Additional details on our review of this TIS are attached. Please contact me at (610) 640-3500 or through e-mail at ajparker@mccormicktaylor.com if you have any questions concerning this review.

Sincerely,
McCormick Taylor, Inc.

A handwritten signature in black ink, appearing to read "Andrew J. Parker".

Andrew J. Parker, P.E., PTOE
Project Manager

Enclosure

General Information

Report date: July 10, 2017

Prepared by: Michael Maris Associates, Inc. (MMA)

Prepared for: Golf Course Associates, LLC

Tax parcels: 07-031.00-001, 07-031.00-014, 08-027.00-001, and 08-027.00-007

Generally consistent with DelDOT's *Development Coordination Manual*: Yes

Project Description and Background

Description: The proposed development would consist of 158 single-family detached homes and 104 townhouse homes. The proposed development would replace the former Delaware National County Club golf course.

Location: Delaware National is proposed to be located on the south side of Delaware Route 48 (Lancaster Pike / New Castle Road 237), on the east and west sides of Hercules Road (New Castle Road 282) and west of Centerville Road (New Castle Road 272) in New Castle County, Delaware. The Wilmington and Western Railroad runs north and south through the site, and the development would therefore be divided into three parts. The part west of Hercules Road would have 20 single-family detached houses; the part east of Hercules Road but west of the railroad would have 104 single-family detached houses; the part east of the railroad but west of Centerville Road would have 34 single-family detached houses and 104 townhouses. A site location map is included on Page 12.

Amount of land to be developed: approximately 205 acres

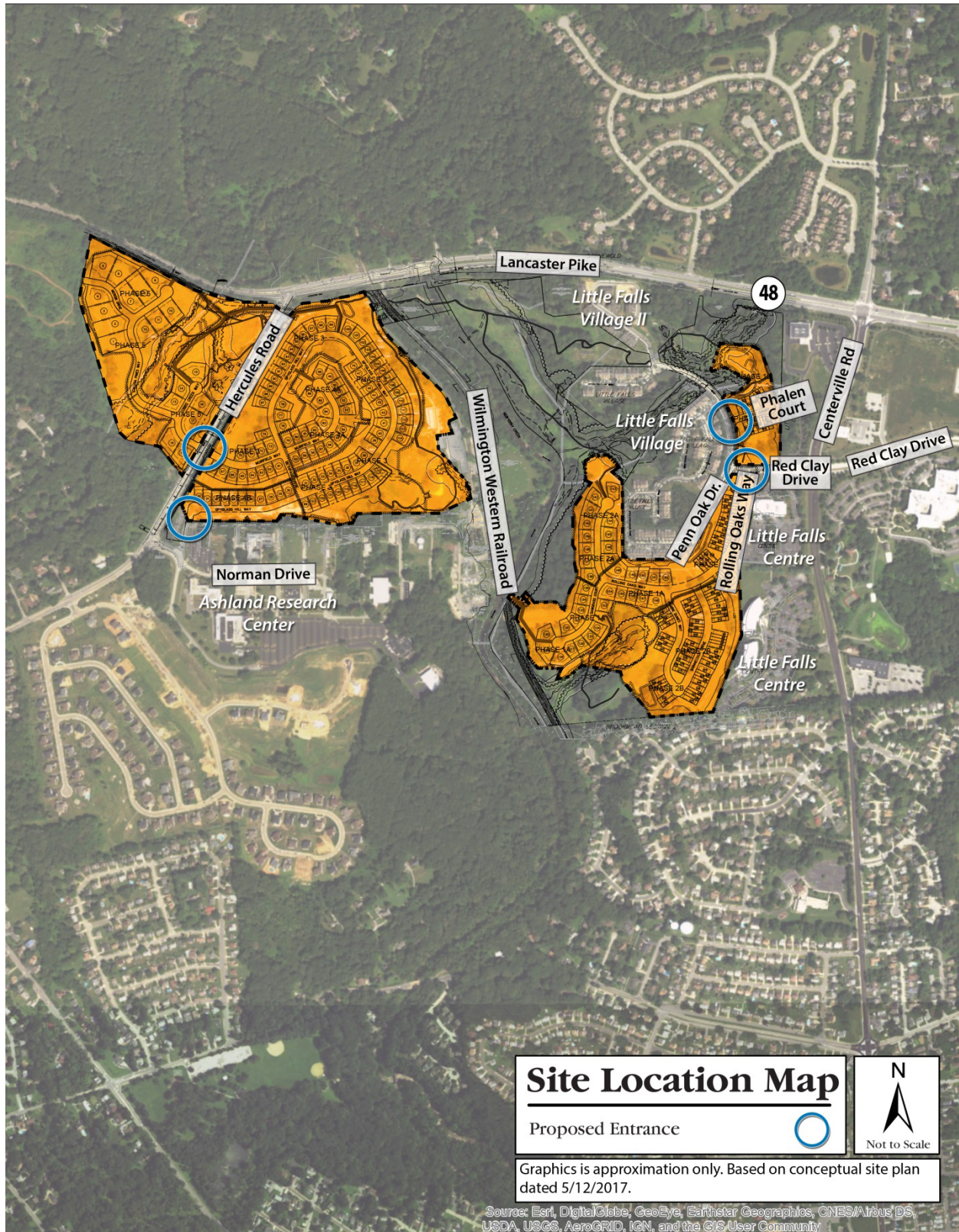
Land use approval(s) needed: The land is currently zoned as S (Suburban) within New Castle County, and will be developed under that zoning as an open-space planned residential development.

Proposed completion date: 2022

Proposed access locations: The following access points are proposed: two along Hercules Road (to serve all parts of the site west of the railroad) with additional access via interconnection to the Ashland Research Center and Norman Drive (to serve units east of Hercules Road and west of the railroad), one along Red Clay Drive (to serve the majority of the site east of the railroad), and one along Penn Oak Drive (to serve approximately 18 units).

Daily Traffic Volumes:

- 2016 Average Annual Daily Traffic on Delaware Route 48: 30,646 vpd
- 2016 Average Annual Daily Traffic on Hercules Road: 7,776 vpd
- 2016 Average Annual Daily Traffic on Centerville Road: 8,694 vpd



2015 Delaware Strategies for State Policies and Spending

Location with respect to the Strategies for State Policies and Spending Map of Delaware:

The majority of the proposed Delaware National residential development lies within investment level 2 areas. However, portions of the development also fall within investment level 3 areas. Out of play areas are also located along Red Clay Creek and throughout the existing Little Falls Village residential development.

Investment Level 2

Investment level 2 has many diverse characteristics. These areas can be composed of less developed areas within municipalities, rapidly growing areas in the counties that have or will have public water and wastewater services and utilities, areas that are generally adjacent to or near investment level 1 areas, smaller towns and rural villages that should grow consistently with their historic character, and suburban areas with public water, wastewater, and utility services. These areas have been shown to be the most active portion of Delaware's developed landscape. They serve as transition areas between level 1 and the state's more open, less populated areas. They generally contain a limited variety of housing types, predominantly detached single-family dwellings.

In investment level 2 areas, state investments and policies should support and encourage a wide range of uses and densities, promote other transportation options, foster efficient use of existing public and private investments, and enhance community identity and integrity.

Investments should encourage departure from the typical single-family-dwelling developments and promote a broader mix of housing types and commercial sites encouraging compact, mixed-use development where applicable. Overall, the State's intent is to use its spending and management tools to promote well-designed development in these areas. Such development provides for a variety of housing types, user-friendly transportation systems, and provides essential open spaces and recreational facilities, other public facilities, and services to promote a sense of community.

Investment Level 3

Investment level 3 areas generally fall into two categories. The first category covers lands that are in the long-term growth plans of counties or municipalities, but where development is not necessary to accommodate expected short-term population growth. The second category includes lands that are adjacent to fast-growing investment level 1 and 2 areas but are often impacted by environmentally sensitive features, agricultural-preservation issues, or other infrastructure issues. In these instances, development and growth may be appropriate in the near term, but the resources on the site and in the surrounding area should be carefully considered and accommodated by state agencies and local governments with land-use authority.

Generally, investment level 3 areas should not be developed until surrounding investment level 1 and 2 areas are substantially built out. From a housing perspective, investment level 3 areas are characterized by low density and rural homes. New housing developments in the short term

would, in most cases, represent leap-frog development, which is undesirable. Higher density housing in investment level 3 areas is more appropriate once level 2 areas are built out and utilities are available.

Out of Play

The Delaware State Strategies 2015 map indicates several out of play areas near the proposed developments. These areas are not expected to be used for private development, typically due to serious legal or environmental constraints. The development of these sites should consider natural resources and the environment, emphasizing the protection of critical natural habitat, wildlife, and stormwater management/drainage areas.

Proposed Development's Compatibility with Strategies for State Policies and Spending:

The proposed Delaware National residential development is located within investment level 2 and investment level 3 areas; the proposed development would replace the former Delaware National golf course. Nearby land uses throughout the study area primarily include low and medium density residential and suburban style office and research complexes.

The proposed development is generally consistent with neighboring land uses and the character of investment level 3 areas. Typically, investment level 2 areas would be developed as more compact sites, with a mix of land uses and multi-family housing. However, it is recognized that this type of mixed-use site is not compatible with the site's zoning and future land use designation. Additionally, the *Strategies for State Policies and Spending* document encourages making use of existing infrastructure through infill development and redevelopment of underutilized tracts rather than encouraging new sprawling or "leap frog" developments. The proposed development is consistent with these guidelines. Assuming the planning and construction takes into account the "out of play" areas, the proposed development generally appears to comply with the policies stated in the 2015 "Strategies for State Policies and Spending."

Comprehensive Plan

New Castle County Comprehensive Plan:

(Source: New Castle County 2012 Comprehensive Plan)

The *2012 Comprehensive Plan* indicates that the proposed development is split between the "Piedmont" (west of Red Clay Creek) and "Lower Christina" (east of Red Clay Creek) planning districts. The Future Land Use Map indicates that the proposed development is located in an area that is designated as low density residential (1-3 dwelling units per acre).

The land is currently zoned as S (suburban) in New Castle County. It appears that no rezoning is proposed. According to Section 40.02.232 of the New Castle County Unified Development Code (UDC), characteristics of S zoning are as follows:

- This district permits a wide range of residential uses. This district includes all the newly developing areas designated as growth areas in the Comprehensive Development Plan.

- This district permits moderate to high density development and a full range of residential uses in a manner consistent with providing a high quality suburban character. Significant areas of open space and/or landscaping shall be provided to maintain the balance between green space and buildings that characterize suburban character. The highest densities are permitted in designed communities, hamlets and villages through the use of Smart Code techniques.
- This district is not intended to be used for fully developed areas. Fully developed areas are zoned Neighborhood Conservation (NC). The Suburban District is used for in-fill tracts containing at least five (5) acres or where New Castle County seeks to redevelop the area to suburban character.

Proposed Development's Compatibility with Comprehensive Plan: Delaware National is planned as a suburban residential housing development, which is compatible with S zoning and the New Castle County Comprehensive Plan. With 262 units on approximately 205 acres, the gross density of this residential development would be approximately 1.3 dwelling units per acre, which is within the desired range for low density residential land use.

Relevant Projects in the DelDOT Capital Transportation Program

DelDOT currently has one relevant project in the study area. It is the Corridor Capacity Preservation Program (CCPP), which is a statewide program intended to sustain the capacity of adopted highway corridors by various means such as limiting access points and using service roads for local vehicle trips. The general purpose of the program is to ensure that existing principal arterial roadways, including Delaware Route 48 between Hercules Road and Delaware Route 41 (Newport Gap Pike / New Castle Road 21), are able to efficiently carry regional traffic without impedance from the effects of local development. As the proposed Delaware National plan has no direct access to Delaware Route 48, DelDOT's CCPP Manager previously indicated no objection to the proposed development.

Trip Generation

Trip generation for the proposed development was computed using comparable land uses and equations contained in Trip Generation, Ninth Edition, 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:

- 158 single-family detached homes (ITE Land Use Code 210)
- 104 residential condominiums/townhomes (ITE Land Use Code 230)

Table 1
DELAWARE NATIONAL PEAK HOUR TRIP GENERATION

Land Use	AM Peak Hour			PM Peak Hour		
	In	Out	Total	In	Out	Total
<i>West of Hercules Road</i>						
20 single-family detached homes	6	18	24	16	9	25
<i>East of Hercules Road, west of railroad</i>						
104 single-family detached homes	21	62	83	69	40	109
<i>East of railroad, west of Centerville Road, North of Red Clay Drive</i>						
18 residential condominiums/townhomes	2	11	13	10	5	15
<i>East of railroad, west of Centerville Road, South of Red Clay Drive</i>						
86 residential condominiums/townhomes	8	38	46	36	17	53
34 single-family detached homes	9	25	34	25	15	40
TOTAL TRIPS	46	154	200	156	86	242

Table 2
DELAWARE NATIONAL DAILY TRIP GENERATION

Land Use	Weekday ADT		
	In	Out	Total
<i>West of Hercules Road</i>			
20 single-family detached homes	119	119	239
<i>East of Hercules Road, west of railroad</i>			
104 single-family detached homes	544	544	1089
<i>East of railroad, west of Centerville Road, North of Red Clay Drive</i>			
18 residential condominiums/townhomes	72	72	145
<i>East of railroad, west of Centerville Road, South of Red Clay Drive</i>			
86 residential condominiums/townhomes	282	282	564
34 single-family detached homes	195	195	389
TOTAL TRIPS	1212	1212	2426

Overview of TIS

Intersections examined:	DelDOT Scope	New Castle County Scope
1) Hercules Road & Proposed Site Entrance	X	X
2) Delaware Route 48 & Hercules Road	X	X
3) Delaware Route 48 & Stratton Drive		X
4) Delaware Route 48 & Westgate Drive		X
5) Delaware Route 48 & Rolling Mill Road	X	X
6) Rolling Mill Road & Foxhill Lane		X
7) Delaware Route 48 & Hampton Way		X
8) Hercules Road & Norman Drive (Ashland Research Center)	X	X
9) Hercules Road & Cheshire Court/Olympus Place		X
10) Hercules Road & Tall Trees Lane		X
11) Red Clay Drive & Penn Oak Drive		X
12) Centerville Road & Red Clay Drive	X	X
13) Delaware Route 48 & Centerville Road	X	X
14) Centerville Road & Spice Mill Circle (Little Falls Centre 1 & 2)		X
15) Delaware Route 48 & Delaware Route 141	X	
16) Delaware Route 41 & Hercules Road / Mill Creek Road	X	

Conditions examined:

- 1) 2017 existing traffic conditions (case 1)
- 2) 2022 no-build traffic conditions (case 2)
- 3) 2022 build traffic conditions (case 3)
- 4) 2022 build traffic conditions with proposed improvements (case 3A – at select intersections)
- 5) 2022 build traffic conditions, with AstraZeneca and DuPont expansions (case 4)
Case 4 was evaluated at the DelDOT scoped intersections only.

Peak hours evaluated: Weekday morning and evening peak hours

Committed developments considered (cases 2-4):

- 1) Little Falls Center – Lots 1 & 2 (26,550 SF office space)
- 2) Little Falls Center – Lot 4 (61,800 SF office space)
- 3) Little Falls Center – Lots 9 & 11 (211,107 SF office space)
- 4) Little Falls Center – Lot 10 (282,008 SF office space)
- 5) DuPont Chestnut Run Plaza expansion (284,950 SF office space)
- 6) Hercules/Ashland expansion (50,000 SF office space & 80,000 SF warehouse space)
- 7) Tatnall School expansion (37,735 SF high school space)
- 8) Greenville Overlook expansion (30 single-family homes)

Additional committed developments considered (additional for case 4 only):

- 1) DuPont Experimental Station expansion (1,069,974 SF research & development space)
- 2) AstraZeneca expansion (1,763,746 SF research & development space)

Intersection Descriptions

1) Hercules Road & Proposed Site Entrance

Type of Control: proposed two-way stop-controlled (four-leg intersection)

Northbound approach: (Hercules Road) existing two thru lanes; TIS proposed one left-turn lane, one thru lane, and one shared thru/right-turn lane; McCormick Taylor proposed one left-turn lane, two thru lanes, and one right-turn lane

Southbound approach: (Hercules Road) existing two thru lanes; TIS proposed one left-turn lane, one thru lane, and one shared thru/right-turn lane; McCormick Taylor proposed one left-turn lane, two thru lanes, and one right-turn lane

Eastbound approach: (Cobbs Creek Way) proposed one shared left-turn/thru/right-turn lane, stop controlled

Westbound approach: (Muirfield Way) TIS proposed one shared left-turn/thru/right-turn lane, stop controlled; McCormick Taylor proposed one shared left-turn/thru lane and one right-turn lane, stop controlled

2) Delaware Route 48 & Hercules Road

Type of Control: signalized three-leg intersection

Northbound approach: (Hercules Road) one left-turn lane and two right-turn lanes

Eastbound approach: (Delaware Route 48) one thru lane and one shared thru/right-turn lane

Westbound approach: (Delaware Route 48) two left-turn lanes and one thru lane

3) Delaware Route 48 & Stratton Drive

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Stratton Drive) one shared left-turn/right-turn lane, stop controlled

Eastbound approach: (Delaware Route 48) one thru lane and one right-turn lane

Westbound approach: (Delaware Route 48) one left-turn lane and one thru lane

4) Delaware Route 48 & Westgate Drive

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Westgate Drive) one shared left-turn/right-turn lane, stop controlled

Eastbound approach: (Delaware Route 48) one thru lane and one right-turn lane

Westbound approach: (Delaware Route 48) one left-turn lane and one thru lane

5) Delaware Route 48 & Rolling Mill Road

Type of Control: one-way stop-controlled (T-intersection)

Southbound approach: (Rolling Mill Road) one right-turn lane, stop controlled

Eastbound approach: (Delaware Route 48) two thru lanes, separated from westbound lanes by grass median

Westbound approach: (Delaware Route 48) two thru lanes (one marked for downstream left turns) and one right-turn lane

6) Rolling Mill Road & Foxhill Lane

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Rolling Mill Road) one shared left-turn/thru lane

Southbound approach: (Rolling Mill Road) one shared thru/right-turn lane

Eastbound approach: (Foxhill Lane) one shared left-turn/right-turn lane, stop controlled
The Foxhill Lane approach is a one-lane covered bridge. This requires all eastbound traffic, northbound left traffic, and southbound right traffic to yield right-of-way to vehicles already on the bridge.

7) Delaware Route 48 & Hampton Way

Type of Control: one-way stop-controlled (T-intersection)

Southbound approach: (Hampton Way) one right-turn lane, stop controlled

Eastbound approach: (Delaware Route 48) two thru lanes, separated from westbound lanes by grass median

Westbound approach: (Delaware Route 48) two thru lanes and one right-turn lane

8) Hercules Road & Norman Drive (Ashland Research Center)

Type of Control: signalized three-leg intersection

Northbound approach: (Hercules Road) one thru lane and one right-turn lane

Southbound approach: (Hercules Road) one left-turn lane and two thru lanes

Westbound approach: (Norman Drive) one left-turn lane and one right-turn lane

9) Hercules Road & Cheshire Court / Olympus Place

Type of Control: two-way stop-controlled four-leg intersection

Northbound approach: (Hercules Road) one left-turn lane, one thru lane, and one right-turn lane

Southbound approach: (Hercules Road) one left-turn lane, one thru lane, and one right-turn lane

Eastbound approach: (Cheshire Court) one shared left-turn/thru/right-turn lane, stop controlled

Westbound approach: (Olympus Place) one shared left-turn/thru lane and one right-turn lane, stop controlled

10) Hercules Road & Tall Trees Lane

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Hercules Road) one shared thru/right-turn lane

Southbound approach: (Hercules Road) one left-turn lane and one thru lane

Westbound approach: (Tall Trees Lane) one shared left-turn/right-turn lane, stop controlled

11) Red Clay Drive & Penn Oak Drive

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Penn Oak Drive) one shared thru/right-turn lane

Southbound approach: (Penn Oak Drive) one shared left-turn/thru lane

Westbound approach: (Red Clay Drive) one shared left-turn/right-turn lane, stop controlled

12) Centerville Road & Red Clay Drive

Type of Control: signalized four-leg intersection

Northbound approach: (Centerville Road) one left-turn lane, one thru lane, and one right-turn lane

Southbound approach: (Centerville Road) one left-turn lane, one thru lane, and one right-turn lane

Eastbound approach: (Red Clay Drive) one left-turn lane, one thru lane, and one right-turn lane

Westbound approach: (Red Clay Drive) one left-turn lane, one thru lane, and one right-turn lane

13) Delaware Route 48 & Centerville Road

Type of Control: signalized four-leg intersection

Northbound approach: (Centerville Road) one left-turn lane, one shared left-turn/thru lane, one thru lane, and one right-turn lane

Southbound approach: (Centerville Road) one left-turn lane, one shared left-turn/thru lane, one thru lane, and one right-turn lane

Eastbound approach: (Delaware Route 48) one left-turn lane, two thru lanes, and one right-turn lane

Westbound approach: (Delaware Route 48) two left-turn lanes, two thru lanes, and one right-turn lane

14) Centerville Road & Spice Mill Circle (Little Falls Centre One & Two)

Type of Control: one-way stop-controlled (T-intersection)

Northbound approach: (Centerville Road) one left-turn lane and one thru lane

Southbound approach: (Centerville Road) one thru lane and one right-turn lane

Eastbound approach: (Spice Mill Circle) one left-turn lane and one right-turn lane, stop controlled

15) Delaware Route 48 & Delaware Route 141

Type of Control: signalized four-leg intersection

Northbound approach: (Delaware Route 141) two left-turn lanes, two thru lanes, and one right-turn lane

Southbound approach: (Delaware Route 141) two left-turn lanes, two thru lanes, and one right-turn lane

Eastbound approach: (Delaware Route 48) two left-turn lanes, two thru lanes, and one right-turn lane

Westbound approach: (Delaware Route 48) two left-turn lanes, two thru lanes, and one right-turn lane

16) Delaware Route 41 & Hercules Road

Type of Control: signalized four-leg intersection

Northbound approach: (Mill Creek Road) one left-turn lane, one thru lane, and one right-turn lane

Southbound approach: (Hercules Road) one left-turn lane, two thru lanes, and one right-turn lane

Eastbound approach: (Delaware Route 41) one left-turn lane, two thru lanes, and one right-turn lane

Westbound approach: (Delaware Route 41) one left-turn lane, two thru lanes, and one right-turn lane

Safety Evaluation

Crash Data: McCormick Taylor reviewed the Delaware Crash Analysis Reporting System (CARS) data that was provided in Appendix E of the TIS. The data includes reportable crashes that occurred within a one-tenth mile radius of the study intersections from March 1, 2014 through March 1, 2017. The data for several intersections was provided for February 28, 2014 to February 28, 2017 (shifted by one day).

Of particular concern for safety evaluations are fatal crashes and crashes involving pedestrians or pedalcyclists. During the study period, there was one fatal crash at the intersection of Delaware Route 48 & Old Wilmington Road (included in the data for Westgate Drive) that resulted in two fatalities. There were no crashes involving a pedestrian or pedalcyclist during the study period. A breakdown of all crashes by intersection is provided below.

1. Hercules Road & Proposed Site Entrance

At the intersection of Hercules Road & Proposed Site Driveways, there was a total of 8 crashes. Of the 8 crashes, 3 (38%) resulted in personal injury. There were no alcohol related collisions. The types of crashes were rear-end crashes (50%), not a collision between two vehicles (25%), angle crashes (13%) and sideswipe – same direction crashes (13%). The crashes occurred during daylight (88%) or dark-not lighted (12%) hours. The majority of the crashes occurred on wet (50%) or dry (38%) pavement conditions. There were several primary contributing circumstances to the crashes, each with one or two

crashes each. These include other environmental circumstances – weather, glare (25%), disregard traffic signal (13%), following too close (13%), driver inattention, distraction, or fatigue (13%), driving in a careless or reckless manner (13%), deer in roadway (13%), and other (13%).

The TIS states that crash data for the proposed site driveways is included in the crash data for Delaware Route 48 & Hercules Road. The meaning of this statement is unclear. The geographical location of the CARS data query is also unclear due to poor image quality of the location map on the CARS report included in the TIS.

2. Delaware Route 48 & Hercules Road

At the intersection of Delaware Route 48 & Hercules Road, there was a total of 22 crashes. Of the 22 total crashes, 7 (32%) resulted in personal injury. None of the crashes were alcohol related. The most common types of crashes were rear-end collisions (50%) or not a collision between two vehicles (41%). The majority of the crashes occurred during daylight (59%) or dark-not lighted (23%) hours with dry (59%) or wet (32%) surface conditions. The common primary contributing circumstances include following too close (18%), deer in roadway (14%) or other environmental circumstances (14%).

3. Delaware Route 48 & Stratton Drive

At the intersection of Delaware Route 48 & Stratton Drive, there was a total of 1 crash. The crash was not a collision between two vehicles, and no injuries or fatalities were reported. The crash was not alcohol related. The crash occurred in dark-not lighted conditions on dry surface conditions. The primary contributing circumstance was a deer in the roadway.

4. Delaware Route 48 & Westgate Drive

At the intersection of Delaware Route 48 & Westgate Drive, there was a total of 7 crashes. Of the 7 crashes, one collision resulted in two fatalities. This crash actually occurred at the intersection of Delaware Route 48 & Old Wilmington Road, which is just within the 0.10-mile radius of crash data obtained for the study intersection. A Delaware Free News article, updated March 24, 2015, describes the fatal crash that occurred at approximately 10:30 p.m. on March 23, 2015. The crash involved an SUV making a left turn from Old Wilmington Road to Delaware Route 48 and a car traveling on Delaware Route 48. As the driver of the SUV attempted to turn onto Delaware Route 48, the vehicle was struck on the driver's side by the oncoming car. The article states that the driver of the SUV sustained fatal injuries as a result of the crash and a passenger in the

SUV sustained serious injuries. It is likely that a second person involved in the crash died at a later time after the article was published.

Of the 7 crashes, 2 (29%) resulted in personal injury. There was one alcohol related crash that resulted in personal injury. The crash types included angle crashes (43%), rear end crashes (29%), and collisions not involving two vehicles (29%). The crashes occurred during daylight (71%) or dark-not lighted (29%) conditions with dry (71%) or wet (29%) surface conditions. The primary contributing circumstances include failing to yield right of way (29%), passed stop sign (14%), made improper turn (14%), driving under the influence (14%), driver inattention, distraction or fatigue (14%), and deer in the roadway (14%).

5. Delaware Route 48 & Rolling Mill Road

At the intersection of Delaware Route 48 & Rolling Mill Road, there was a total of 7 crashes. Of the 7 crashes, 2 (29%) resulted in personal injury. There were no alcohol related crashes. The types of crashes were rear-end crashes (57%), sideswipe – same direction crash (14%), sideswipe – opposite direction crash (14%), and not a collision between two vehicles (14%). The crashes occurred during daylight hours (86%) or dark-not lighted hours (14%). The majority (71%) of the crashes occurred on dry surface conditions. The primary contributing circumstances include following too close (57%), driver inattention, distraction or fatigue (14%) and other environmental circumstances – weather, glare (14%).

6. Rolling Mill Road & Foxhill Lane

The TIS states that this intersection is not included in the Delaware Crash Analysis Reporting System.

7. Delaware Route 48 & Hampton Way

At the intersection of Delaware Route 48 & Hampton Way, there was a total of 2 crashes. The crashes at this intersection did not result in personal injury and were not alcohol related. The types of crashes were rear-end collisions (50%) and not a collision between two vehicles (50%). Both crashes occurred during daylight hours (100%) with dry surface conditions (100%). The primary contributing circumstance include following too close (50%) and unknown circumstances (50%).

8. Hercules Road & Norman Drive (Ashland Research Center)

No crashes were reported at this intersection.

9. Hercules Road & Cheshire Court / Olympus Place

At the intersection of Hercules Road & Cheshire Court / Olympus Place, there was a total of one crash. This crash did not result in personal injury and was not alcohol related. The type of crash and primary contributing circumstance are unknown. The lighting and surface conditions during the crash are also unknown.

10. Hercules Road & Tall Trees Lane

At the intersection of Hercules Road & Tall Trees Lane, there was a total of one crash. This crash did not result in personal injury and was not alcohol related. The type of crash and primary contributing circumstance are unknown. The lighting and surface conditions during the crash are also unknown.

11. Red Clay Drive & Penn Oak Drive

The TIS states that this intersection is not included in the Delaware Crash Analysis Reporting System.

12. Centerville Road & Red Clay Drive

At the intersection of Centerville Road & Red Clay Drive, there was a total of 4 crashes. Of the 4 crashes, one (25%) resulted in personal injury. None of the collisions were alcohol related. The types of crashes were rear end collisions (75%) and angle crashes (25%). All of the crashes occurred during daylight hours. A majority of the crashes occurred in dry conditions (50%) with the other collisions occurring in wet (25%) conditions and ice/frost conditions (25%). The primary contributing circumstances include driver inattention, distraction or fatigue (50%), failure to yield right of way (25%) and mechanical defects (25%).

This intersection was recently modified from two-way stop control to signalized control in March 2016.

13. Delaware Route 48 & Centerville Road

At the intersection of Delaware Route 48 & Centerville Road, there was a total of 25 crashes. Of the 25 crashes, 5 (20%) resulted in personal injury. There were two alcohol related crashes; both resulted in personal injury. The most common types of crashes were rear-end crashes (68%), angle crashes (16%), and not a collision between two vehicles

(8%). The majority of crashes occurred during daylight hours (56%) or dark-lighted (24%) conditions with dry (88%) surface conditions. Common primary contributing circumstances include driver inattention, distraction or fatigue (36%), following too close (28%), failing to yield right of way (8%) and deer in roadway (8%).

14. Centerville Road & Spice Mill Circle (Little Falls Centre 1 & 2)

At the intersection of Centerville Road & Spice Mill Circle, there was a total of 2 crashes. The crashes at this intersection did not result in personal injury and were not alcohol related. The types of crashes were a head on collision (50%) and the manner of impact of the other crash was unknown. One of the crashes occurred during daylight hours (50%) and the other in dark-not lighted conditions (50%). Both collisions occurred on dry surface conditions. The primary contributing circumstances include driver inattention, distraction or fatigue (50%) and unknown circumstances (50%).

15. Delaware Route 48 & Delaware Route 141

At the intersection of Delaware Route 48 & Delaware Route 141, there was a total of 68 crashes. Of the total 68 crashes, 11 (16%) resulted in personal injury. Five of the crashes were alcohol related, 2 of which resulted in personal injury. The most common types of crashes were rear-end collisions (68%), angle crashes (12%), sideswipe – same direction crashes (9%), and head-on crashes (7%). The majority of crashes occurred in daylight (69%), dark-lighted (13%), or dark-not lighted (13%) conditions. Most of the crashes occurred on dry surface conditions (84%) with 10 crashes (15%) occurring on wet surface conditions. The common primary contributing circumstances include driver inattention, distraction or fatigue (38%), following too close (22%), and disregarding traffic signal (13%).

16. Delaware Route 41 & Hercules Road / Mill Creek Road

At the intersection of Delaware Route 41 & Hercules Road / Mill Creek Road, there was a total of 33 crashes. Of the 33 crashes, 5 (15%) resulted in personal injury. Three of the crashes were alcohol related, none resulting in personal injury. The most common types of crashes were rear-end crashes (45%), angle crashes (24%), and collisions not involving two vehicles (15%). The majority of crashes occurred during daylight (70%) conditions. Most crashes also occurred on dry (88%) surface conditions. Common primary contributing circumstances include driver inattention, distraction, or fatigue (27%), disregarding traffic signal (12%), and failing to yield right of way (12%). There were also 4 (12%) crashes with unknown primary contributing circumstances.

Sight Distance: There is a minor vertical crest curve just south of the proposed site driveway locations on Hercules Road. The impacts of this vertical curve on available sight distance should be analyzed as part of the site plan review process to confirm that adequate sight distance will be available for all proposed movements at this intersection.

The proposed site access driveway on Red Clay Drive is to be located in close proximity to the existing intersection of Red Clay Drive & Penn Oak Drive. The configuration of this proposed driveway should be confirmed during the site plan review process to verify that adequate sight distance will be available for all proposed movements at this intersection and that road users will be provided with adequate traffic control devices to easily determine who has the right-of-way at the closely spaced intersections.

Other than the proposed site entrances, the existing roadways in the study area have numerous grades and some curves that present safety concerns. In particular, Delaware Route 48 west of Hercules Road narrows down to a two-lane road with some moderate grades on a reverse curve as it cuts through a wooded area. Additionally, some of the smaller unsignalized intersections, such as Stratton Drive and Westgate Drive on Delaware Route 48, and Cheshire Court and Tall Trees Lane on Hercules Road, are access points with limited sight distance due to vegetation, guide rail, horizontal/vertical curves, and/or embankment near the intersection.

Transit, Pedestrian, and Bicycle Facilities

Existing transit service: The Delaware Transit Corporation (DTC) currently operates one bus route in the immediate area of the proposed Delaware National development. DART route 20 completes 14 round trips each weekday during rush hours and provides connections between downtown Wilmington and Hockessin. No service is provided on weekends. Route 20 runs along Delaware Route 48 and Delaware Route 141. The closest existing stops to the proposed development are located at Delaware Route 48 & Centerville Road and mid-block on Delaware Route 48 between Hercules Road and Rolling Mill Road. The only stop with amenities (such as a shelter and bench) is the eastbound stop at Delaware Route 48 & Centerville Road. This stop also provides a pedestrian connection to nearby office developments.

The TIS indicates that DART route 4 stops near the proposed site on Centerville Road near the Red Clay Drive intersection. However, it appears that these bus stops have been discontinued. McCormick Taylor did not locate any DART bus stop signs in the area of Red Clay Drive during an August 2017 field view. The stops also do not appear on the current version of the interactive DART bus stop map as accessed from the DART website. Based on the current version of the route 4 map, this route connects downtown Wilmington to the Barley Mill Plaza (near the intersection of Delaware Route 48 & Delaware Route 141) and runs throughout the day on both weekdays and weekends.

DART route 48 also operates along Delaware Route 141, but this is an express bus route that exclusively serves the DuPont Chestnut Run Plaza, the JP Morgan Chase DE Technical Center, the A.I. DuPont Hospital for Children, and the Wilmington Amtrak station.

Planned transit service: McCormick Taylor contacted DTC via email on August 11, 2017 but did not receive a reply. Going back to an earlier version of the Delaware National development proposal, DTC had the following comments in February 2011:

- DTC does not plan to serve the proposed Delaware National development onsite.
- DTC does not currently serve Hercules Road, but is open to service at a future date depending on ridership and funding. The developer should provide right of way for two future bus stops on Hercules Road, and sidewalk along the Hercules Road site frontage.
- The developer should relocate the existing bus stop along eastbound Delaware Route 48 east of Hercules Road so that it is closer to Hercules Road. Sidewalk to be constructed along the Hercules Road frontage should be extended along the south side of Delaware Route 48 to reach this relocated bus stop location.
- The nearest Park & Ride facility is located at the intersection of Kennett Pike & DuPont Road. DTC requests that the developer contribute a one-time fee of \$1,000 towards the ongoing maintenance of this facility.

Existing bicycle and pedestrian facilities: According to the *New Castle County Bicycle Map*, Delaware Route 48 between Hercules Road and Delaware Route 141 is designated as a connector bicycle route with bikeway. This route is also labeled as having high traffic volumes (over 10,000 vehicles per day). Centerville Road is also designated as a connector bicycle route; a bikeway is provided south of Red Clay Drive. Near the study area, Delaware Route 41 and Delaware Route 141 area also designated as connector bicycle routes with bikeways (with high traffic volumes).

There are currently sidewalks in place along Penn Oak Drive, Red Clay Drive, Hampton Way, Olympus Place, and Centerville Road (between Red Clay Drive and Delaware Route 48). There are sidewalks provided in some locations along Delaware Route 48 (between Centerville Road and Delaware Route 141), but these sidewalks are not continuous for the full length of this segment. There are no sidewalks along Hercules Road. There are crosswalks and pedestrian signals provided for limited pedestrian movements at the signalized intersections of Delaware Route 48 & Centerville Road and Centerville Road & Red Clay Drive. The remaining signalized intersections do not provide pedestrian facilities.

Planned bicycle and pedestrian facilities: McCormick Taylor contacted DelDOT's Bicycle and Pedestrian Facilities Team via email on August 11, 2017. We received a reply from Ms. Maria Andaya, but she did not offer any input. Going back to an earlier version of the Delaware National development proposal, DelDOT had the following comments in March 2011 regarding bicycle and pedestrian transportation. Some of these comments are still applicable, while others are not due to differences in the proposed site plans, etc.

- a. The existing golf cart tunnel under Hercules Road just south of Delaware Route 48 should be retained as a multi-use path.
- b. The existing golf cart paths along the west side of Hercules Road that run from the tunnel under Hercules Road toward the Estate Homes should be retained as multi-use paths. As needed, these paths should be extended to connect to the proposed sidewalks along the cul-de-sacs in the Estate Homes section of the proposed

- development. A stub multi-use path should also be built to connect the northern path to the south side of Delaware Route 48, which would allow for a connection to a potential future multi-use path along Delaware Route 48 to Hockessin.
- c. The existing golf cart path along the east side of Hercules Road should be retained as a multi-use path. As needed, either the site plan should be revised so the proposed Village Homes residential lots avoid the alignment of the path, or portions of the path should be relocated to avoid the residential lots. This path should connect to the proposed sidewalks along the site entrance driveway and the cul-de-sac further south.
 - d. The existing golf cart path along the south side of Delaware Route 48 that runs from the tunnel under Hercules Road to east of Red Clay Creek should be retained as a multi-use path. As needed, either the site plan should be revised so the proposed Village Homes residential lots avoid the alignment of the path, or portions of the path should be relocated to avoid the residential lots. Some upgrades may be needed at the path's at-grade railroad crossing. A stub multi-use path should also be built to connect this existing path from just west of the railroad crossing to the proposed sidewalk along the residential street in the northeastern portion of the Village Homes section of the proposed development.
 - e. East of Red Clay Creek, the existing golf cart path splits, with one path heading east through Little Falls Village II and the other heading south to near the southern portion of Little Falls Village. The northern path should be retained as a multi-use path, connecting to the proposed sidewalk along the cul-de-sac for the proposed townhouses along the east side of the northern portion of Penn Oak Drive, and should continue south to connect with the sidewalk along Red Clay Drive. The western path should be retained as a multi-use path, connecting to the proposed sidewalk along a cul-de-sac for the proposed Executive Homes (to the south and west of Little Falls Village).
 - f. Sidewalks should be included along all residential streets within the proposed development, including along a proposed stub street leading to the adjacent Hercules Research Center property on the east side of Hercules Road.
 - g. Crosswalks should be included across all site entrances.

Previous Comments

All comments from DelDOT's Scoping Letter, and Traffic Count Review, and Preliminary TIS Review were addressed in the Final TIS submission, with the following exceptions:

- The DelDOT scope requires the consultant to use the "most recent version of the Highway Capacity Software (HCS) that implements the 2010 Highway Capacity Manual (HCM)." As per the scoping minutes, this was HCS 2010. It appears that the TIS did not utilize up-to-date HCS software to complete the analyses. Additional details are provided in the following section.

General HCS Analysis Comments

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

- 1) Based on the HCS reports included in the TIS, it appears that outdated analysis software was utilized to produce the delay and LOS results. For signalized intersections, the reports are labeled as HCS 2010, version 6.65 (released 10/1/2014). There have been three updates released for HCS 2010 since version 6.65, most recently in October 2016. For unsignalized intersections, the reports are labeled as HCS+ Release 5.6. HCS+ software does not implement the procedures of the 2010 Highway Capacity Manual, as required by the DelDOT scoping meeting minutes (dated 12/5/2016). For all analyses, McCormick Taylor utilized the most recent version of HCS software available at the time of the traffic study review (HCS 7, version 7.3). This software implements an updated version of the HCM (Highway Capacity Manual 6th Edition).
- 2) The TIS states that Little Falls Center Lots 1 & 2 will consist of 26,550 SF of office space to be located west of Centerville Road and south of Red Clay Drive and have access from Penn Oak Drive. However, based on the site plans for Delaware National, Little Falls Center Lots 1 & 2, and coordination with DelDOT, McCormick Taylor determined that access for this office development will be via the existing intersection of Centerville Road & Spice Mill Circle. McCormick Taylor re-distributed the trips associated with Little Falls Center Lots 1 & 2 to account for this discrepancy. Volumes were updated at Centerville Road & Red Clay Drive, Red Clay Drive & Penn Oak Drive, and Centerville Road & Spice Mill Circle, and the redistributed volumes were used for McCormick Taylor's analysis.
- 3) For unsignalized intersections, the TIS and McCormick Taylor applied heavy vehicle factors (HV) by movement. For signalized intersections, the TIS and McCormick Taylor applied HV by lane group. For future conditions, the TIS and McCormick Taylor generally assumed future HV to be the same as existing HV. The TIS assumed 0 % HV on the proposed site driveway approaches to Hercules Road. As per guidance in the DelDOT Development Coordination Manual, McCormick Taylor assumed 3% HV on these approaches.
- 4) Both the TIS and McCormick Taylor determined an overall intersection PHF for each intersection based on the traffic count data and applied those PHFs to existing and future conditions.
- 5) As per the DelDOT Development Coordination Manual, both the TIS and McCormick Taylor used a base saturation flow rate of 1900 vehicles per hour for all analyses.
- 6) The HCS analyses included in the TIS did not always reflect the lane widths observed in the field by McCormick Taylor. McCormick Taylor's HCS analyses incorporated our field-measured lane widths. It appears that the TIS assumed 12' lanes throughout the analysis.

- 7) McCormick Taylor's HCS analyses incorporated field-measured approach grades. It appears that the TIS assumed 0% approach grades throughout the study area.
- 8) The TIS and McCormick Taylor used different cycle lengths and/or signal timing parameters when analyzing the signalized intersections in some cases.
- 9) Both the TIS and McCormick Taylor input existing right turn on red (RTOR) volumes where available and also coded right-turn overlap phases with protected left-turn phases where appropriate.

Table 3
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹ Two-Way Stop Control	LOS per TIS		LOS per McCormick Taylor	
1) Hercules Road & Proposed Site Entrance	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2022 build (case 3) <i>TIS proposed configuration</i> ²				
Eastbound Cobbs Creek Way	D (30.0)	E (36.6)	D (26.7)	E (35.3) ³
Westbound Muirfield Way	E (50.0)	C (23.6)	E (48.4) ⁴	C (22.4)
Northbound Hercules Road - Left	A (8.5)	B (10.2)	A (8.5)	B (10.2)
Southbound Hercules Road - Left	B (11.7)	A (9.0)	B (11.7)	A (9.1)
2022 build (case 3) <i>With Improvement Option 1</i> ⁵				
Eastbound Cobbs Creek Way	-	-	D (26.6)	D (34.9)
Westbound Muirfield Way	-	-	E (39.7) ⁶	C (20.8) ³
Northbound Hercules Road - Left	-	-	A (8.5)	B (10.2)
Southbound Hercules Road - Left	-	-	B (11.7)	A (9.1)
2022 build with AstraZeneca & DuPont (case 4) <i>TIS proposed configuration</i> ²				
Eastbound Cobbs Creek Way	D (31.1)	E (38.3)	D (27.6)	E (37.1) ³
Westbound Muirfield Way	F (55.3)	C (24.4)	F (52.5) ⁴	C (23.0)
Northbound Hercules Road - Left	A (8.5)	B (10.3)	A (8.5)	B (10.3)
Southbound Hercules Road - Left	B (11.8)	A (9.1)	B (11.9)	A (9.1)
2022 build with AstraZeneca & DuPont (case 4) <i>With Improvement Option 1</i> ⁵				
Eastbound Cobbs Creek Way	-	-	D (27.5)	E (36.6) ³
Westbound Muirfield Way	-	-	E (42.5) ⁴	C (21.4) ³
Northbound Hercules Road - Left	-	-	A (8.5)	B (10.3)
Southbound Hercules Road - Left	-	-	B (11.9)	A (9.1)

¹ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

² The TIS proposes installation of left-turn lanes on northbound and southbound Hercules Road and one shared left-turn/thru/right-turn lane on the site egress approaches.

³ 95th percentile queue length is expected to be less than one vehicle.

⁴ 95th percentile queue length is expected to be approximately two vehicles.

⁵ In addition to the improvements proposed in the TIS, Improvement Option 1 includes installation of right-turn lanes on northbound and southbound Hercules Road and a right-turn lane on the westbound site egress approach.

⁶ 95th percentile queue length is expected to be approximately one vehicle.

Table 4
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ⁷	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2) Delaware Route 48 & Hercules Road				
2017 existing (case 1)	C (27.2)	C (20.9)	C (31.3)	C (23.8)
2022 no-build (case 2)	D (37.0)	C (34.4)	D (42.0)	D (37.9)
2022 build (case 3)	D (40.1)	C (34.9)	D (43.7)	D (38.2)
2022 build with AstraZeneca & DuPont (case 4)	D (46.2)	D (43.5)	D (51.0)	D (46.9)

⁷ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 5
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ⁸ One-Way Stop Control (T-intersection)	LOS per TIS		LOS per McCormick Taylor	
3) Delaware Route 48 & Stratton Drive	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Westbound Delaware Route 48 – Left	B (14.3)	A (9.0)	B (14.1)	A (9.0)
Northbound Stratton Drive	F (63.2)	F (52.9)	E (37.4)	D (26.4)
2022 no-build (case 2)				
Westbound Delaware Route 48 – Left	C (16.6)	A (9.3)	C (16.2)	A (9.3)
Northbound Stratton Drive	F (110.4)	F (84.3)	F (53.4)	D (34.9)
2022 build (case 3)				
Westbound Delaware Route 48 – Left	C (16.6)	A (9.3)	C (16.3)	A (9.4)
Northbound Stratton Drive	F (110.4)	F (84.3)	F (54.0)	E (35.6)

⁸ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 6
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ⁹ One-Way Stop Control (T-Intersection)	LOS per TIS		LOS per McCormick Taylor	
4) Delaware Route 48 & Westgate Drive	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Westbound Delaware Route 48 – Left	B (13.7)	A (9.0)	B (13.7)	A (9.0)
Northbound Westgate Drive ¹⁰	E (42.7)	E (35.5)	F (50.3)	F (59.4)
2022 no-build (case 2)				
Westbound Delaware Route 48 – Left	C (15.7)	A (9.4)	C (15.6)	A (9.4)
Northbound Westgate Drive ¹⁰	F (63.0)	F (53.5)	F (78.8)	F (104.5)
2022 build (case 3)				
Westbound Delaware Route 48 – Left	C (15.7)	A (9.4)	C (15.7)	A (9.4)
Northbound Westgate Drive ¹⁰	F (63.9)	F (55.5)	F (79.5)	F (108.4)

⁹ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

¹⁰ The northbound approach is approximately 22-feet wide, but has no pavement markings to delineate separate left-turn and right-turn lanes. The TIS assumed one shared lane. Due to the width of the approach, McCormick Taylor coded separate left-turn and right-turn lanes to model expected operations.

Table 7
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹¹ One-Way Stop Control (T-Intersection)	LOS per TIS		LOS per McCormick Taylor	
5) Delaware Route 48 & Rolling Mill Road	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Southbound Rolling Mill Road - Right	B (11.7)	C (20.7)	B (11.6)	C (19.3)
2022 no-build (case 2)				
Southbound Rolling Mill Road - Right	B (12.7)	D (25.6)	B (12.5)	C (23.4)
2022 build (case 3)				
Southbound Rolling Mill Road - Right	B (12.8)	D (26.4)	B (12.6)	C (24.1)
2022 build with AstraZeneca & DuPont (case 4)				
Southbound Rolling Mill Road - Right	B (12.9)	D (28.2)	B (12.7)	D (25.6)

¹¹ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 8
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹² One-Way Stop Control (T-Intersection) ¹³	LOS per TIS Addendum		LOS per McCormick Taylor	
6) Rolling Mill Road & Foxhill Lane	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Eastbound Foxhill Lane	A (8.5)	A (8.5)	A (8.5)	A (8.4)
Northbound Rolling Mill Road - Left	A (7.2)	A (7.2)	A (7.2)	A (7.2)
2022 no-build (case 2)				
Eastbound Foxhill Lane	A (8.5)	A (8.5)	A (8.5)	A (8.4)
Northbound Rolling Mill Road - Left	A (7.2)	A (7.2)	A (7.2)	A (7.2)
2022 build (case 3)				
Eastbound Foxhill Lane	A (8.5)	A (8.5)	A (8.5)	A (8.4)
Northbound Rolling Mill Road - Left	A (7.2)	A (7.2)	A (7.2)	A (7.2)

¹² For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

¹³ The Foxhill Lane approach is a one-lane covered bridge. This requires all eastbound traffic, northbound left traffic, and southbound right traffic to yield right-of-way to vehicles already on the bridge.

Table 9
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹⁴ One-Way Stop Control (T-intersection)	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
7) Delaware Route 48 & Hampton Way				
2017 existing (case 1)				
Southbound Hampton Way - Right	B (11.5)	C (19.8)	B (11.4)	C (19.8)
2022 no-build (case 2)				
Southbound Hampton Way - Right	B (12.3)	C (24.1)	B (12.3)	C (24.1)
2022 build (case 3)				
Southbound Hampton Way - Right	B (12.4)	C (24.9)	B (12.4)	C (24.9)

¹⁴ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 10
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ¹⁵	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
8) Hercules Road & Norman Drive (Ashland Research Center)				
2017 existing (case 1)	B (15.0)	A (8.4)	A (5.7)	B (11.4)
2022 no-build (case 2)	C (27.6)	B (13.6)	C (24.9)	B (18.7)
2022 build (case 3)	C (28.9)	B (13.4)	C (24.2)	B (18.4)
2022 build with AstraZeneca & DuPont (case 4)	C (33.4)	B (13.3)	C (26.3)	B (18.1)

¹⁵ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 11
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹⁶ Two-Way Stop Control (Four-Leg intersection)	LOS per TIS		LOS per McCormick Taylor	
9) Hercules Road & Cheshire Court / Olympus Place	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Eastbound Cheshire Court	D (31.1)	C (21.6)	E (48.1)	A (5.0)
Westbound Olympus Place	D (28.1)	C (17.9)	C (23.0)	B (13.8)
Northbound Hercules Road – Left	A (7.7)	A (9.2)	A (7.7)	A (9.2)
Southbound Hercules Road - Left	B (10.7)	A (8.0)	B (10.7)	A (8.0)
2022 no-build (case 2)				
Eastbound Cheshire Court	F (58.7)	D (32.1)	F (110.3)	A (5.0)
Westbound Olympus Place	F (66.3)	D (29.5)	E (41.5)	C (17.9)
Northbound Hercules Road – Left	A (7.9)	B (10.1)	A (7.9)	B (10.1)
Southbound Hercules Road - left	B (12.4)	A (8.3)	B (12.4)	A (8.3)
2022 build (case 3)				
Eastbound Cheshire Court	F (64.0)	D (34.5)	F (123.5)	A (5.0)
Westbound Olympus Place	F (73.1)	D (32.6)	E (44.7)	C (18.9)
Northbound Hercules Road – Left	A (8.0)	B (10.2)	A (8.0)	B (10.2)
Southbound Hercules Road - left	B (12.5)	A (8.4)	B (12.5)	A (8.4)

¹⁶ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 12
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ¹⁷ One-Way Stop Control (T-intersection)	LOS per TIS		LOS per McCormick Taylor	
10) Hercules Road & Tall Trees Lane	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Westbound Tall Trees Lane	C (19.0)	C (17.8)	C (17.8)	C (18.5)
Southbound Hercules Road – Left	B (10.1)	A (7.9)	B (10.1)	A (7.9)
2022 no-build (case 2)				
Westbound Tall Trees Lane	D (26.1)	C (24.4)	C (23.8)	D (25.3)
Southbound Hercules Road – Left	B (11.4)	A (8.2)	B (11.4)	A (8.2)
2022 build (case 3)				
Westbound Tall Trees Lane	D (27.0)	D (25.9)	C (24.5)	D (26.9)
Southbound Hercules Road – Left	B (11.5)	A (8.3)	B (11.5)	A (8.3)

¹⁷ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 13
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection¹⁸ One-Way Stop Control (T-intersection)	LOS per TIS		LOS per McCormick Taylor	
11) Red Clay Drive & Penn Oak Drive	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Westbound Red Clay Drive	A (8.7)	A (8.6)	A (8.7)	A (8.6)
Southbound Penn Oak Drive	A (7.3)	A (7.2)	A (7.3)	A (7.2)
2022 no-build (case 2)				
Westbound Red Clay Drive	A (9.9)	B (10.3)	A (9.3)	A (8.9)
Southbound Penn Oak Drive	A (7.3)	A (7.8)	A (7.3)	A (7.5)
2022 build (case 3)				
Westbound Red Clay Drive	B (10.6)	B (13.3)	A (9.7)	B (11.1)
Southbound Penn Oak Drive	A (7.5)	A (7.9)	A (7.5)	A (7.6)

¹⁸ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 14
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ¹⁹	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
12) Centerville Road & Red Clay Drive				
2017 existing (case 1)	B (17.9)	C (31.6)	B (10.0)	C (29.1)
2022 no-build (case 2)	C (34.1)	E (76.8)	C (20.1)	E (61.5)
2022 build (case 3)	C (34.5)	E (79.1)	C (25.1)	E (64.0)
2022 build (case 3A) <i>With TIS proposed improvements</i> ²⁰	C (33.8)	D (42.0)	B (18.6)	D (40.8)
2022 build with AstraZeneca & DuPont (case 4) <i>With TIS proposed improvements</i> ²⁰	C (34.4)	D (42.5)	B (18.7)	D (40.4)
2022 build with AstraZeneca & DuPont (case 4) <i>With existing traffic signal phasing</i>	-	-	C (25.2)	E (64.3)

¹⁹ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

²⁰ The proposed improvement is to change the side street (Red Clay Drive) signal phasing from split phasing to concurrent phasing with protected/permitted left turns. Although the proposed phasing results in lower expected intersection delay, DelDOT and New Castle County may wish to keep the existing phasing as this signal was recently installed (March 2016) with split phasing; altering the phasing would require changing the recently installed four-section signal heads to five-section signal heads on both side street mast arms.

Table 15
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ²¹	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
13) Delaware Route 48 & Centerville Road ²²				
2017 existing (case 1)	E (55.7)	D (48.8)	D (40.4)	C (34.2)
2022 no-build (case 2)	E (79.6)	E (64.0)	F (94.2)	F (84.2)
2022 build (case 3)	F (83.6)	E (66.7)	F (99.3)	F (91.3)
2022 build (case 3A) <i>With TIS proposed improvements</i> ²³	D (54.7)	D (53.2)	D (44.5)	D (53.5)
2022 build with AstraZeneca & DuPont (case 4) <i>With TIS proposed improvements</i> ²³	E (55.7)	D (54.6)	D (48.2)	E (68.8)

²¹ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

²² For analysis purposes, McCormick Taylor assumed 30 percent of northbound and southbound left-turns are made from the shared through/left-turn lane, with the other 70 percent from the exclusive left-turn lane. It is unknown what the TIS assumed for this parameter, as it is not shown on the provided HCS reports.

²³ The proposed improvement is to construct an additional eastbound thru lane beginning approximately 1,600 feet west of Centerville Road and terminating as a right-turn lane for Little Falls Drive approximately 900 feet east of Centerville Road.

Table 16
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Unsignalized Intersection ²⁴ One-Way Stop Control (T-intersection)	LOS per TIS		LOS per McCormick Taylor	
14) Centerville Road & Spice Mill Circle (Little Falls Centre One & Two)	Weekday AM	Weekday PM	Weekday AM	Weekday PM
2017 existing (case 1)				
Eastbound Spice Mill Circle	D (27.2)	D (33.0)	C (19.9)	C (18.1)
Northbound Centerville Road - Left	A (9.1)	A (8.9)	A (9.2)	A (8.9)
2022 no-build (case 2)				
Eastbound Spice Mill Circle	F (129.7)	F (417.5)	F (56.2) ²⁵	F (132.8) ²⁶
Northbound Centerville Road - Left	A (9.9)	B (12.2)	B (10.4)	B (12.0)
2022 build (case 3)				
Eastbound Spice Mill Circle	F (146.6)	F (480.1)	F (61.2) ²⁵	F (151.2) ²⁶
Northbound Centerville Road - Left	B (10.1)	B (12.3)	B (10.7)	B (12.1)

²⁴ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

²⁵ 95th percentile queue length is expected to be approximately one vehicle.

²⁶ 95th percentile queue length is expected to be approximately 13 vehicles.

Table 17
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ²⁷	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
15) Delaware Route 48 & Delaware Route 141				
2017 existing (case 1)	F (108.3)	F (90.9)	F (87.0)	F (92.2)
2022 no-build (case 2)	F (169.3)	F (134.9)	F (145.6)	F (145.3)
2022 build (case 3)	F (174.5)	F (140.7)	F (150.4)	F (153.1)
2022 build with AstraZeneca & DuPont (case 4)	F (214.9)	F (172.5)	F (183.5)	F (186.3)

²⁷ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

Table 18
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Impact Study for Delaware National Residential Development
Report dated July 10, 2017
Prepared by Michael Maris Associates, Inc.

Signalized Intersection ²⁸	LOS per TIS		LOS per McCormick Taylor	
	Weekday AM	Weekday PM	Weekday AM	Weekday PM
16) Delaware Route 41 & Hercules Road / Mill Creek Road ²⁹				
2017 existing (case 1)	D (47.0)	C (30.8)	D (39.2)	C (31.5)
2022 no-build (case 2)	E (69.7)	C (30.9)	D (53.9)	C (34.5)
2022 build (case 3)	E (70.8)	C (32.0)	E (56.2)	D (35.5)
2022 build with AstraZeneca & DuPont (case 4)	E (74.3)	C (32.1)	E (59.8)	D (36.1)

²⁸ For both unsignalized and signalized intersection analyses, the numbers in parentheses following LOS are average delay per vehicle, measured in seconds. For signalized analyses, LOS analysis results are given for only the overall intersection delay.

²⁹ This intersection was improved in 2015 as part of the Toll Brothers Greenville Overlook residential development.