SR1 and Trap Shooters Road Interchange Recommendations Report

Prepared for:

DOVER/KENT COUNTY MPO
METROPOLITAN PLANNING ORGANIZATION

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Executive Summary

The Dover Kent County MPO, in conjunction with the project sponsor, DelDOT, initiated a detailed study to evaluate options to improve safety at the intersection of Trap Shooters Road and SR1. This intersection provides a critical connection between the developing area around the Town of Magnolia and SR1, a major north south Expressway. As the area around the town of Magnolia continues to develop, there are increasingly more cars using Trap Shooters Road to access SR1. Over the years, as more traffic utilized the ramp connections, the safety of the ramp interfaces began to degrade.

The purpose and need for the project are directly related to the safety and capacity of SR1 at this interchange location. The purpose of the project is to improve the safety and capacity of the SR1 and Trap Shooters Road interchange. This project is needed based on the disproportionately high crash rates and the impacts on the roadway capacity caused by the existing interchange configuration.

The study evaluated the existing environmental constraints as well as the existing traffic operations to determine what improvements might be considered to accomplish the purpose and need for the project. Although there are a lot of natural resources in the area, most would not be impacted by the alternatives developed. This information was presented at the first public workshop on January 23, 2023, where the public was encouraged to provide additional information about their experiences navigating the intersection. The overwhelming conclusion from the meeting was that something needs to be done.

Four alternatives were developed to satisfy the overall purpose and need for the project.

Alternative 1 – Relocation of existing ramps filling impacted wetlands - This alternative shifts the SB SR1 offramps to the south and increases the exit ramp radius. The NB SR1 Access ramps would be relocated approximately ¾ of a mile to the south to allow for interstate standard deceleration lanes and acceleration lanes to be developed along SR1 prior to entering onto the Barkers Landing Bridge. The extension of Trap Shooters Road south, parallel to existing SR1, would require the crossing of a small area of identified wetlands. This alternative contemplates filling of the wetlands and mitigation of those impacts in an area adjacent to the project.

Alternative 2 - Relocation of existing ramps with bridge over impacted wetlands - This alternative is the same as Alternative 1 except that it spans the wetland impacts with a bridge.

Alternative 3 – New alignment from Barkers Landing Road to SR1 with new diamond interchange - This alternative creates a new ramp alignment from Barkers Landing Road to SR1. The new connection with SR1 allows for a more efficient interchange design with SR1. Alternative 3 considers using a diamond interchange that allows for traffic to easily access both NB and SB SR1.

The diamond interchange ramps are designed to meet all state and federal design standards for interstate interchanges. Alternative 3 impacts several agricultural areas west of SR1 including 2 pivot irrigation systems.

Alternative 4 - New alignment from Barkers Landing Road to SR1 with new trumpet interchange – This alternative is the same as Alternative 3 except it replaces the diamond interchange with the trumpet interchange. The impacts between Alternative 3 and Alternative 4 are very similar.

These alternatives were evaluated using defined Measures of Effectiveness (MOE). These considered overall capacity improvements, improved safety, travel time comparison and a physical impact to environmental and other features. The results of the analysis showed similar improvements for both capacity and safety. This resulted from each alternative utilizing the AASHTO interstate standards for ramp configuration and lengths. Each ramp interface with SR1 will also be illuminated with roadway lighting. The impacts to the physical environment differed greatly between Alternatives 1 and 2 and Alternatives 3 and 4. Below is a chart of the physical impacts associated with each of the 4 alternatives.

SR1 Trap Shooters Road Interchnage Study

Measures of Effectiveness - Physical Impacts

Measure	UOM	Move SR1 Access Points South No Bridge		Move SR1 Access Points South With Bridge		Alternate 3 New Spur Road to SR1 with Diamond Interchnage		Alternate 4 New Spur Road to SR1 with Trumpet Interchnage	
Wetland Impacts Permanent	Square Feet / Ac	10,155	0.23	786	0.02	0	0.00	0	0.00
Wetland Impacts Temp	Square Feet / Ac	0	0.00	6,621	0.15	0	0.00	0	0.00
Forested Land Impacts	Square Feet / Ac	278,036	6.38	287,930	6.61	357,621	8.21	326,427	7.49
Agricultural Land Impacts	Square Feet / Ac	164,408	3.77	164,408	3.77	549,855	12.62	558,526	12.82
Ag. Land Preservation Impacts	Square Feet / Ac	0	0.00	0	0.00	5,294	0.12	5,294	0.12
Irrigation Impacts	Square Feet / Ac	10,482	0.24	10,482	0.24	123,248	2.83	123,248	2.83
Right-of-way Area	Square Feet / Ac	519,455	11.93	553,971	12.72	919,292	21.10	969,772	22.26
Costs	Thousands Dollars	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

The results indicate that option 1 provides the overall best value with improved operations and safety, and minimal impacts to the natural environment.

Community involvement on this project consisted of two community meetings with online surveys. The second public workshop provided the public an opportunity to review and comment on the four alternatives presented in this report. Public opinion was split between Alternative 1 and Alternative 3. Additional comments were received from a farm owner who expressed concerns with the agricultural impacts associated with Alternative 3 and Alternative 4.

This report summarizes all the information gathered and assessed during the study. Based on the MOE analysis, Alternative 1 provides the best value for this project. It is recommended that this alternative be advanced to DelDOT for further development, permitting, design, and construction.

Introduction

The intersection of Trap Shooters Road and SR1 provides a critical connection between the developing area around the Town of Magnolia and SR1, a major north south Expressway. As the area around the Town continues to develop, there are increasingly more cars using Trap Shooters Road to access SR1. Over the years, more traffic utilizing the ramp connections have led to the safety of the ramp interfaces degrading. To address the increasing safety concerns, the ramp connections from Trap Shooters Road were reconfigured about 15 years ago to eliminate the NB yield and merge and replace it with a stop condition with no NB acceleration lane. The SB on ramp was modified from a short taper merge to a parallel ramp configuration. These changes were made to address increasing crash rates and safety concerns. Initially, the ramp configurations helped address safety concerns, however the existing configurations make it difficult for the local traffic waiting to access SR1 to merge in with existing SR1 traffic. This situation continues to worsen as traffic volumes on SR1 increase and the available gaps to merge into existing traffic continue to decrease. In addition, the speeds on SR1 have been increasing over the years making in difficult to accelerate from a stop condition to highway speeds within the existing gaps in traffic. This study was initiated by DelDOT to evaluate possible alternatives to improve the ramp configurations from Trap Shooters Road and SR1 to meet current Federal and State standards.

Study Location and Study Area

The intersection of Trap Shooters Road and SR1 is located just south of Barkers Landing Bridge in Central Kent County. Trap Shooters Road connects Barkers Landing Road and Ponderosa Drive to SR1 providing the developing areas around the town of Magnolia with access to SR1. The study area includes areas beyond the actual intersection and are shown in **Figure 1**. The study area is comprised mostly of agricultural lands to the east and south. The Saint Jones River and the surrounding flood plain is located to the north. Additional flood plain areas for the Saint Jones River are located to the west of the current interchange.

Figure 1 - Study Area

Purpose and Need

The purpose and need for the project are directly related to the safety and capacity of SR1 at this interchange location.

The purpose of the project is to improve the safety and capacity of the SR1 and Trap Shooters Road interchange. This project is needed based on the disproportionately high crash rates and the impacts on the roadway capacity caused by the existing interchange configuration.

Existing Conditions – Environmental Assessment

The proposed project limits are located on two private parcels and public right-of-way. A desktop analysis was performed to assess any environmental constraints that would influence any alternatives development.

Federal Waters of the United States and State of Delaware Wetlands and Subaqueous Lands are likely located within project limits. The resources are likely to be both tidal and non-tidal. Any work resulting from temporary or permanent impacts to Waters of the U.S. and/or State of Delaware would undergo permitting to review the project impacts. Impacts resulting from the loss of aquatic resources in excess of 0.10-acre of wetlands and/or 0.03-acre of stream channel would require compensatory mitigation from the USACE. Additionally, any loss of State of Delaware Wetlands and/or Subaqueous Lands may require compensatory mitigation or in-lieu-fee. Compensatory mitigation is often restoration, creation, enhancement, or preservation of wetlands and waters to meet the policy of no net loss of aquatic resources. In-lieu-fee is similar, but instead of permittee responsible mitigation, a sum is paid to government or non-profit organizations with competence in natural resource management.

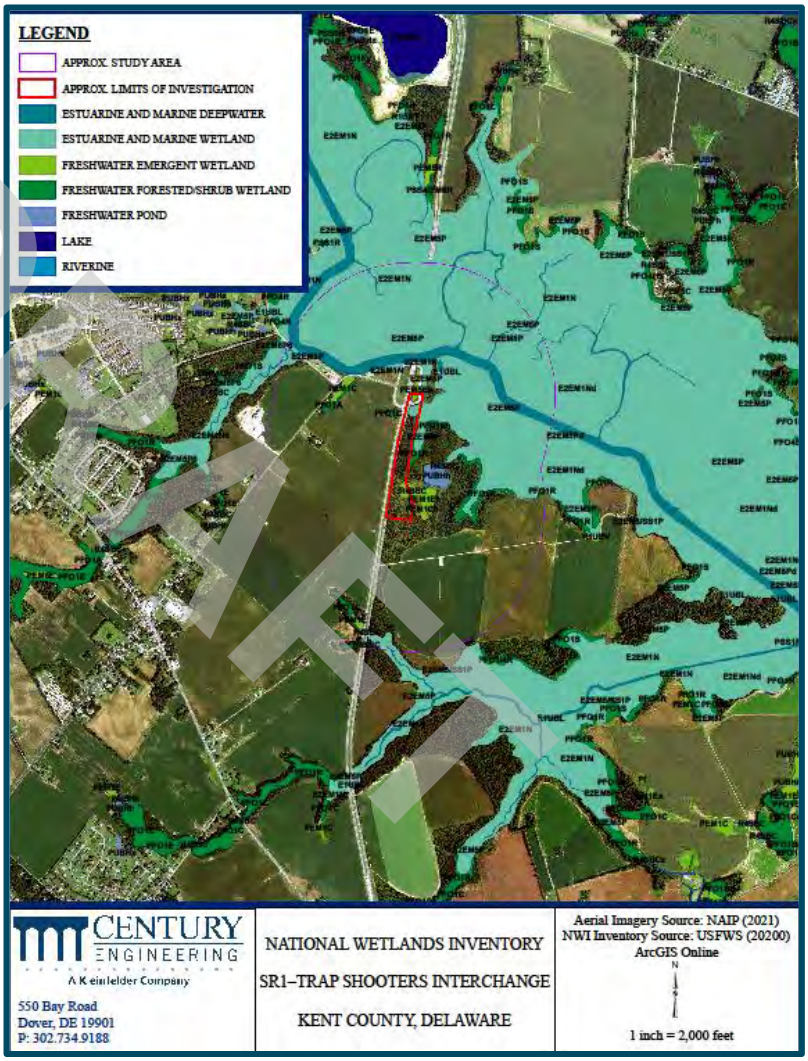


Figure 2 - Natural Wetlands Inventory

Portions of FEMA Flood Zones are located within the project area. Impacts (filling) of the regulated floodway may require permitting.

Initial queries indicate the presence or possibility of Rare, Threatened, and Endangered species in the vicinity of the project area. Consultation with both Federal and State agencies will determine the likelihood or presence of those species within the proposed study area. Often work is effectively performed through time-of-year restriction windows to avoid impacts to Rare, Threatened, and Endangered species. The initial correspondence is included in *Appendix A*.

Historic and/or Archaeological resources are indicated within the vicinity of the project limits. Consultation with the State Historic Preservation Office after review of the proposed project will indicate whether additional consultation or investigations are needed. If surveys are performed and/or resources are discovered, additional consultation will determine if the project can move forward or if there are ways to mitigate the discovery or impact to resources. The initial inventory of historical and archaeological resources is shown in **Figure 3**.

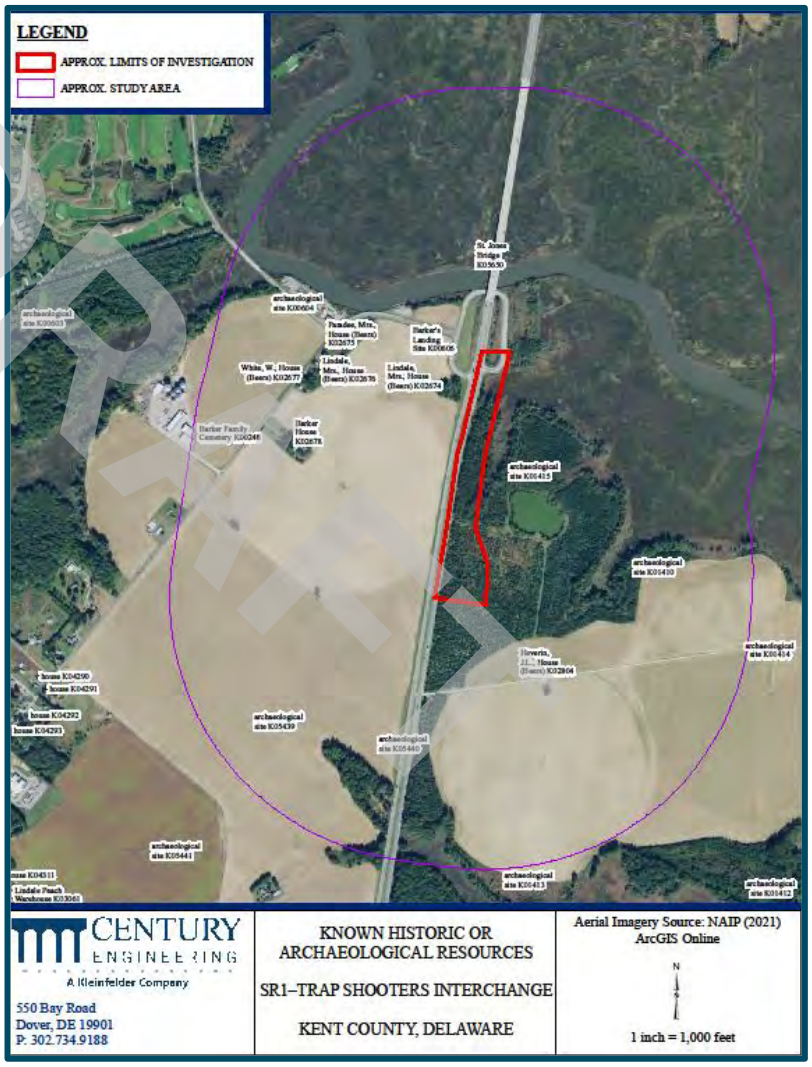


Figure 3 - Historic and Archaeological Resources

State Natural Areas, public protected lands, and/or National Estuarine Research Reserves are located within or adjacent to the proposed project area. Consultation with appropriate agencies will determine what effect the proposed project will have on the resource and/or what potential ways impacts to the resources can be minimized. Additionally, further consultation will indicate any proposed easements or restrictions encumbering any potential right-of-way takes for the project. Existing lands or easements previously purchased or funded with Land and Water Conservation funds and/or the use of public parks, recreation areas, refuges, etc. where no other alternative is possible for the proposed project require detailed evaluation, coordination, and approval. Further inquiries will reveal any existence of those properties

within the project limits. **Figure 4** illustrates the limits of the Delaware National Estuarine Research Reserve (DNERR) Saint Jones Reserve.

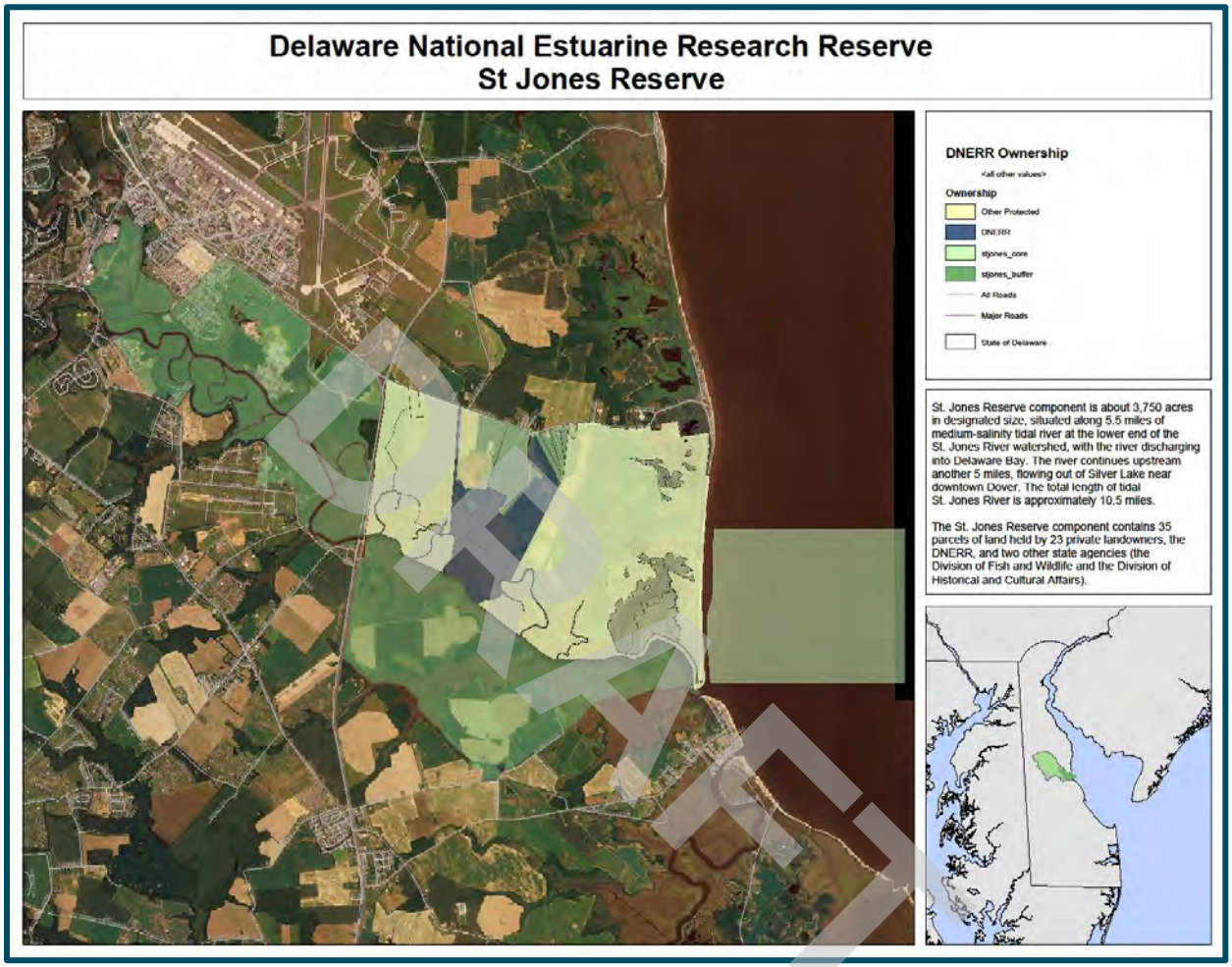


Figure 4 - Delaware National Estuarine Research Reserve (DNERR) Saint Jones Reserve

Public wells are indicated within the vicinity of the proposed project. Consultation with agencies during the permitting phase will ensure that the wells will not be impacted. No well head protection areas, underground storage tanks, brownfields, hazmat, or biosolids facilities were indicated within the study limits.

The environmental justice report for the project limits yielded no results, as the project limits are too small for reporting. The environmental justice report for a 1-mile screen from the project limits provides information on the demographics in the project area and is included in **Appendix B**.

Existing Conditions – Corridor Capacity Preservation Program

The project is located within the limits of SR1 that are governed by the Corridor Capacity Preservation Program (CCPP). The program has had a plan in place for SR1 since the initial pilot program started in 1991. DelDOT developed the program to preserve existing capacity of critical corridors throughout the state. SR1 was selected for this program because it serves as the main north-south highway to access the Delaware Beach resort areas. In addition to the resort traffic, eastern Sussex County has been experiencing a high rate of growth in year-round residential traffic and supporting commercial development. This has led to increased congestion and safety issues due to increased travel demand and the mixing of local and through traffic. The need for corridor capacity preservation on this section of SR1 is clearly demonstrated in the high volumes of existing and proposed traffic.

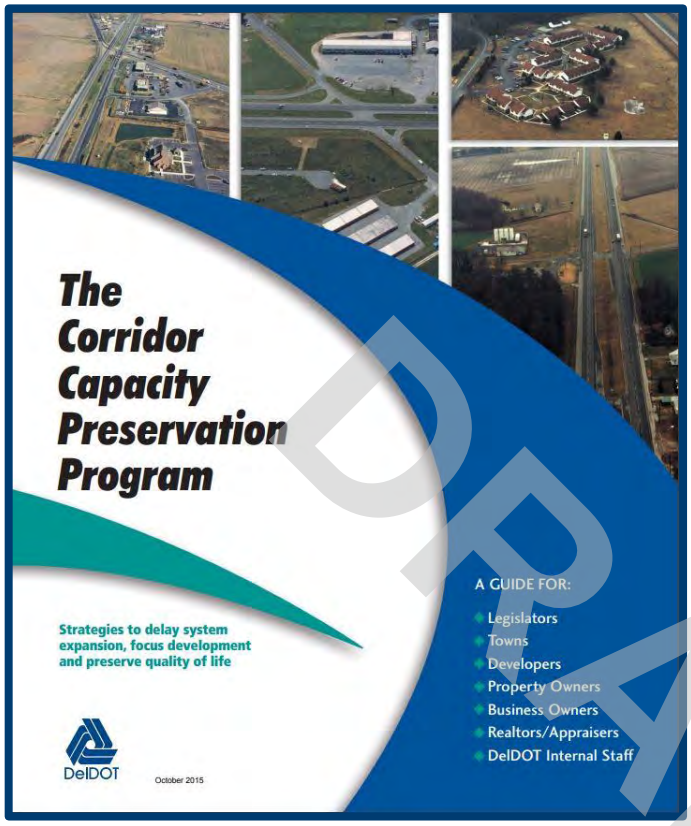


Figure 5 - Corridor Capacity Preservation Program Manual

Plans to improve this area of Trap Shooters Road and SR1 have been included in the SR1

Plan since it's inception. These ideas have been tweaked and refined in subsequent updates in 2007 and 2023.

Existing Conditions – Traffic

The Trap Shooters Road ramps to SR1 are limited by the St. Jones River bridge and topography of the land adjacent to the highway. SR1 has a posted speed of 55 MPH within the project limits. No acceleration lane exists for the northbound entrance ramp due to this limitation, therefore vehicles from Trap Shooters Road enter from a complete stop condition. During high northbound SR1 (NB SR1) traffic volume periods, these entering vehicles must wait for unacceptably long durations for rare gaps in the NB SR1 traffic stream that are adequate to allow for acceleration to the highway speed to avert crashes. These conditions create a high probability for potentially dangerous operating conditions. The existing conditions traffic study has proposed to evaluate the feasibility of moving the existing NB SR1 entrance and exit ramps further south in order to accommodate an acceleration lane for the entrance ramp and a compliant deceleration lane for the exit ramp.

Existing Traffic Volumes

Intersections within the study limits are as follows:

1. Barkers Landing Road at Trap Shooters Road
2. Southbound SR1 (SB SR1) at Trap Shooters Road
3. NB SR1 at Trap Shooters Road.

A combination of turning movement counts performed in October and November of 2022, and traffic data for the same periods from existing Wavetronix devices along SR1 located north and south of the intersections were used to obtain the turning movement volumes for non-summer/regular weekday A.M., midday, P.M. and Saturday peak hour turning movement volumes presented in **Figure 6** Traffic data for the summer Saturday peak hours presented in **Figure 7** were obtained from the Wavetronix devices. A separate count of trucks / heavy vehicles was also collected for all the various peak hours for the traffic operational analysis.

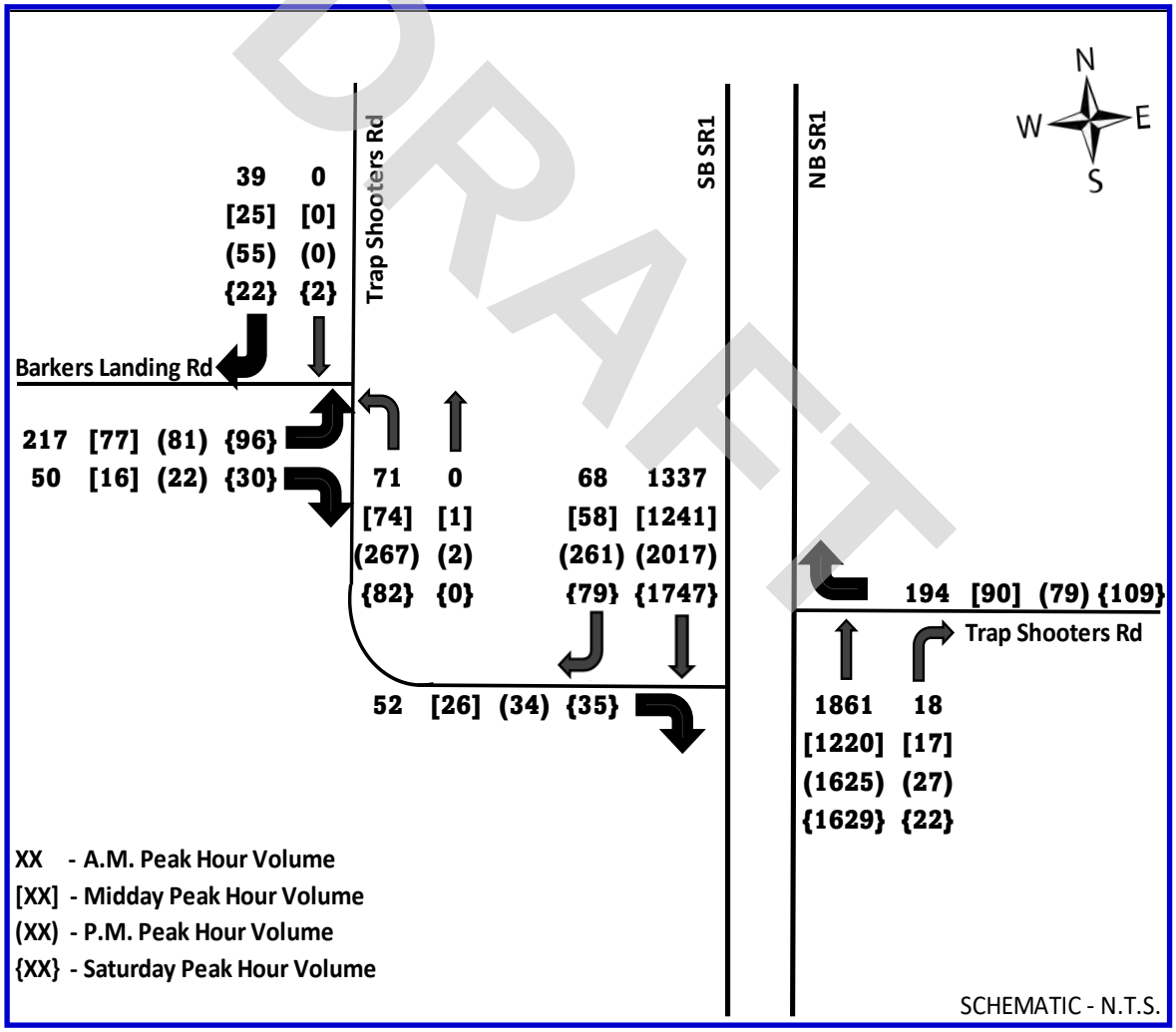


Figure 6 - 2022 Non-Summer Peak Hour Turning Movement Traffic Volumes

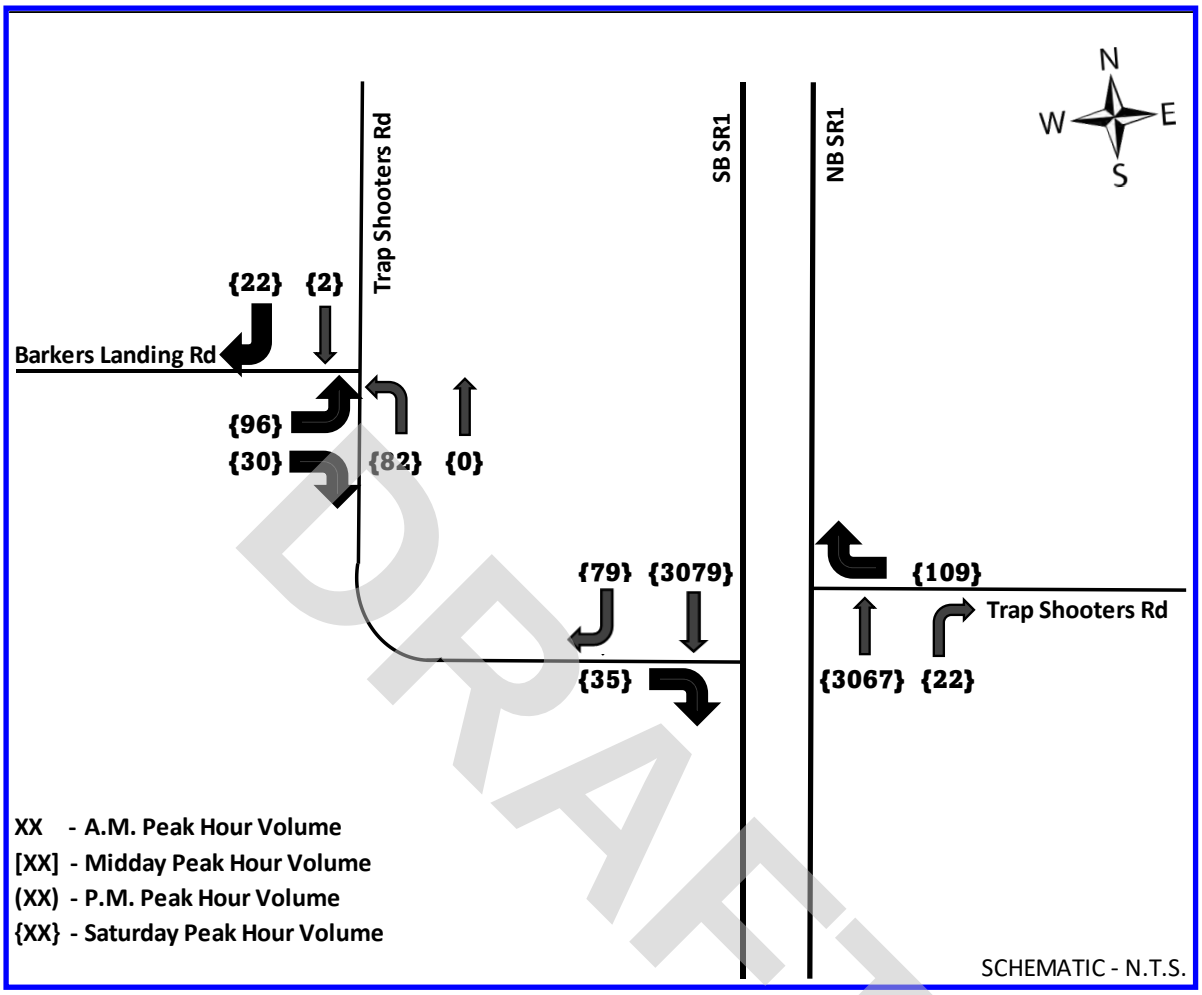


Figure 7 - 2022 Summer Saturday Peak Hour Turning Movement Traffic Volumes

Traffic Operational Analysis

The intersection of NB SR1 at Trap Shooters Road is comprised of an exit and entrance ramp on a limited access facility, however, due to the stop-controlled condition and absence of an acceleration lane for the entrance ramp, the intersection essentially operates as a stop-controlled T-intersection. It was therefore analyzed as two-way stop controlled (TWSC) intersection. While the entrance ramp for SB SR1 has an acceleration lane, the entering traffic is controlled by a yield sign, making the eastbound movement operate like a channelized right-turn at a controlled intersection. The intersection of SB SR1 at Trap Shooters Road was therefore analyzed as such.

HCS Software Version 2022, which utilizes the methodologies of the current Highway Capacity Manual (HCM) Version 7, was used for the traffic operational analysis for the three intersections within the project limits. The measures of effectiveness presented from the analysis are average control delay measured in seconds per vehicle, Level of service (LOS) and 95th percentile queues in feet. Per the HCM methodology, for TWSC intersections, no measures of effectiveness are provided for the free movements and approaches, and an overall intersection LOS is not defined either. The LOS criteria for unsignalized analysis are presented in **Table 1**. As provided in the table, LOS F is defined by delay greater than 80 seconds per vehicle and/or volume-to-capacity ratio (V/C) greater than one (1), irrespective of control delay value. The operational analysis results for the three study intersections are presented in **Table 2, Table 3, and Table 4**.

Table 1: LOS Criteria

Control Delay (Seconds per Vehicle)	LOS by V/C Ratio	
	V/C ≤ 1.0	V/C > 1.0
0 to 10	A	F
>10 to 15	B	F
>15 to 25	C	F
>25 to 35	D	F
>35 to 50	E	F
>50	F	F

Table 2: Barkers Landing at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions													
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	NBL Trap Shooters Rd	7.5	A	5	7.5	A	5	7.9	A	18	7.4	A	5	7.4	A	5
	EB L/R Bakers Landing Rd	11.9	B	40	10.3	B	13	16.5	C	28	10.5	B	18	10.5	B	18

Table 3: SB SR1 at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions													
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	EBR Trap Shooters Rd	17.4	C	15	16.4	C	8	27.6	D	15	21.5	C	13	93.5	F	53

Table 4: SB SR1 at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions													
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	WBR Trap Shooters Rd	87.6	F	198	16.9	C	23	27.1	D	38	35.6	E	70	301.4	F	213

As provided in Table 2, per the analysis, under current traffic and geometric conditions, Trap Shooters Road northbound left-turn movement and the stop-controlled Barkers Landing Road eastbound movements / approach operates at satisfactory LOS C or better for all non-summer and summer Saturday peak hours analyzed. The highest control delay of 16.5 seconds per vehicle is experienced by the Barkers Landing Road eastbound approach during the non-summer weekday P.M. peak hour.

Per the analysis, under current traffic and geometric conditions, at the intersection of SB SR1 and Trap Shooters Road, the eastbound yield controlled right-turn movement operates at satisfactory LOS D or better for all the non-summer peak hour periods analyzed with the worst delay of 27.1 seconds per vehicle experienced during the weekday P.M. peak hour as given in **Table 3**. Under existing summer traffic conditions, the Trap Shooter's Road eastbound right-turn movement operates at LOS F with average control delay of 93.5 seconds per vehicle.

As shown in **Table 4**, under current traffic and geometric conditions, per the analysis, Trap Shooters Road westbound movement / approach operates at satisfactory LOS C with 16.9 seconds average control delay, and LOS D with 27.1 seconds average control delay respectively for the non-summer midday and P.M. peak hours. The Trap Shooters Road westbound movement / approach operates at unsatisfactory LOS E with 35.6 seconds average control delay for the non-summer Saturday peak hour. For the non-summer A.M. peak hour, the Trap Shooters Road westbound movement / approach operates at LOS F with 87.6 seconds average control average control delay. During the summer Saturday peak hour, the Trap Shooters Road westbound movement / approach operates at LOS F with 301.4 seconds average control delay. That is an average control delay of more than 5 minutes per vehicle.

While current 95th percentile queues do not appear to be bad per the analysis for current conditions, these queues will get worse and become a problem as developments in the Magnolia area continue to grow with their associated increase in traffic volumes. The already unacceptable control delays will

deteriorate further and will be exacerbated by this continued growth in developments if no improvements are implemented.

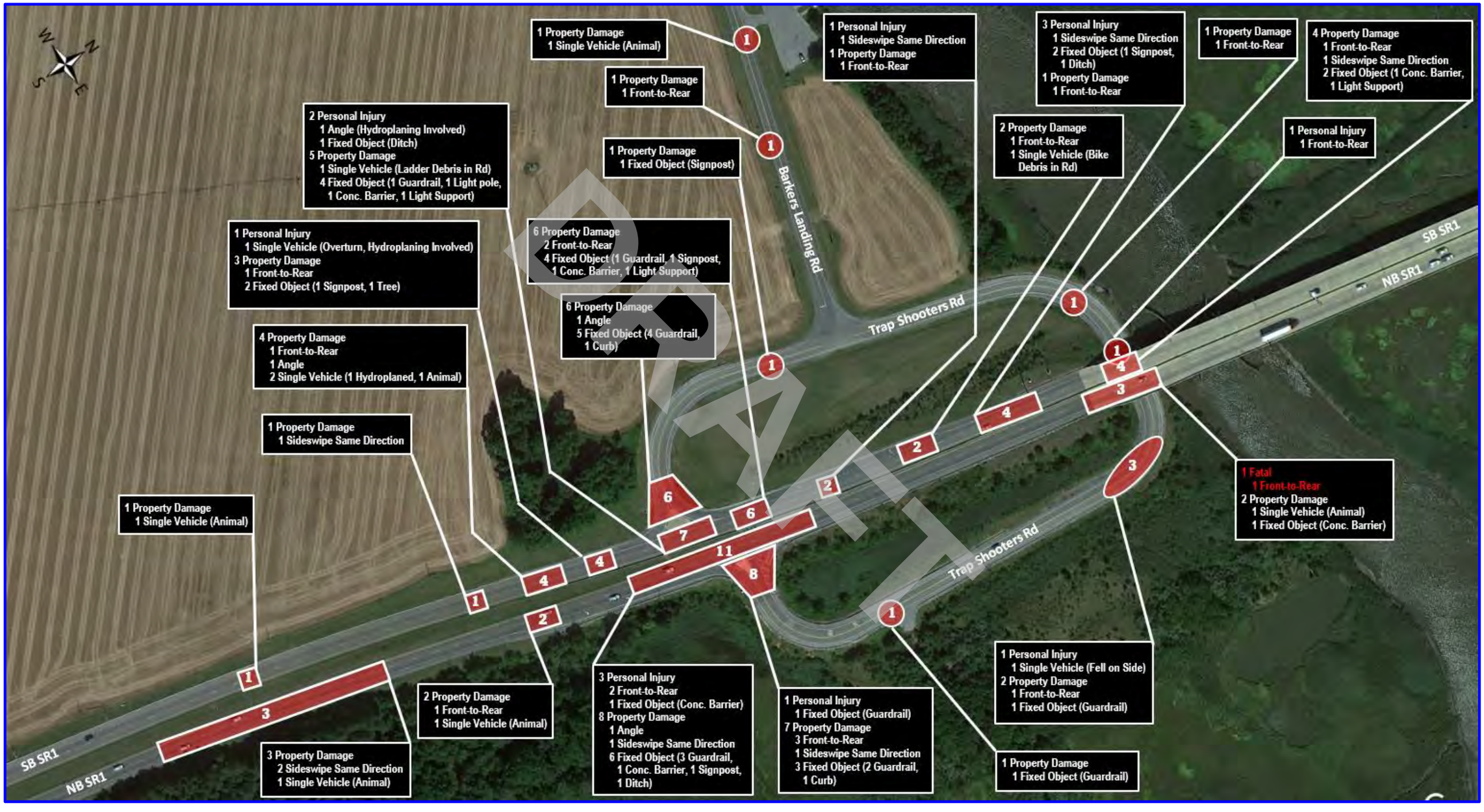
Existing Conditions – Safety

Five-year crash data from October 21, 2017, to October 31, 2022, for NB SR1, SB SR1, Trap Shooters Road and Barkers Landing Road within the project limits was obtained from DelDOT Traffic Safety Section for Evaluation. All reported crashes that occurred on the specified roadways and their intersections were mapped. The approximate crash locations, number, type and severity of crashes are presented **Figure 8**. The full crash analysis can be found in **Appendix C.**

Barkers Landing Road

A total of two (2) crashes were reported as having occurred on Barkers Landing Road for the 5-year period. Both crashes involved property damage only. One crash was a front-to-rear collision and the other was a vehicle collision with deer in the road.

Figure 8: Crash Map



Trap Shooters Road

A total of twenty-one (21) crashes were reported as occurring on Trap Shooters Road for the 5-year period, comprising three (3) personal injury and eighteen (18) property damage only crashes. A total of three (3) people were injured in the injury crashes. A majority of the crashes (13 / 61.9%) were reported as not a collision between two vehicles followed by (3 / 14.3%) each of front-to-front and front-to-rear crashes. One (1 / 4.8%) each of angle crashes and sideswipe same direction crashes were also reported. **Table 5** presents annual and five-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI).

Table 5 - Trap Shooters Road Crash Type and Severity

Collision Type	Crash Severity / Classification															Crash Severity / Classification			
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021			October 31, 2021 - October 31, 2022			5-Year Totals			
Front to Front	0	1	1	0	0	0	1	0	1	0	0	0	1	0	1	2	1	3	14.3%
Front to Rear	0	0	0	1	0	1	1	0	1	1	0	1	0	0	0	3	0	3	14.3%
Angle	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	4.8%
Sideswipe, Opposite Direction	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4.8%
Not a Collision Between Two Vehicles	4	1	5	1	1	2	5	0	5	1	0	1	0	0	0	11	2	13	61.9%
Total	5	2	7	3	1	4	7	0	7	2	0	2	1	0	1	18	3	21	100.0%

Figure 9 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, seven (7), was reported during the 2017–2018 and 2019–2020 period. Four (4) crashes were reported for the 2018–2019 period, approximately 42.9% lower than both the prior and the following 12-month period. For the 2020–2021 period, reported crashes dropped approximately 71.4% from seven (7) to two (2). Reported crashes dropped 50.0% from two (2) the preceding 12-month period to one during the most recent one-year period from October 31, 2021, to October 31, 2022. It appears reported crashes for Trap Shooters Road are on a downward trend.

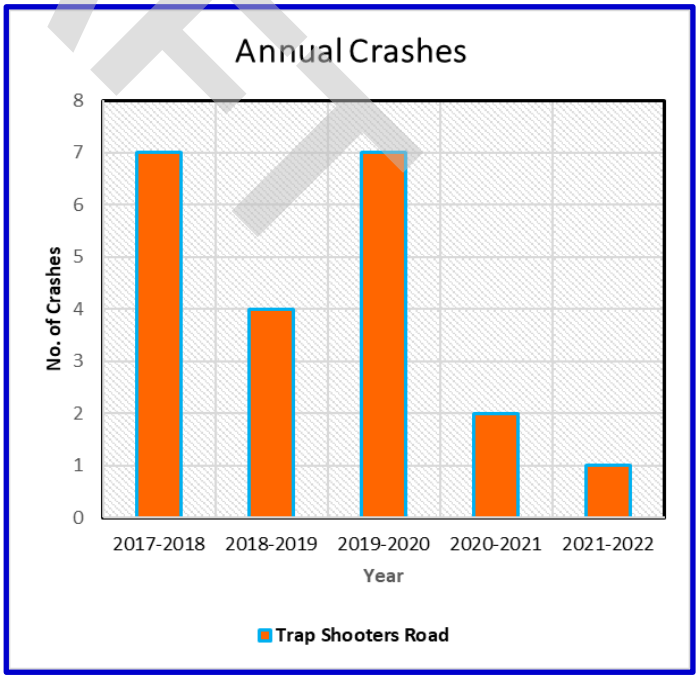


Figure 9 - Trap Shooters Road Annual Crashes

Southbound SR1

A total of thirty-five (35) crashes were reported as occurring on SB SR1 for the 5-year period, comprising seven (7) personal injury and twenty-eight (28) property damage only crashes. A total of eight (8) people were injured in the seven injury crashes. A majority of the crashes (21 / 60.0%) were reported as not a collision between two vehicles followed by (8 / 22.9%) front-to-front crashes. Four (4 / 11.4%) sideswipe same direction crashes and two (2 / 5.7%) angle crashes were also reported. **Table 6** presents annual and three-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI).

Collision Type	Crash Severity / Classification															Crash Severity / Classification			
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021			October 31, 2021 - October 31, 2022			5-Year Totals			
Front to Rear	3	0	3	1	0	1	1	0	1	1	0	1	2	0	2	8	0	8	22.9%
Angle	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	1	2	5.7%
Sideswipe, Same Direction	0	0	0	0	0	0	1	1	2	1	0	1	0	1	1	2	2	4	11.4%
Not a Collision Between Two Vehicles	2	0	2	2	1	3	7	1	8	3	1	4	3	1	4	17	4	21	60.0%
Total	5	0	5	3	1	4	10	3	13	5	1	6	5	2	7	28	7	35	100.0%

Table 6 - Southbound SR1 Crash Type and Severity

Figure 10 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, thirteen (13), was reported during the 2019–2020 period. Five (5) crashes were reported for the 2017–2018 period, approximately 61.5% lower than 2019–2020 period. For the 2018–2019 period, reported crashes dropped from five (5) to four (4), a 20% decrease. For the 2020–2021 period, reported crashes dropped approximately 53.8% from thirteen (13) to six (6). During the most recent one-year period from October 31, 2021, to October 31, 2022, reported crashes increased from six (6) for the preceding 12-month period to seven (7), i.e., by approximately 16.7%. While reported crashes have dropped significantly since the 2019-2020 period, it appears crash frequency is on SB SR1 is on an upward trend.

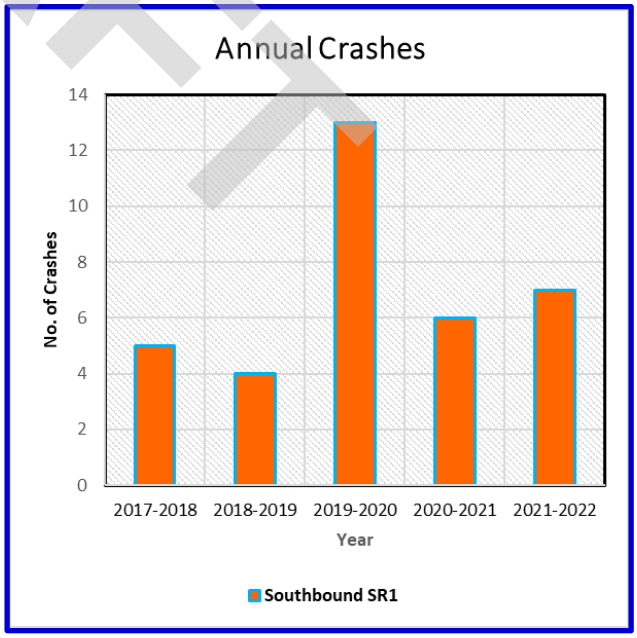


Figure 10 - Southbound SR1 Annual Crashes

Northbound SR1

A total of nineteen (19) crashes were reported as having occurred on NB SR1 for the 5-year period, comprising one (1) fatal, three (3) personal injury and fifteen (155) property damage only crashes. One person died in the fatal crash and a total of eleven (11) people were injured in the three injury crashes. A majority of the crashes (11 / 57.9%) were reported as not a collision between two vehicles followed front-to-front and sideswipe same direction crashes, of which three each (3 / 15.8%) were reported. There remainder of the reported crashes comprised one (1 / 5.3%) front-to-front crash, which resulted in the fatality, and one (1 / 5.3%) angle crash. **Table 11** presents annual and three-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI) and Fatal (F).

Collision Type	Crash Severity / Classification																Crash Severity / Classification				
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	F	Total	PD	PI	Total	PD	PI	F	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021				October 31, 2021 - October 31, 2022			5-Year Totals				
Front to Front	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	5.3%
Front to Rear	0	0	0	0	0	0	1	1	2	0	0	0	0	0	1	1	1	2	0	3	15.8%
Angle	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	5.3%
Sideswipe, Same Direction	2	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	3	0	0	3	15.8%
Not a Collision Between Two Vehicles	3	0	3	3	0	3	1	0	1	2	0	0	2	1	1	2	10	1	0	11	57.9%
Total	5	0	5	3	0	3	3	1	4	3	0	1	4	1	2	3	15	3	1	19	100.0%

Table 7 - Northbound SR1 Crash Type and Severity

Figure 11 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, five (5), was reported during the 2017–2018 period. Three (3) crashes were reported for the 2018–2019 period, 40% lower than the preceding year. For the 2019–2020 period, reported crashes increased from three (3) to four (4), a 33.3% increase. For the 2020–2021 period, reported crashes remained the same as for the preceding year. During the most recent one-year period from October 31, 2021, to October 31, 2022, reported crashes decreased from four (4) for the preceding 12-month period to seven (3), a 25% decrease. It appears from the data that crash frequency on NB SR1 has remained lower for the

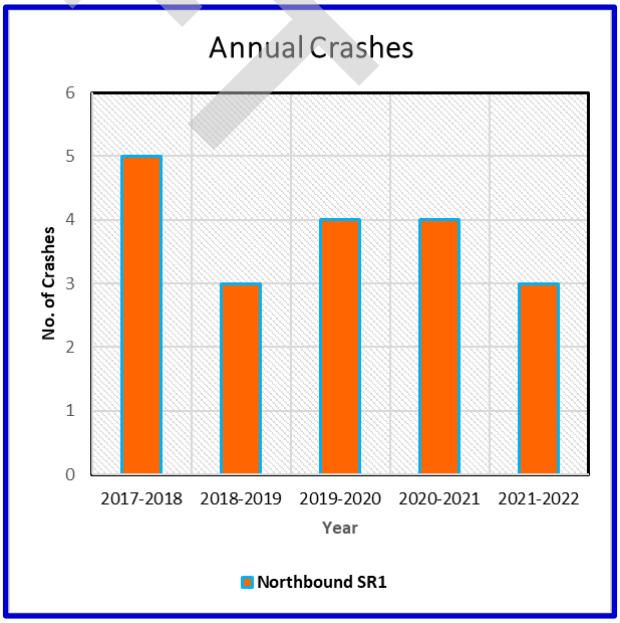


Figure 11 - Northbound SR1 Annual Crashes

last four years than they were for the 2017-2018 period and have not fluctuated significantly.

Crash Rates

Crash rates for the length of the study roadways within the study area were computed for 2018, 2019, 2020 and 2021 and compared to the 2018, 2019, 2020 and 2021 crash rates obtained from DelDOT for roadways with similar characteristics in Kent County and statewide. The entire length of Trap Shooters Road was considered within the study length. The rates were computed for the years identified for which the five-year crash data includes a full calendar year in addition to current availability of annual average daily traffic (AADT) from DelDOT. Since the crash rates for Kent County and State of Delaware are based on calendar year data, this allows for a fair comparison. The crash rates are measured in crashes per million vehicle miles travelled (C/MVMT).

Available DelDOT gateway AADT for SR1 is bidirectional. Based on Wavetronix device data in the vicinity of the study area, NB SR1 and SB SR1 diurnal traffic volumes average out close to even. The directional AADT were therefore assigned according to a 50% directional distribution.

SR1 (northbound and southbound) is functionally classified as Other Expressway & Freeway. Northbound SR1 and Southbound SR1 crash rates were compared to the crash rates for similar Other Expressways and Freeway in Kent County and statewide. Trap Shooters Road and Barkers Landing Road are both two-lane roadways classified as Major Collectors. Since the current setting of these two roads is more rural than urban, their crash rates were compared to the crash rates for similar Rural Major Collectors in Kent County and statewide. **Table 8**, **Table 9**, **Table 10,** and **Table 11** respectively present the 2018, 2019, 2020 and 2021 crash rates for the study roadways and the 2018, 2019, 2020 and 2021 crash rates for similar roadways in Kent County and statewide.

Road	Functional Class	2018 AADT	No of Crashes (2018)	Length	Roadway Crash Rate (C/MVMT) (2018)	2018 Kent County Crash Rate (C/MVMT)	2018 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	18,664	4	0.65	**0.90**	0.77	0.67
Southbound SR1	Other Expressway & Freeway	18,664	5	0.65	**1.13**	**0.77**	0.67
Trap Shooters Rd	Rural Major Collectorl	1,784	7	0.44	**24.43**	**2.47**	2.88
Barkers Landing Rd	Rural Major Collectorl	1,898	2	0.16	**18.04**	**2.47**	2.88

Table 8 - 2018 Study Roadways Crash Rate

Road	Functional Class	2019 AADT	No of Crashes (2019)	Length	Roadway Crash Rate (C/MVMT) (2019)	2019 Kent County Crash Rate (C/MVMT)	2019 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	18,808	4	0.65	**0.90**	0.17	0.13
Southbound SR1	Other Expressway & Freeway	18,808	5	0.65	**1.12**	**0.17**	0.13
Trap Shooters Rd	Rural Major Collectorl	1,847	5	0.44	**16.86**	**0.75**	0.76
Barkers Landing Rd	Rural Major Collectorl	1,989	0	0.16	**0.00**	**0.75**	0.76

Table 9 - 2020 Study Roadways Crash Rate

Road	Functional Class	2020 AADT	No of Crashes (2020)	Length	Roadway Crash Rate (C/MVMT) (2020)	2020 Kent County Crash Rate (C/MVMT)	2020 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	14,962	3	0.65	**0.85**	0.18	0.15
Southbound SR1	Other Expressway & Freeway	14,962	13	0.65	**3.66**	**0.18**	0.15
Trap Shooters Rd	Rural Major Collectorl	1,468	5	0.44	**21.21**	**0.54**	0.67
Barkers Landing Rd	Rural Major Collectorl	1,581	0	0.16	**0.00**	**0.54**	0.67

Table 10 - 2020 Study Roadways Crash Rate

Road	Functional Class	2021 AADT	No of Crashes (2021)	Length	Roadway Crash Rate (C/MVMT) (2021)	2021 Kent County Crash Rate (C/MVMT)	2021 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	19,533	5	0.65	**1.08**	0.15	0.14
Southbound SR1	Other Expressway & Freeway	19,533	8	0.65	**1.73**	**0.15**	0.14
Trap Shooters Rd	Rural Major Collectorl	1,714	2	0.44	**7.27**	**0.54**	0.67
Barkers Landing Rd	Rural Major Collectorl	2,018	0	0.16	**0.00**	**0.54**	0.67

Table 11 - 2028 Study Roadways Crash Rates Ratio to County and State Rates

The ratio of each study roadway crash rate to the rate for Kent County and the State of Delaware for similar roadways in 2018, 2019, 2020 and 2021 were also computed. The 2018, 2019, 2020 and 2021 crash rate comparisons are respectively provided in **Table 12**, **Table 13**, **Table 14** and **Table 15**.

Functional Class	Ratio of 2018 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2018 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	**1.17**	**1.35**
Southbound SR1	**1.47**	**1.69**
Trap Shooters Rd	**9.89**	**8.48**
Barkers Landing Rd	**7.31**	**6.27**

Table 12 - 2018 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2019 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2019 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	**5.27**	**6.90**
Southbound SR1	**6.59**	**8.62**
Trap Shooters Rd	**22.47**	**22.18**
Barkers Landing Rd	**0.00**	**0.00**

Table 13 - 2019 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2020 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2020 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	4.70	5.63
Southbound SR1	20.35	24.41
Trap Shooters Rd	39.27	31.65
Barkers Landing Rd	0.00	0.00

Table 14 - 2020 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2021 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2021 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	7.19	7.71
Southbound SR1	11.51	12.33
Trap Shooters Rd	13.45	10.84
Barkers Landing Rd	0.00	0.00

Table 15 - 2021 Study Roadways Crash Rates Ratio to County and State Rates

As provided in the tables, the 2018 crash rates for all the study roadways are higher than those for similar roadways in the County and Statewide. For 2019, 2020 and 2021, no crashes were reported on Barkers Landing Road for the segment assessed as part of this study, therefore crash rates were zero, lower than for the Kent County and statewide. As the ratios show, for NB SR1, SB SR1 and Trap Shooters Road, the crash rates for 2019, 2020 and 2021 are much higher than for similar roadways in Kent County and statewide.

Northbound SR1

As provided in **Table 12** through **Table 15**, the NB SR1 crash rate ratios compared to the Kent County and statewide rates increased sharply in 2019 compared to the 2018 ratios. The 2020 ratios dropped some compared to the 2019 ratios, then increased more than they dropped for 2021.

Southbound SR1

As provided in **Table 12** through **Table 15**, the SB SR1 crash rate ratios to the Kent County and statewide rates increased sharply in 2019 compared to the 2018 ratios. The 2020 rates increased steeply from the 2019 6.59 times the Kent County rate of 0.17 and 8.62 times the statewide rate of 0.13, to 22.47 times the Kent County rate of 0.18 and 22.18 times the statewide rate of 0.15. For 2021, the ratios dropped by almost half, but the crash rate was still 11.51 times the Kent County rate of 0.15, and 12.33 times the statewide rate of 0.14.

Trap Shooters Road

As provided in **Table 12** through **Table 15**, the Trap Shooters crash rate ratios to the Kent County and statewide rates increased steeply in 2019 compared to the 2018 ratios. The 2019 rates increased from the 2018 by 9.89 times the Kent County rate of 2.47, and 8.48 times the statewide rate of 2.88, to 22.47 times the Kent County rate of 0.75 and 22.18 times the statewide rate of 0.76. The 2020 rates again increase sharply from the 2019 rates to 39.27 times the Kent County rate of 0.54 and 31.65 times the statewide rate of 0.67. For 2021, the ratios dropped, but the crash rate was still 13.45 times the Kent County rate of 0.54 and 10.84 times the statewide rate of 0.67.

Public Involvement

Public involvement is an integral element of any successful planning study. The SR1 and Trap Shooter Road Project developed a public engagement strategy to help garner as much public input on the process and proposed alternative as possible. Based on the rural location of the project, it was decided that the initial public workshop would be an online virtual experience followed by an in-person workshop style to present the proposed alternatives and have one-on-one conversations with the public. Several strategies were employed to advertise the public workshops. Both workshops involved a direct mailing to the local residents to notify them of the upcoming workshop. A project webpage was created by and housed on the MPO website. Information was provided to the local legislators, and they used those materials to advertise the workshops in their newsletters. The workshops were also advertised and placed on the DelDOT public meeting calendar. The following provides a summary of the public involvement and outreach that occurred throughout the study and helped guide the development of conceptual improvement alternatives:

Community Workshop 1 — January 23, 2023

- Location: Virtual via Zoom Webinar
- Advertised through direct mailings, legislative newsletters, MPO website and social media, DelDOT website.

- Century Engineering presented a PowerPoint presentation including the study area, purpose and need, work plan, existing conditions, current DelDOT efforts, the proposed study schedule and then took questions after the presentation.
- 13 people registered for the workshop and 8 people attended.
- Community members were asked for feedback on their main concerns about how the intersection operates today.
- 4 Comments were received
- See ***Appendix D*** for Public Involvement Summaries

Community Workshop 2 — March 28, 2023

- Location: In-Person – McIlvaine Elementary School
- Advertised through direct mailings, legislative newsletters, MPO website and social media, DelDOT website.
- Century Engineering presented numerous display boards with information including the study area, project goals, existing traffic volumes, crash data, 4 alternatives, measures of effectiveness, and the anticipated schedule for the study.
- Feedback was gathered from attendees through conversations with Century Engineering personnel, questionnaires, and comment forms.
- 39 Attendees
- 26 Comments were received
- See ***Appendix D*** for Public Involvement Summaries

Public Advisory Committee (PAC) — June 8, 2023

- Study Area
- Goals
- Crash Summary
- Existing LOS
- Existing Crash Data
- First Workshop Summary
- Second Workshop Summary
- Preferred Alternative
- Alternatives considered but not progressed
- Cost Estimates
- Schedule & Next Steps

Technical Advisory Committee (TAC) — June 13, 2023

- Study Area
- Goals
- Crash Summary
- Existing LOS
- Existing Crash Data
- First Workshop Summary
- Second Workshop Summary
- MOE/Sensitivity Analysis
- Preferred Alternative
- Alternatives considered but not progressed
- Cost Estimates
- Schedule & Next Steps

MPO Council Presentation

- Study Area
- Goals
- Crash Summary
- Existing LOS
- Existing Crash Data
- First Workshop Summary

July 6, 2023

- Second Workshop Summary
- MOE/Sensitivity Analysis
- Preferred Alternative
- Alternatives considered but not progressed
- Cost Estimates

Alternatives Considered

A total of 4 alternatives were included as part of this study. Each alternative met the criteria of the purpose and need. Alternative 1 and 2 utilized the existing roadway geometry at Barkers Landing Road and Trap Shooters Road and made modification to the ramps to meet current Federal and State standards. Alternative 3 and 4 created a new connection from Barkers Landing Road to SR1 and implemented a higher type interchange to better address the overall safety and congestion concerns.

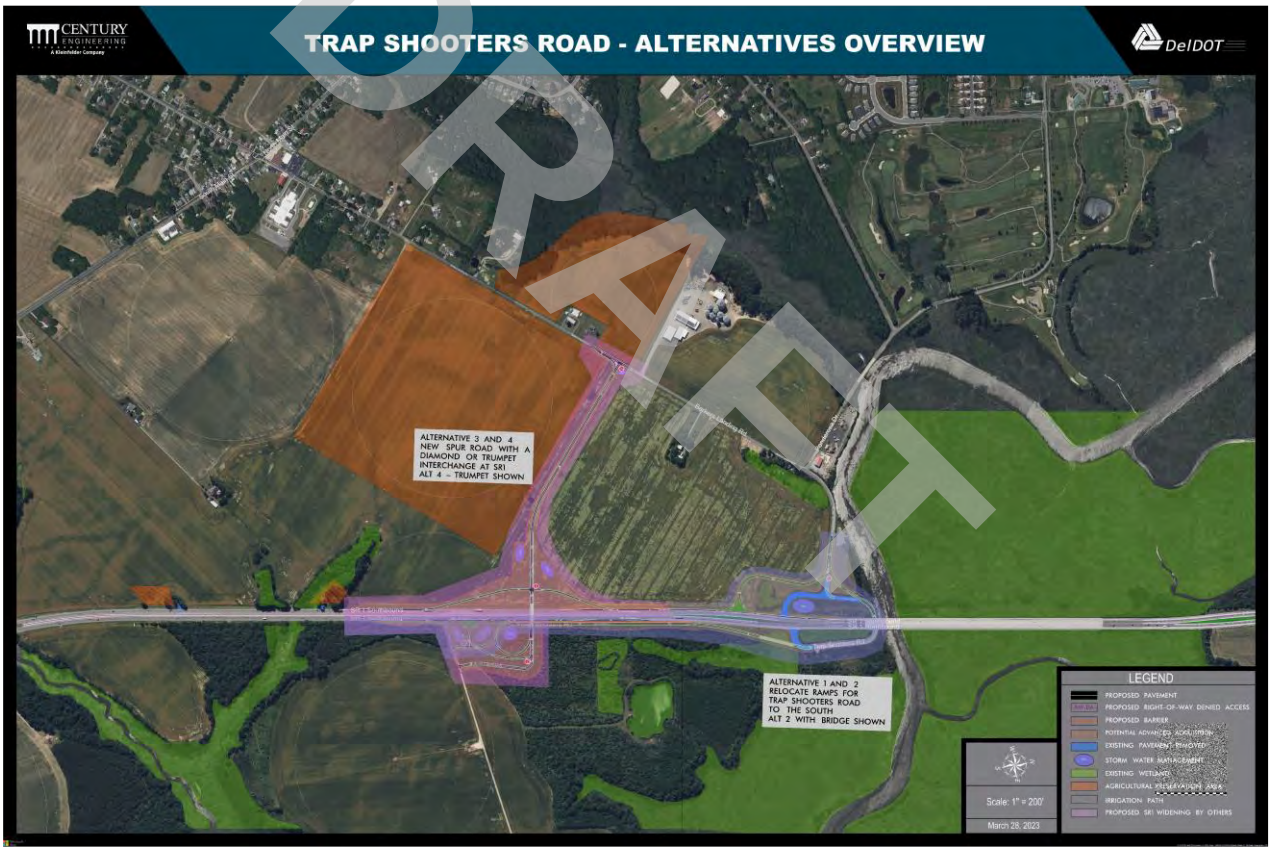


Figure 12 - Alternatives Overview

Alternative 1 – Relocation of existing ramps filling impacted wetlands

This alternative shifts the SB SR1 offramps to the south and increases the exit ramp radius. It also reconfigured the Barkers Landing Road and Trap Shooters Road Intersection to allow EB Barkers Landing

Road to access the NB SR1 ramp without stopping. SB SR1 existing traffic would have to stop at Barkers Landing Road prior to making a left turn to head WB in Magnolia.

NB SR1 Access ramps would be relocated approximately ¾ of a mile to the south to allow for interstate standard deceleration lanes and acceleration lanes to be developed along SR1 prior to entering onto the Barkers Landing Bridge. The extension of Trap Shooters Road south, parallel to existing SR1, would require the crossing of a small area of identified wetlands. This alternative contemplates filling of the wetlands and mitigation of those impacts in an area adjacent to the project.

Alternative 2 = Relocation of existing ramps with bridge over impacted wetlands

This alternative shifts the SB SR1 offramps to the south and increases the exit ramp radius. It also reconfigured the Barkers Landing Road and Trap Shooters Road Intersection to allow EB Barkers Landing Road to access the NB SR1 ramp without stopping. SB SR1 existing traffic would have to stop at Barkers Landing Road prior to making a left turn to head WB in Magnolia.

NB SR1 Access ramps would be relocated approximately ¾ of a mile to the south to allow for interstate standard deceleration lanes and acceleration lanes to be developed along SR1 prior to entering onto the Barkers Landing Bridge. The extension of Trap Shooters Road south, parallel to existing SR1, would require the crossing of a small area of identified wetlands. This alternative contemplates bridging the wetlands with a 300' long bridge over the wetlands. All other design details are the same as Alternative 1.

Alternative 3 – New alignment from Barkers Landing Road to SR1 with new diamond interchange

This alternative creates a new ramp alignment from Barkers Landing Road to SR1. The new connection with SR1 allows for a more efficient interchange design with SR1. Alternative 3 considers using a diamond interchange that allows for traffic to easily access both NB and SB SR1.

The diamond interchange ramps are designed to meet all state and federal design standards for interstate interchanges. Alternative 3 impacts several agricultural areas west of SR1 including 2 pivot irrigation systems.

Alternative 4 - New alignment from Barkers Landing Road to SR1 with new trumpet interchange

This alternative creates a new ramp alignment from Barkers Landing Road to SR1. The new connection with SR1 allows for a more efficient interchange design with SR1. Alternative 4 considers using a trumpet interchange that allows for traffic to easily access both NB and SB SR1.

The trumpet interchange ramps are designed to meet all state and federal design standards for interstate interchanges. Alternative 4 impacts several agricultural areas west of SR1 including 2 pivot irrigation systems.

Conceptual plans for each alternative are provided in ***Appendix E*** of this report.

Alternatives Evaluation

The alternatives were evaluated using a comparison matrix to assess both the physical and traffic operational impacts associated with each of the alternatives. The traffic analysis evaluated the future volumes and the ramp merge areas with SR1. It also looked at travel time and differences and the overall crash reductions that can be expected based on the new design configurations.

Future Traffic Volumes

Opening Year 2028 and design year 2050 traffic volumes presented in **Figure 13** and **Figure 14** were generated by DelDOT Planning based on the existing traffic volumes submitted. The Delmarva Peninsula

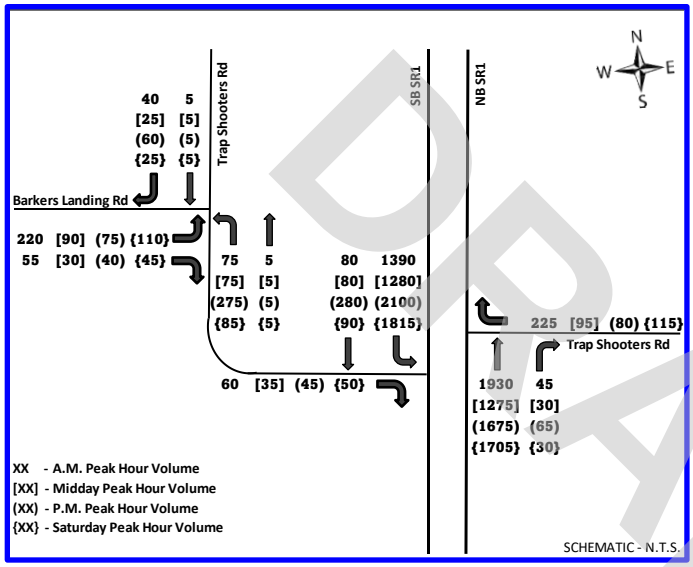


Figure 14 - 2028 Non-Summer Peak Hour Turning Movement Traffic Volumes

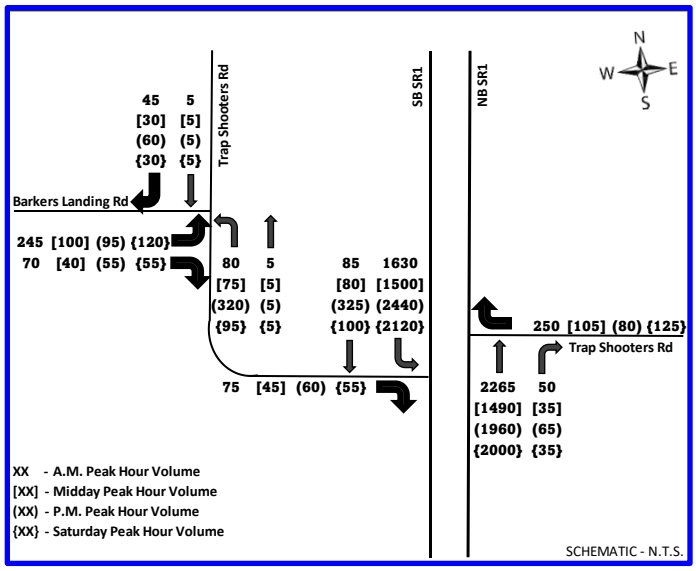


Figure 13- 2050 Non-Summer Peak Hour Turning Movement Traffic Volumes

Travel Demand Model (TDM) was used in the development of the future traffic forecast. Summer Saturday traffic forecast was not included in the data received; therefore, Century used the growth factor computed based on the ratio of the non-summer Saturday forecasts to the existing Saturday traffic volumes. The Opening Year 2028 and design year 2050 Summer Saturday traffic volumes generated are shown in **Figure 15** and **Figure 16**.

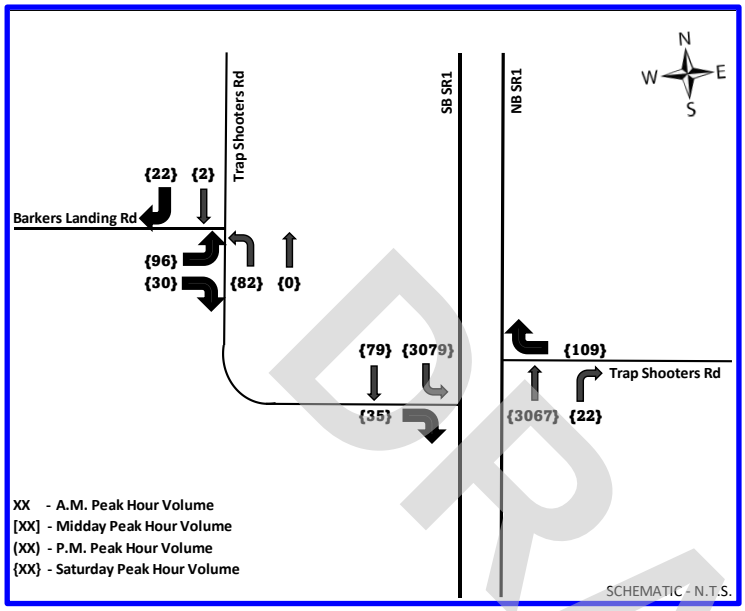


Figure 16 - 2028 Summer Saturday Peak Hour Turning Movement Traffic Volumes

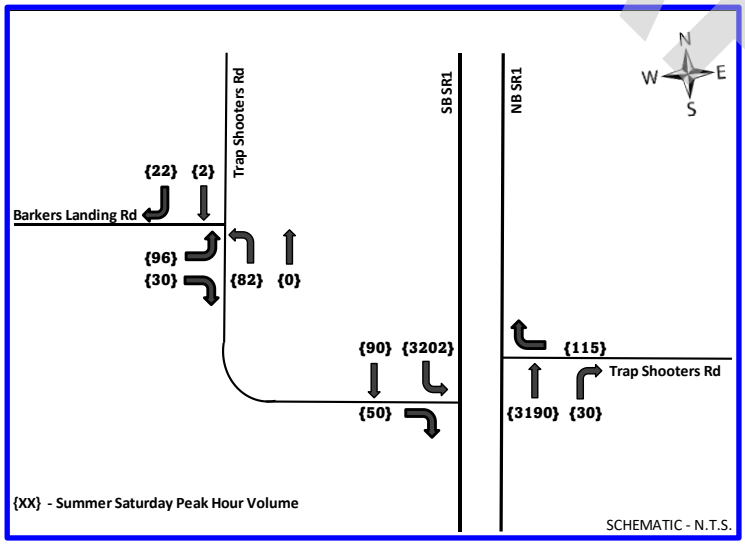


Figure 15 - 2050 Summer Saturday Peak Hour Turning Movement Traffic Volumes

Ramp Analysis

Since the existing conditions analysis already show unacceptable operational results for the existing intersections, future without improvements (No-Build) was not analyzed. Four improvement alternatives were developed, all of which allow for access to and from SR1 via ramps with AASHTO compliant acceleration and deceleration lanes. Per HCM methodology for freeway facilities, freeway basic segments, ramps merge, and ramps diverge influence areas, the measures of effectiveness presented for future (Build) conditions are density measured in passenger car per mile per lane (pc/mi/ln) and LOS. Merge and diverge influence areas and the LOS criteria for them are presented in the full traffic report found in ***Appendix C***.

There were no significant variations in densities between alternatives for the basic freeway segments and ramps merge/diverge influence areas and therefore there were no differences in LOS between alternatives. LOS for the various segments for Opening Year 2028 and Design Year 2050 for all Alternatives are presented in Table 16 for northbound and Table 17 for southbound. For year 2050, SR1 was analyzed with three lanes in each direction.

Facility	Opening Year 2028 LOS (2-Lane SR1)				Design Year 2050 LOS (3-Lane SR1)			
	Non-Summer			Summer	Non-Summer			Summer
	AM	PM	Saturday	Saturday	AM	PM	Saturday	Saturday
NB Basic Segment South of Exit Ramp	B	B	B	D	B	B	B	C
NB Exit Ramp Diverge Influence Area	C	B	B	D	B	B	B	C
NB Basic Segment between Exit Ramp & Entrance Ramp	B	B	B	D	B	B	B	C
NB Entrance Ramp Merge Influence Area	C	B	B	C	B	A	B	B
NB Basic Freeway Segment North of Entrance Ramp	C	B	B	D	B	B	B	C

Table 16 - Northbound SR1 Freeway Facilities LOS for Future Conditions

Facility	Opening Year 2028 LOS (2-Lane SR1)				Design Year 2050 LOS (3-Lane SR1)			
	Non-Summer			Summer	Non-Summer			Summer
	AM	PM	Saturday	Saturday	AM	PM	Saturday	Saturday
SB Basic Segment North of Exit Ramp	B	C	B	D	A	B	B	C
SB Exit Ramp Diverge Influence Area	B	C	B	D	B	B	B	C
SB Basic Segment between Exit Ramp & Entrance Ramp	B	B	B	D	A	B	B	C
SB Entrance Ramp Merge Influence Area	B	B	B	D	A	B	B	C
SB Basic Freeway Segment South of Entrance Ramp	B	B	B	D	A	B	B	C

Table 17 - Southbound SR1 Freeway Facilities LOS for Future Conditions

As shown in **Table 16** and **Table 17**, all SR1 segments, northbound and southbound would operate at LOS C or better under both 2028 and 2050 peak hour conditions except for 2028 Summer Saturday under 2-Lane directional conditions. Under the 2028 Summer Saturday conditions almost northbound and southbound segments would operate at LOS D except for the northbound Entrance Ramp influence area, which would operate at LOS C.

Travel Time Analysis

To assess travel time changes between each of the four alternatives and the existing geometric conditions, Synchro/SimTraffic 11 was utilized to develop models for each. Two origin-destination (O-D) locations were assessed – Ponderosa Drive and the Town of Magnolia. The travel time changes were calculated based on travel times generated in SimTraffic. The results are presented in **Table 18** for Ponderosa Drive O-D, and **Table 19** for Town of Magnolia O-D.

Travel Time Change with Ponderosa Drive Origin-Destination

Travel Time Change (Seconds)	Alt 1 Geometry				Alt 2 Geometry				Alt 3 Geometry				Alt 4 Geometry			
	Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	11.7	20.6	12.5	6.7	0.2	9.2	9.7	5.7	(22.6)	(15.9)	63.5	9.0	(21.7)	4.5	62.6	10.4

Table 18 - Travel Time Change with Ponderosa Drive Origin-Destination

Travel Time Change with Magnolia Origin-Destination

Travel Time Change (Seconds)	Alt 1 Geometry				Alt 2 Geometry				Alt 3 Geometry				Alt 4 Geometry			
	Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip		Northbound Trips		Southbound Trip	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	11.7	20.6	12.5	6.7	0.2	9.2	9.7	5.7	(72.8)	(72.4)	13.3	(47.5)	(71.9)	(53.2)	12.7	(47.3)

Table 19 - Travel Time Change with Town of Magnolia Origin-Destination

Safety Improvement / Crash Reduction Benefit

Crashes for calendar year 2018 through 2021 were used to assess the safety benefits of the proposed improvements in terms of their potential for crash reduction. Only crashes susceptible to correction with the geometric improvements were included in the assessment. All four proposed alternatives allow for access to and from SR1 via ramps with AASHTO compliant acceleration and deceleration lanes, therefore the crash reduction potential would be the same irrespective of the alternative that is selected and built. The 2010 AASHTO Highway Safety Manual was used to determine the crash modification factor (CMF) used in computing the potential crash reduction. Estimated annual monetary value of the reduction in crashes was obtained using the US Department of transportation (USDOT) suggested 2021 base year dollar rates. The results are summarized in **Table 20**. As provided in the table, the project would yield an estimated annual crash reduction benefit of approximately $3.5 million.

Crash Reduction Benefits Due to Project (All Alternatives)				
	No. of Vehicles involved in Property Damage Crashes	Injury Crashes	Fatal Crashes	Total Annual Crash Reduction Benefit
2018 through 2021 Calendar Years*	72	11	1	
Crash Modification Factor (CMF)	0.84	0.84	0.84	
Crashes after Project	60.48	9.24	0.84	
Annual Crash Reduction	15.12	2.31	0.21	
USDOT Monetized Value per crash**	$4,800.00	$307,800.00	$13,046,800.00	
Annual Crash Reduction Benefit	**$72,576.00**	**$711,018.00**	**$2,739,828.00**	**$3,523,422.00**

* Excluding Crashes with animals as they are not susceptible to reduction with any geometric changes
** 2021 Base Year Dollars

Table 20 - Project Estimated Annual Safety Improvement / Crash Reduction Benefit

The physical impacts were evaluated using each of the alternatives layered on aerial imagery with several GIS layers to determine the impacts. The physical impacts that were evaluated included:

- Wetland Impacts – Permanent
- Wetland Impacts – Temporary
- Forested Lands Impacts
- Agricultural Lands Impacts
- Agricultural Land Preservation Impacts
- Irrigation Impacts
- Right-of-Way Needed

Table 21 summarizes the impacts of each alternative on the physical resources. Alternatives 1 and 2 impact the most protected resources. Alternatives 3 and 4 impact the most agricultural lands and require the most right-of-way. The cost estimate information is described in the next section of this report.

SR1 Trap Shooters Road Interchnage Study Measures of Effectiveness - Physical Impacts									
Measure	UOM	Move SR1 Access Points South No Bridge		Move SR1 Access Points South With Bridge		Alternate 3 New Spur Road to SR1 with Diamond Interchnage		Alternate 4 New Spur Road to SR1 with Trumpet Interchnage	
Wetland Impacts Permanent	Square Feet / Ac	10,155	0.23	786	0.02	0	0.00	0	0.00
Wetland Impacts Temp	Square Feet / Ac	0	0.00	6,621	0.15	0	0.00	0	0.00
Forested Land Impacts	Square Feet / Ac	278,036	6.38	287,930	6.61	357,621	8.21	326,427	7.49
Agricultural Land Impacts	Square Feet / Ac	164,408	3.77	164,408	3.77	549,855	12.62	558,526	12.82
Ag. Land Preservation Impacts	Square Feet / Ac	0	0.00	0	0.00	5,294	0.12	5,294	0.12
Irrigation Impacts	Square Feet / Ac	10,482	0.24	10,482	0.24	123,248	2.83	123,248	2.83
Right-of-way Area	Square Feet / Ac	519,455	11.93	553,971	12.72	919,292	21.10	969,772	22.26
Costs	Thousands Dollars	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Table 21 - Alternatives Comparison - Physical Measures of Effectiveness

Cost Estimates

Conceptual cost estimates were developed for the alternatives evaluated in the study. The following provides a summary of the conceptual cost estimates.

Alternate 1

Preliminary Engineering	$2,248,360
Right-of-Way	$1,300,000
Construction	$13,877,220
Total Cost	**$17,425,580**

Alternate 2

Preliminary Engineering	$3,348,610
Right-of-Way	$1,400,000
Construction	$20,487,951
Total Cost	**$25,236,561**

Alternate 3

Preliminary Engineering	$4,541,790
Right-of-Way	$2,300,000
Construction	$27,697,481
Total Cost	**$34,539,271**

Alternate 4

Preliminary Engineering	$4,107,700
Right-of-Way	$2,500,000
Construction	$25,097,374
Total Cost	**$31,705,074**

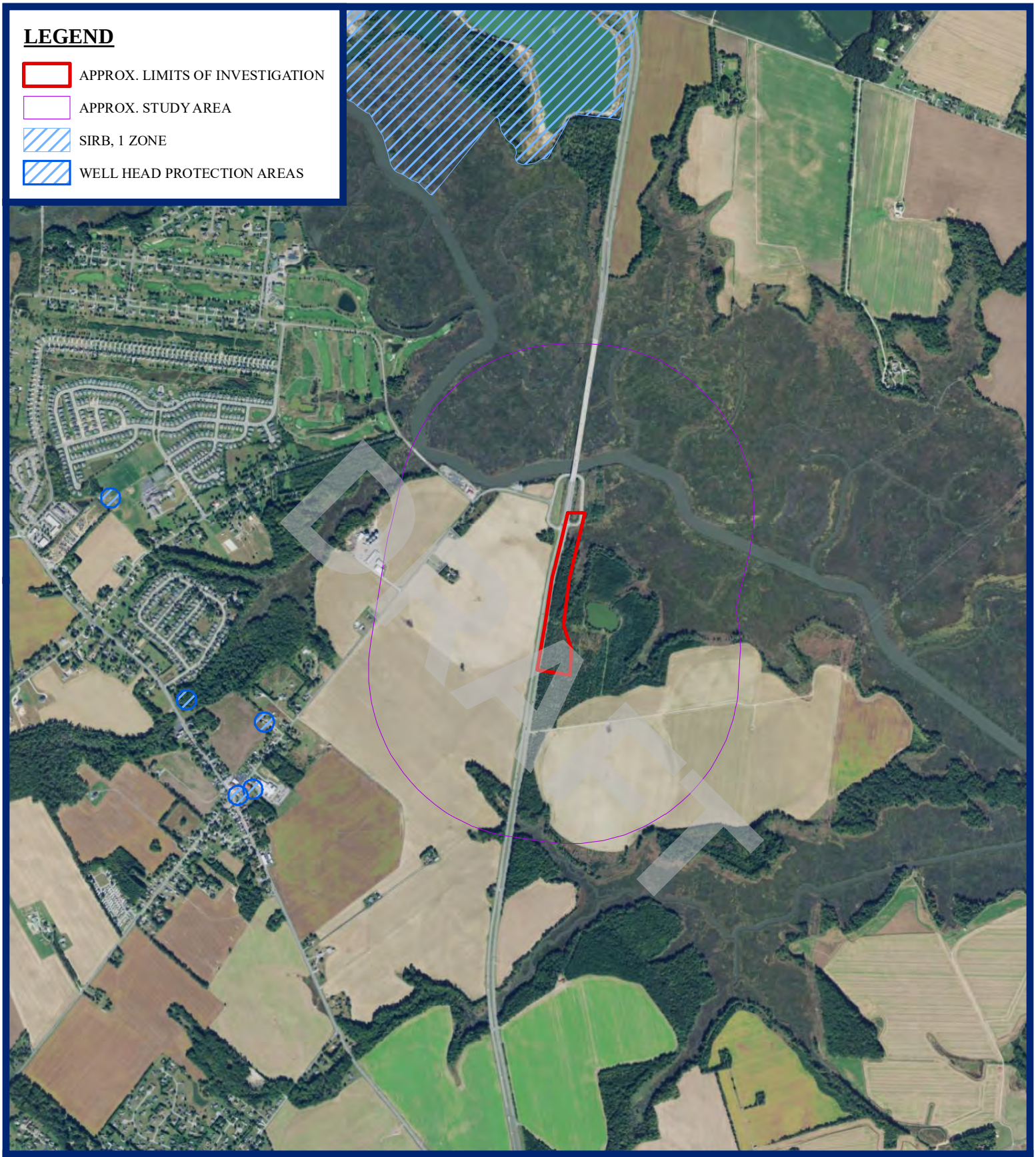
Complete conceptual cost estimates are provided in ***Appendix F*** of this report.

Final Recommendations

All four Alternates meet the identified purpose and need of the study related to the safety and capacity of SR1 and to reduce high crash rates at the existing design of the interchange. Based on the MOE analysis, Alternative 1 provides the best value for this project, at a cost of $17,425,580. Public input generally supports Alternative 1 as well.

Therefore, it is the recommendation of this study that Alternative 1 be advanced to DelDOT for further development, permitting, design, and construction.

Appendix A: Environmental Assessment Maps



CENTURY ENGINEERING
A Kleinfelder Company

550 Bay Road
Dover, DE 19901
P: 302.734.9188

GROUNDWATER MANAGEMENT ZONES

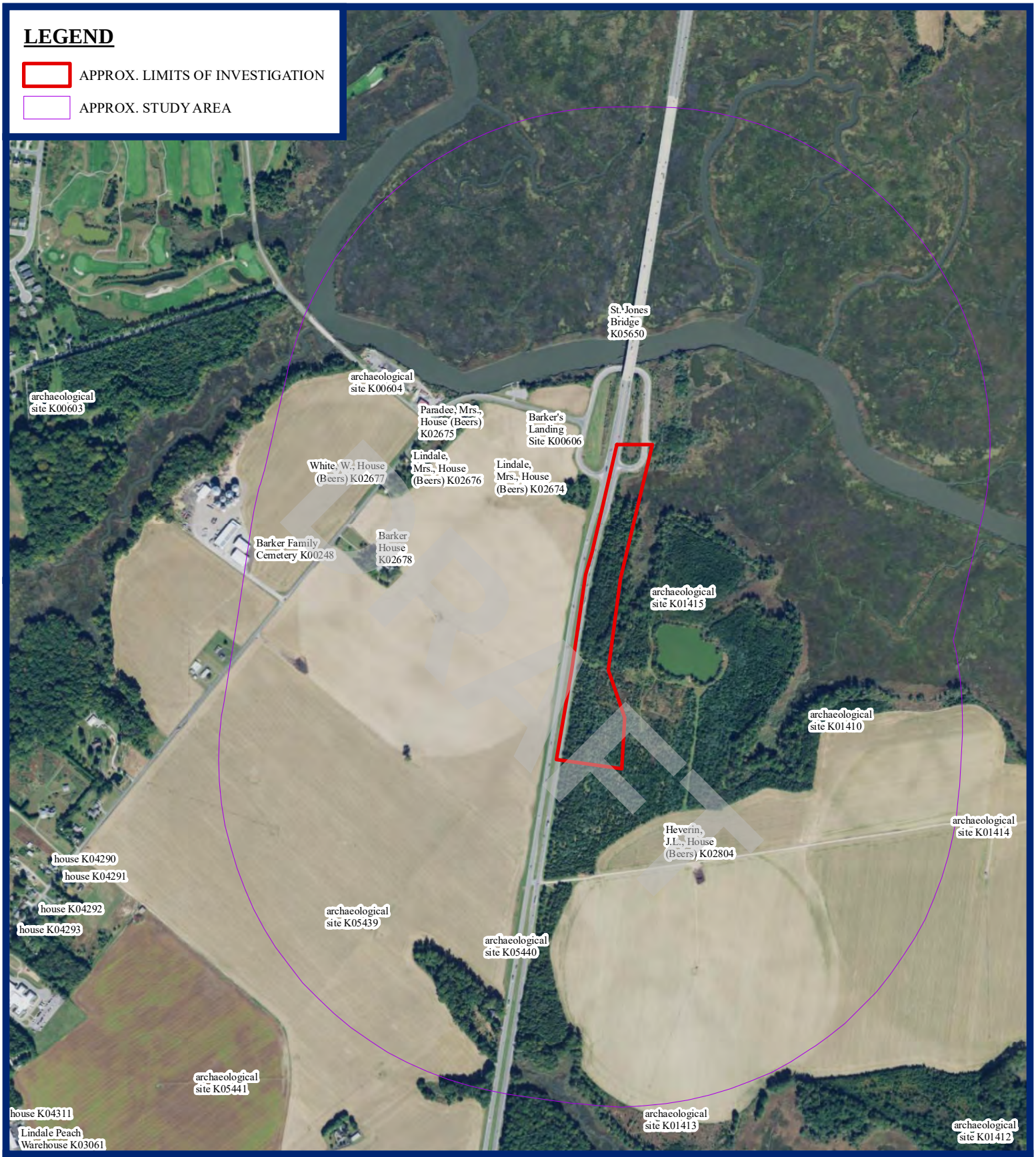
SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
FirstMap
ArcGIS Online

N

1 inch = 2,000 feet



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KNOWN HISTORIC OR ARCHAEOLOGICAL RESOURCES

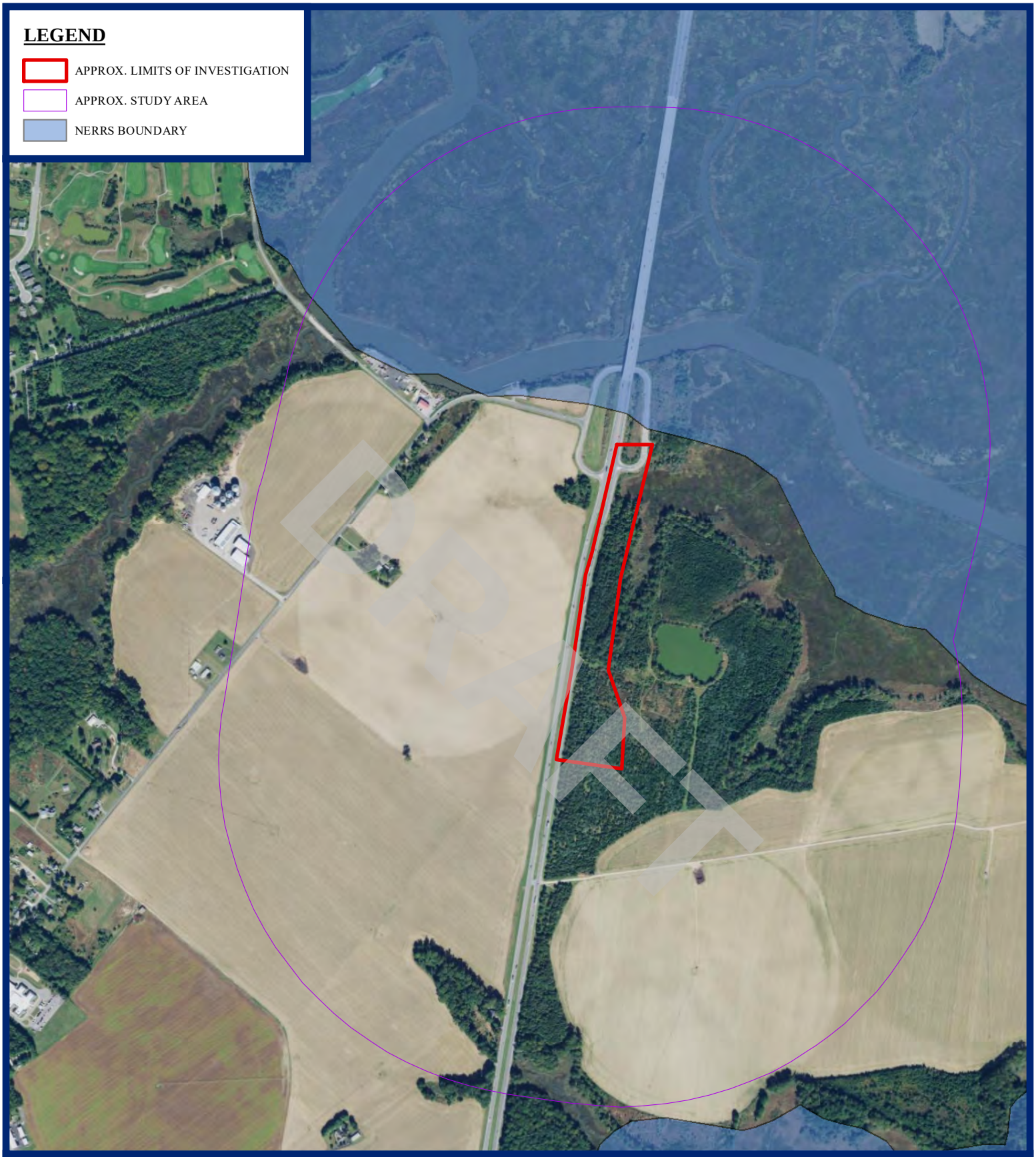
SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
ArcGIS Online

N

1 inch = 1,000 feet



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NATIONAL ESTUARINE RESEARCH RESERVE (NOAA)

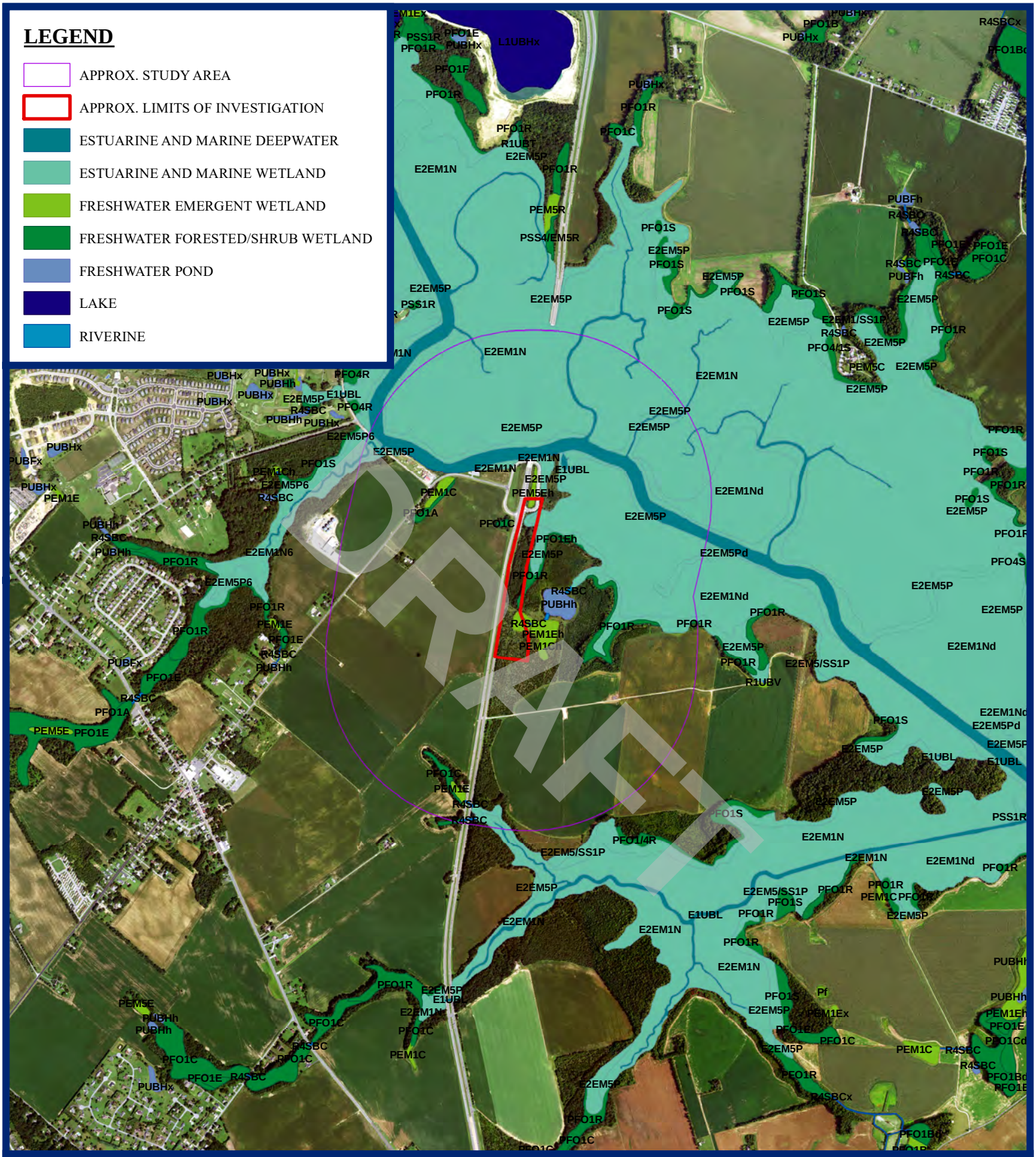
SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
NOAA
ArcGIS Online

N

1 inch = 1,000 feet



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NATIONAL WETLANDS INVENTORY

SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
NWI Inventory Source: USFWS (20200)
ArcGIS Online

N

1 inch = 2,000 feet

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TAX PARCELS

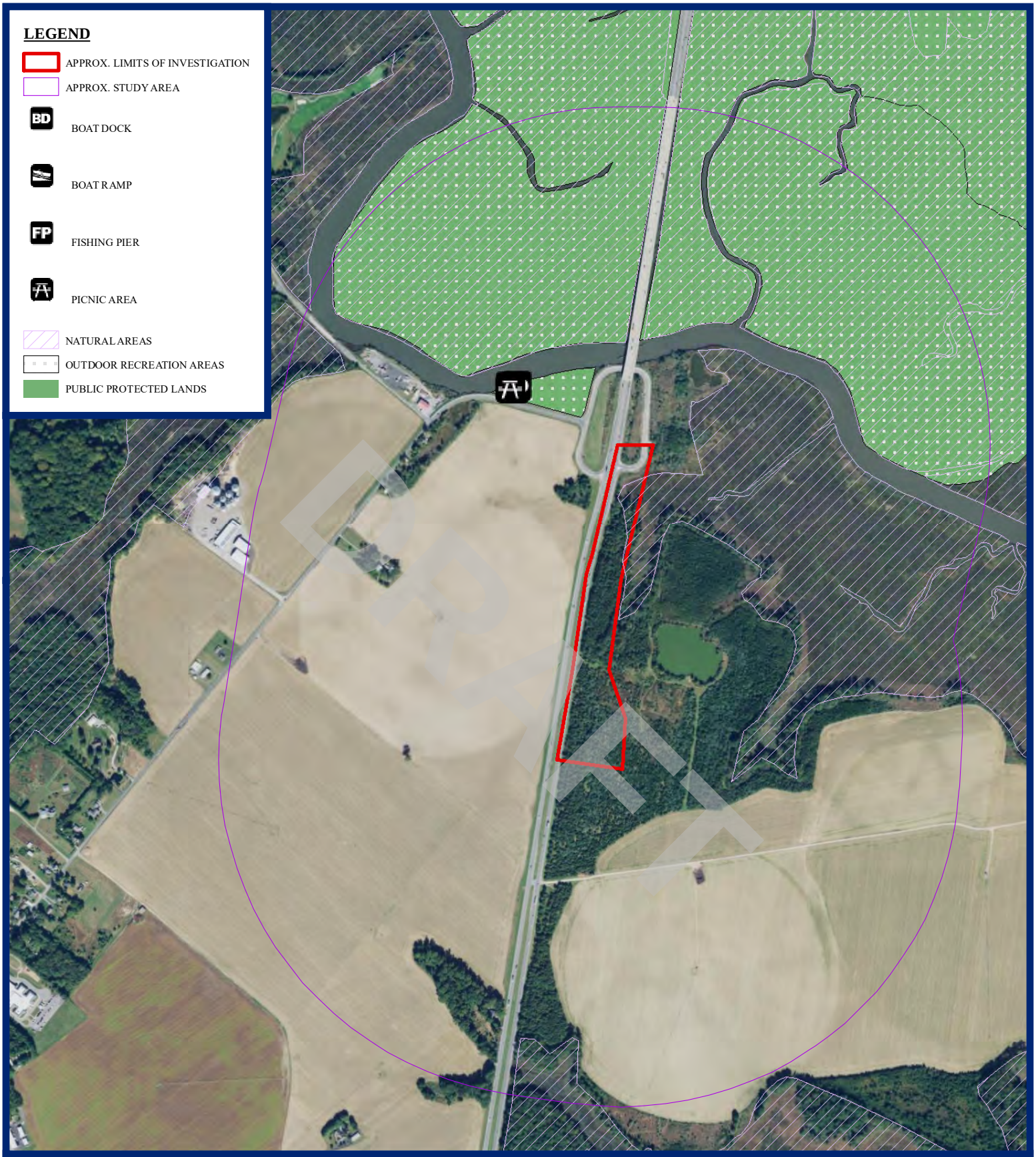
SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
Parcel Source: FirstMap (2022)
ArcGIS Online

N

1 inch = 1,000 feet



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DELAWARE PROTECTED NATURAL RESOURCES

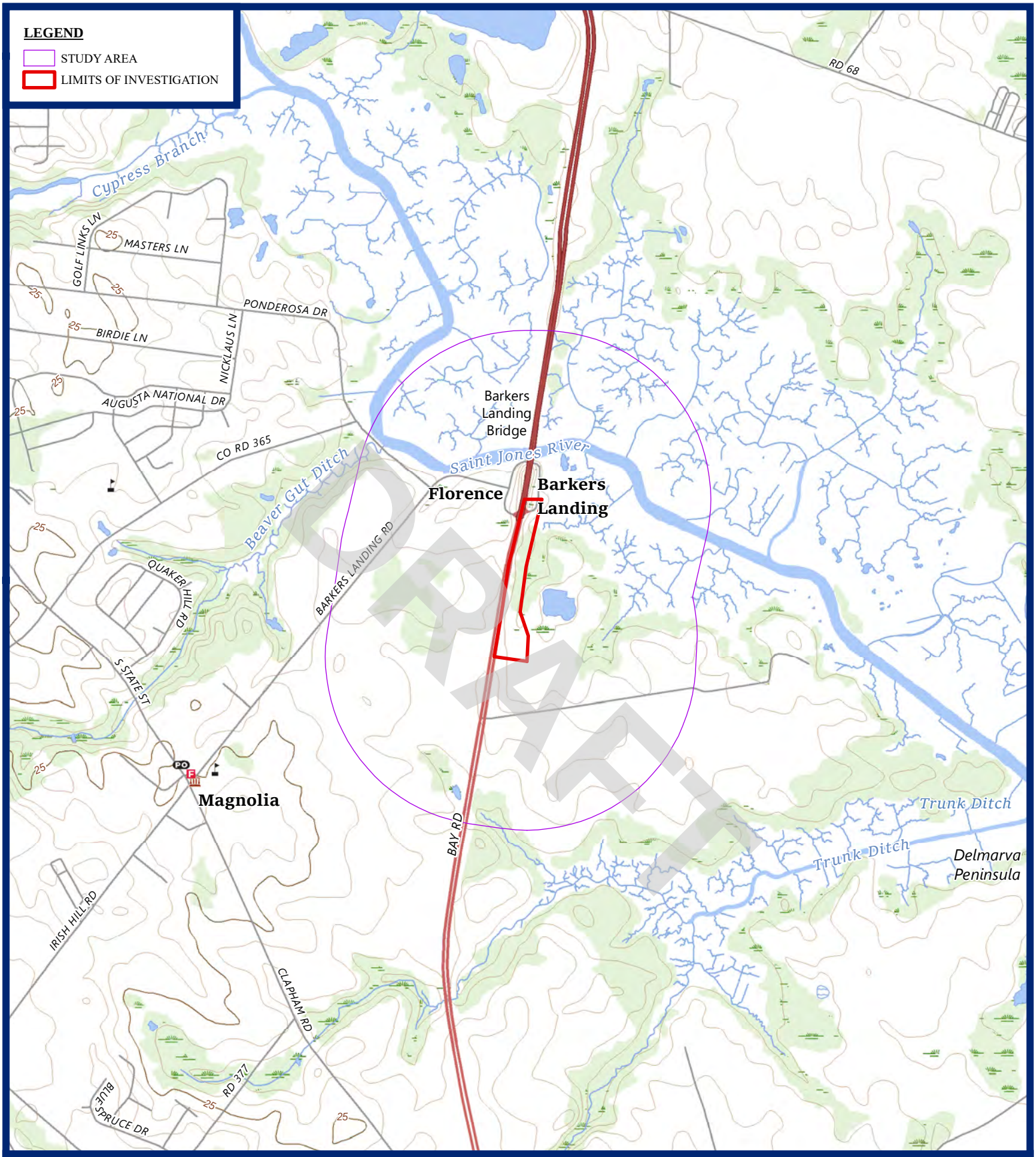
SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
FirstMap
ArcGIS Online

N

1 inch = 1,000 feet



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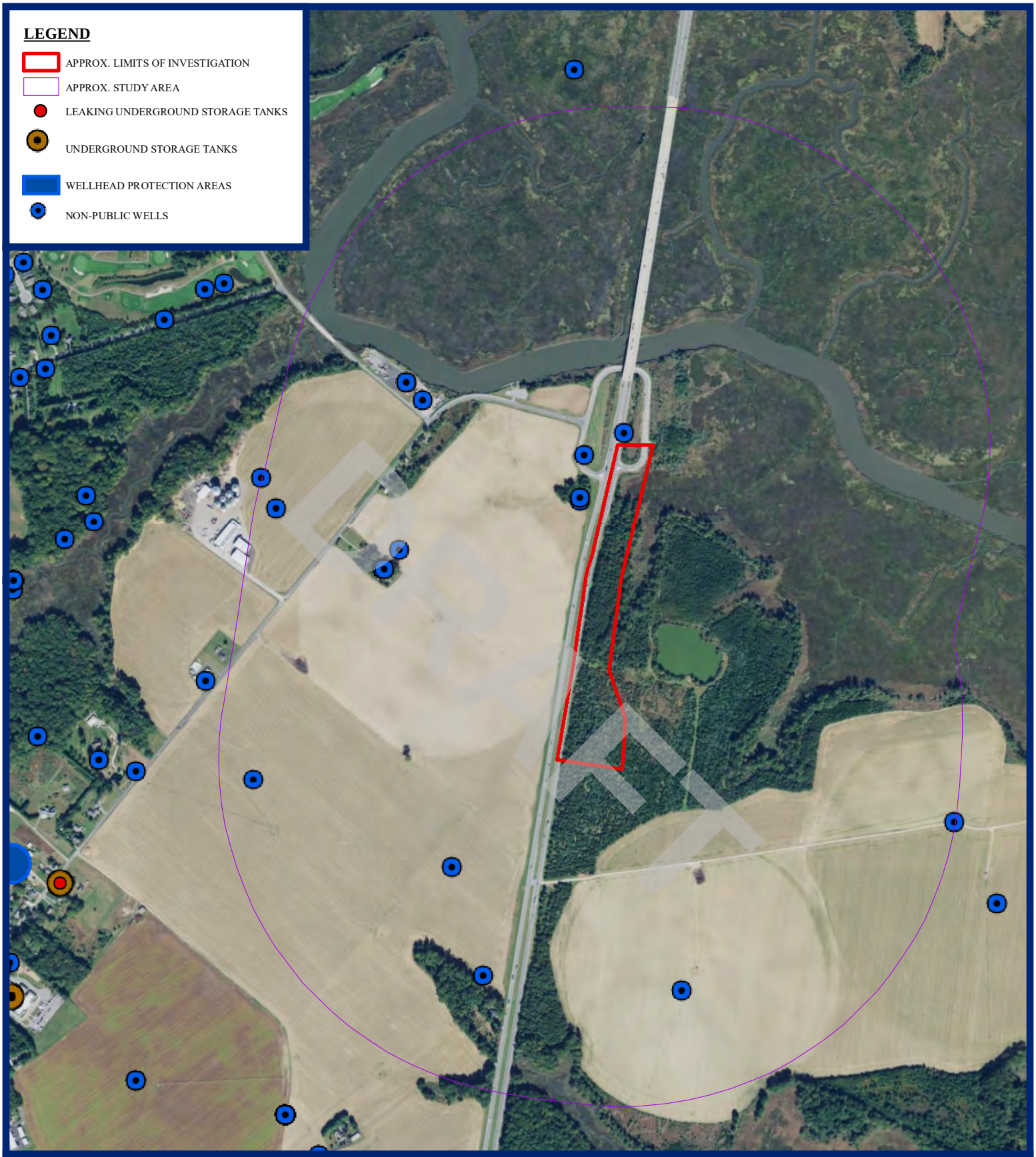
USGS TOPOGRAPHIC QUADRANGLE MAP

SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

USGS Topo Quads:
FREDERICA (DE)

Area: 18.70 +/- AC
Latitude: 39° 04' 51.2"N
Longitude: 75° 27' 28.7"W
Elevation: ~2 – 25 feet
Scale: 1:24,000



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WELLS, UNDERGROUND TANKS
HAZMAT, BROWNSFIELD, & BIOSOLIDS

SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
FirstMap
ArcGIS Online

N

1 inch = 1,000 feet

Delaware National Estuarine Research Reserve
St Jones Reserve

DNERR Ownership

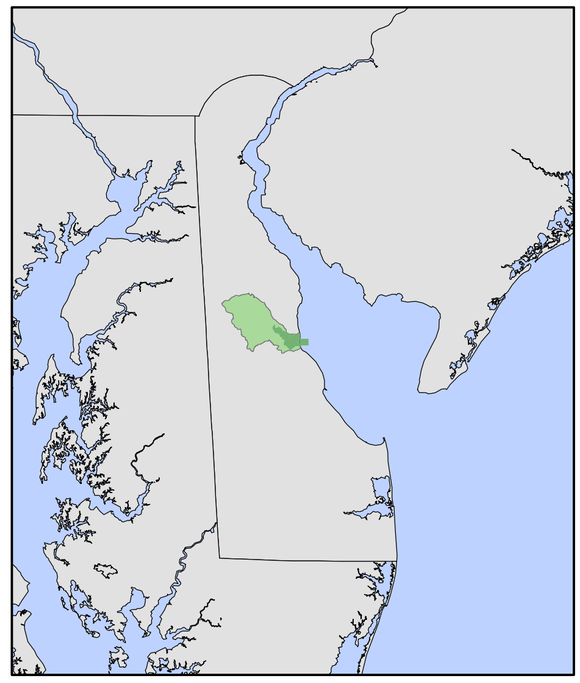
<all other values>

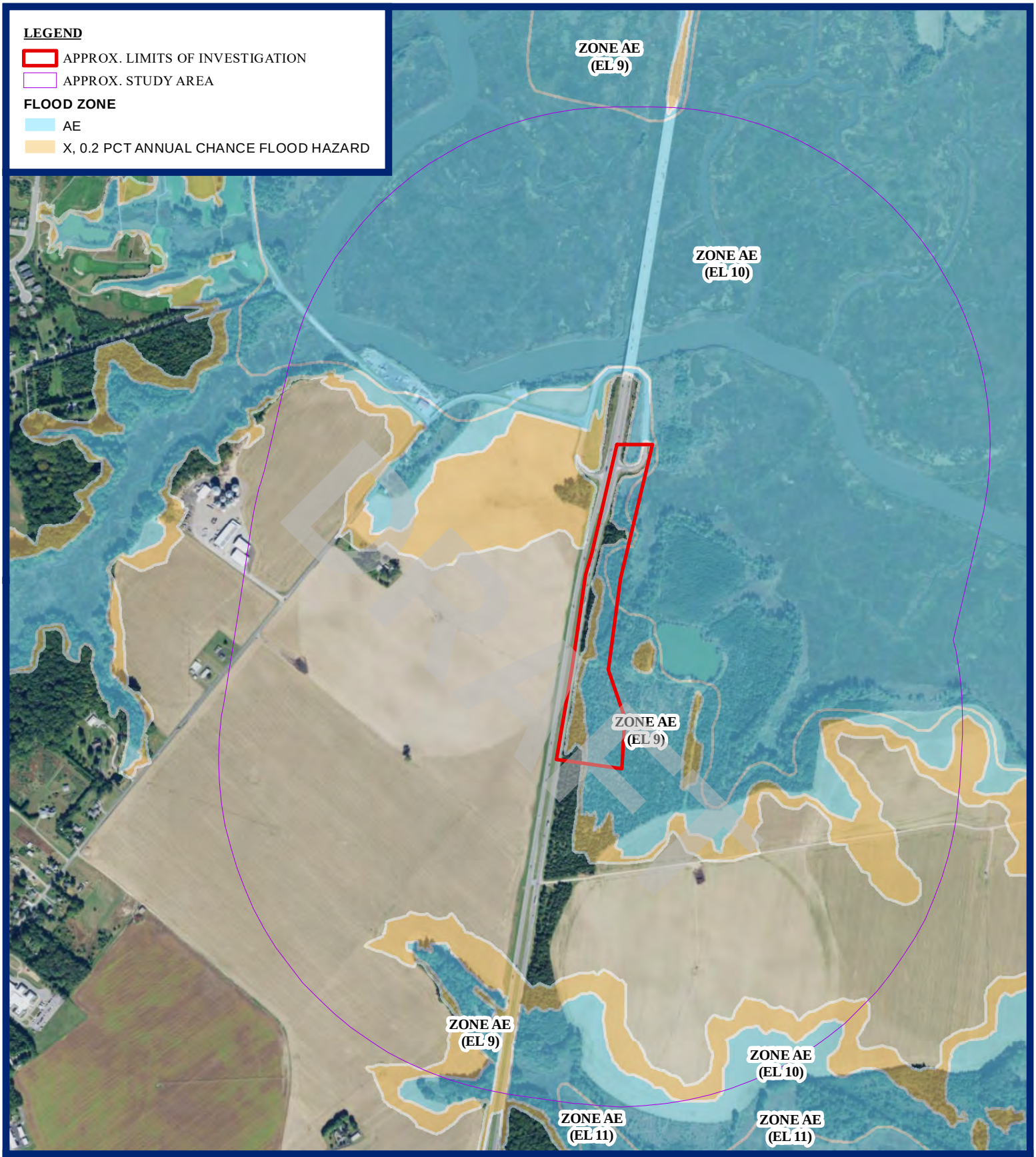
Ownership

- Other Protected
- DNERR
- stjones_core
- stjones_buffer
- All Roads
- Major Roads
- State of Delaware

St. Jones Reserve component is about 3,750 acres in designated size, situated along 5.5 miles of medium-salinity tidal river at the lower end of the St. Jones River watershed, with the river discharging into Delaware Bay. The river continues upstream another 5 miles, flowing out of Silver Lake near downtown Dover. The total length of tidal St. Jones River is approximately 10.5 miles.

The St. Jones Reserve component contains 35 parcels of land held by 23 private landowners, the DNERR, and two other state agencies (the Division of Fish and Wildlife and the Division of Historical and Cultural Affairs).





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DELAWARE PROTECTED NATURAL RESOURCES

SR1–TRAP SHOOTERS INTERCHANGE

KENT COUNTY, DELAWARE

Aerial Imagery Source: NAIP (2021)
FirstMap
ArcGIS Online

N

1 inch = 1,000 feet

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Ecological Services Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401-7307
Phone: (410) 573-4599 Fax: (410) 266-9127

In Reply Refer To:
Project Code: 2023-0034660
Project Name: SR1/Trapshooters Interchange

January 17, 2023

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological

evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Chesapeake Bay Ecological Services Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401-7307
(410) 573-4599

Project Summary

Project Code: 2023-0034660
Project Name: SR1/Trapshooters Interchange
Project Type: Road/Hwy - New Construction
Project Description: DelDOT is proposing a study of the present intersection of Trapshooters Road at SR 1 (pp 59 of 2017 MTP). With continued development in the Magnolia area, this Grade Separated Intersection has become an increasing cause of congestion as vehicles enter SR 1 northbound from a full stop.. This study should evaluate moving the Trapshooters Road entrance for the northbound lane, along with the exit ramp, south to accommodate a deceleration lane to exit and a merge lane which can safely manage the current and projected future volume of traffic. The study should look at a type of scenario that minimizes acquisition of additional right-of-way to limit impact on the sensitive environmental features in the area.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@39.08017585,-75.45808710238263,14z

Counties: Kent County, Delaware

Endangered Species Act Species

There is a total of 2 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 2 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Eastern Black Rail *Laterallus jamaicensis ssp. jamaicensis*	Threatened

No critical habitat has been designated for this species.

This species only needs to be considered under the following conditions:

- Potential habitat for Black Rail exists in this area.

Species profile: https://ecos.fws.gov/ecp/species/10477

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus*	Candidate

No critical habitat has been designated for this species.

This species only needs to be considered under the following conditions:

- The monarch is a candidate species and not yet listed or proposed for listing. There are generally no section 7 requirements for candidate species (FAQ found here: https://www.fws.gov/savethemonarch/FAQ-Section7.html).

Species profile: https://ecos.fws.gov/ecp/species/9743

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

IPaC User Contact Information

Agency: Delaware Department of Transportation
Name: TJ Austin
Address: 550 BAY ROAD
City: DOVER
State: DE
Zip: 19901
Email tjaustin@kleinfelder.com
Phone: 3027349188

Lead Agency Contact Information

Lead Agency: Federal Highway Administration

Appendix B: Demographics Reports

EJSCREEN Census 2010 Summary Report

Location: User-specified point center at 39.081922, -75.457353
Ring (buffer): 1-miles radius
Description:

Summary	Census 2010
Population	361
Population Density (per sq. mile)	121
People of Color Population	107
% People of Color Population	30%
Households	134
Housing Units	142
Land Area (sq. miles)	2.98
% Land Area	99%
Water Area (sq. miles)	0.02
% Water Area	1%

Population by Race	Number	Percent
Total	361	-------
Population Reporting One Race	347	96%
White	262	72%
Black	71	20%
American Indian	2	1%
Asian	8	2%
Pacific Islander	0	0%
Some Other Race	4	1%
Population Reporting Two or More Races	14	4%
Total Hispanic Population	17	5%
Total Non-Hispanic Population	344	95%
White Alone	254	70%
Black Alone	69	19%
American Indian Alone	2	1%
Non-Hispanic Asian Alone	8	2%
Pacific Islander Alone	0	0%
Other Race Alone	0	0%
Two or More Races Alone	11	3%

Population by Sex	Number	Percent
Male	179	49%
Female	182	51%

Population by Age	Number	Percent
Age 0-4	25	7%
Age 0-17	100	28%
Age 18+	261	72%
Age 65+	36	10%

Households by Tenure	Number	Percent
Total	134	
Owner Occupied	112	83%
Renter Occupied	22	17%

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, Census 2010 Summary File 1.

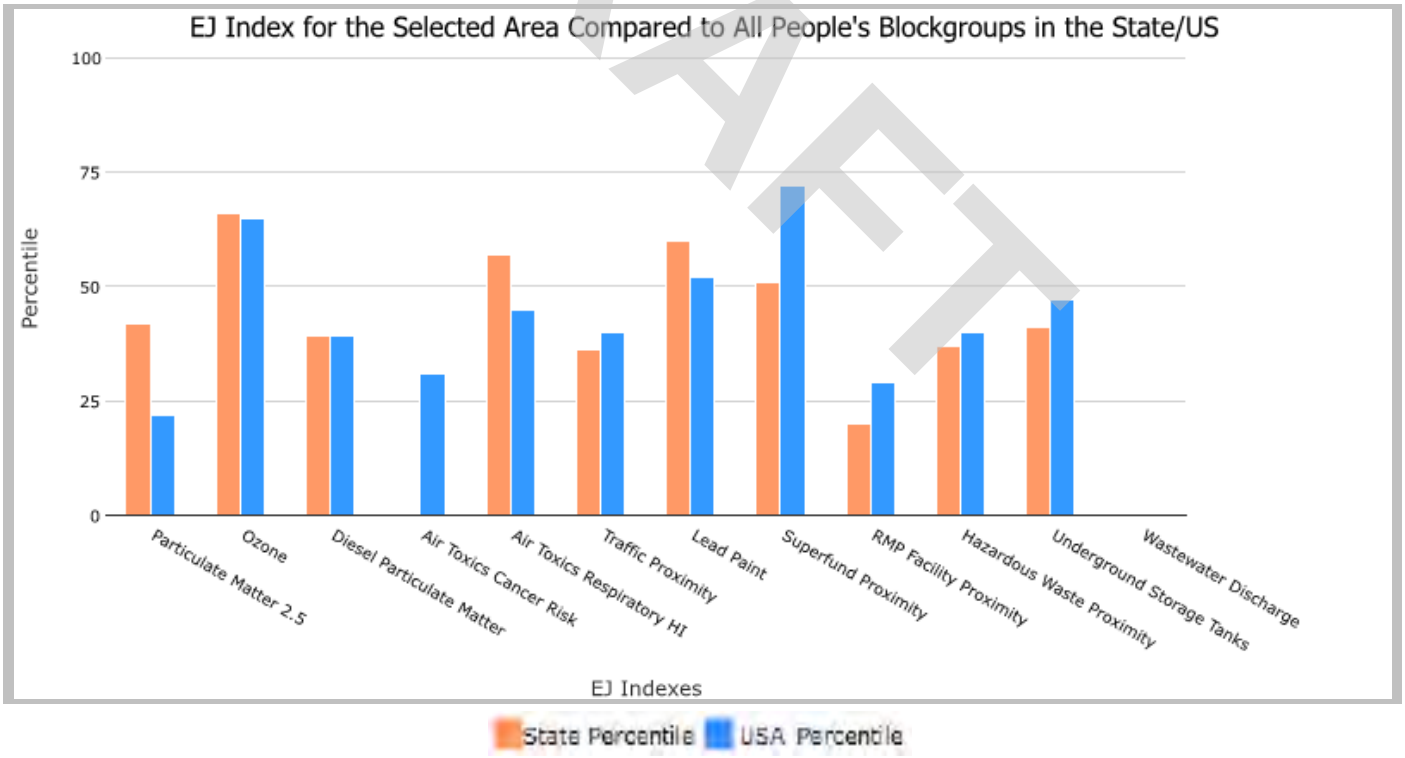
EJScreen Report (Version 2.1)

1 mile Ring Centered at 39.081922,-75.457353, DELAWARE, EPA Region 3

Approximate Population: 399

Input Area (sq. miles): 3.14

Selected Variables	State Percentile	USA Percentile
Environmental Justice Indexes		
EJ Index for Particulate Matter 2.5	42	22
EJ Index for Ozone	66	65
EJ Index for Diesel Particulate Matter*	39	39
EJ Index for Air Toxics Cancer Risk*	0	31
EJ Index for Air Toxics Respiratory HI*	57	45
EJ Index for Traffic Proximity	36	40
EJ Index for Lead Paint	60	52
EJ Index for Superfund Proximity	51	72
EJ Index for RMP Facility Proximity	20	29
EJ Index for Hazardous Waste Proximity	37	40
EJ Index for Underground Storage Tanks	41	47
EJ Index for Wastewater Discharge	0	0



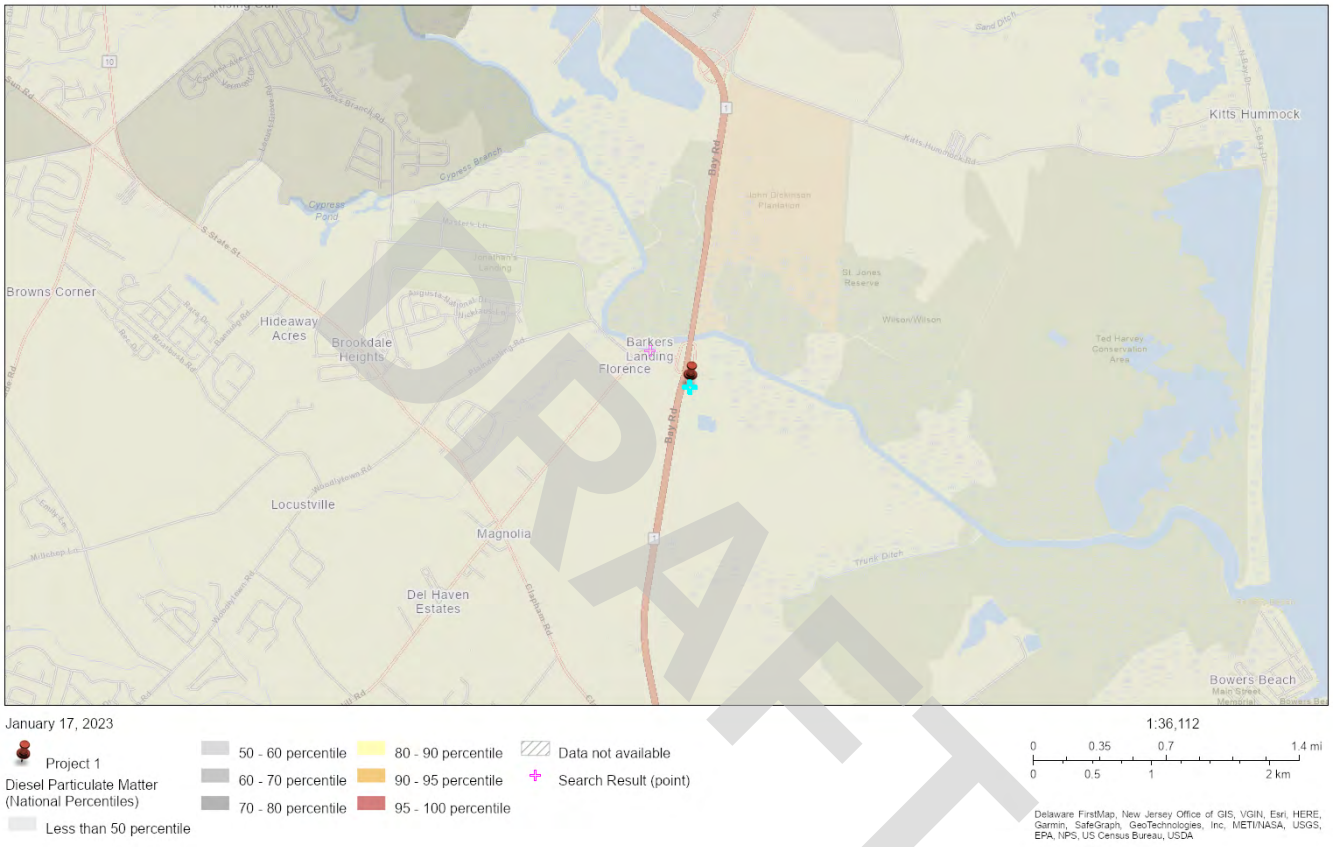
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

EJScreen Report (Version 2.1)

1 mile Ring Centered at 39.081922,-75.457353, DELAWARE, EPA Region 3

Approximate Population: 399

Input Area (sq. miles): 3.14



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0

EJScreen Report (Version 2.1)

1 mile Ring Centered at 39.081922,-75.457353, DELAWARE, EPA Region 3

Approximate Population: 399

Input Area (sq. miles): 3.14

Selected Variables	Value	State Avg.	%ile in State	USA Avg.	%ile in USA
Pollution and Sources					
Particulate Matter 2.5 (µg/m^3)	7.01	7.82	31	8.67	13
Ozone (ppb)	43.1	42.7	76	42.5	59
Diesel Particulate Matter* (µg/m^3)	0.145	0.252	25	0.294	<50th
Air Toxics Cancer Risk* (lifetime risk per million)	20	26	0	28	<50th
Air Toxics Respiratory HI*	0.3	0.29	80	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	78	640	22	760	30
Lead Paint (% Pre-1960 Housing)	0.17	0.23	53	0.27	44
Superfund Proximity (site count/km distance)	0.17	0.33	42	0.13	81
RMP Facility Proximity (facility count/km distance)	0.1	0.56	9	0.77	17
Hazardous Waste Proximity (facility count/km distance)	0.17	1.9	23	2.2	29
Underground Storage Tanks (count/km^2)	0.21	2.3	27	3.9	32
Wastewater Discharge (toxicity-weighted concentration/m distance)	0	1.7	0	12	0
Socioeconomic Indicators					
Demographic Index	30%	31%	55	35%	52
People of Color	28%	38%	46	40%	49
Low Income	32%	26%	69	30%	57
Unemployment Rate	7%	6%	68	5%	70
Limited English Speaking Households	2%	2%	67	5%	62
Less Than High School Education	5%	9%	42	12%	37
Under Age 5	6%	6%	60	6%	56
Over Age 64	17%	19%	50	16%	57

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

For additional information, see: www.epa.gov/environmentaljustice

Appendix C: Traffic Analysis

Introduction

The Trap shooters Road ramps to SR1 are limited by the St. Jones River bridge and topography of the land adjacent to the highway. SR1 has a posted speed of 55 MPH within the project limits. No acceleration lane exists for the northbound entrance ramp due to this limitation, therefore vehicles from Trap Shooters Road enter from a complete stop condition. During high northbound SR1 (NB SR1) traffic volume periods, these entering vehicles have to wait for unacceptably long durations for rare gaps in the NB SR1 traffic stream that are adequate enough to allow for acceleration to the highway speed to avert crashes. These conditions create a high probability for potentially dangerous operating conditions. This existing conditions traffic study is a component of the study that has proposed to evaluate the feasibility of moving the existing NB SR1 entrance and exit ramps further south in order to accommodate an acceleration lane for the entrance ramp and a compliant deceleration lane for the exit ramp.

Existing Traffic Volumes

Intersections within the study limits are as follows:

1. Barkers Landing Road at Trap Shooters Road
2. Southbound SR1 (SB SR1) at Trap Shooters Road
3. NB SR1 at Trap Shooters Road.

A combination of turning movement counts performed in October and November of 2022, and traffic data for the same periods from existing Wavetronix devices along SR1 located north and south of the intersections were used to obtain the turning movement volumes for non-summer /regular weekday A.M., midday, P.M. and Saturday peak hour turning movement volumes presented in **Figure 1**. Traffic data for the summer Saturday peak hours presented in **Figure 2** were obtained from the Wavetronix devices. A separate counts of trucks / heavy vehicles were also collected for all the various peak hours for the traffic operational analysis.

Future Traffic Volumes

Opening Year 2028 and design year 2050 traffic volumes presented in **Figure 3** and **Figure 4** were generated by DelDOT Planning based on the existing traffic volumes submitted. The Delmarva Peninsula Travel Demand Model (TDM) was used in the development of the future traffic forecast. Summer Saturday traffic forecast was not included in the data received; therefore, Century used the growth factor computed from based on the ratio of the non-summer Saturday forecasts to the existing Saturday traffic volumes. The Opening Year 2028 and design year 2050 Summer Saturday traffic volumes so generated are shown in **Figure 5** and **Figure 6**.

Figure 1: 2022 Non-Summer Peak Hour Turning Movement Traffic Volumes

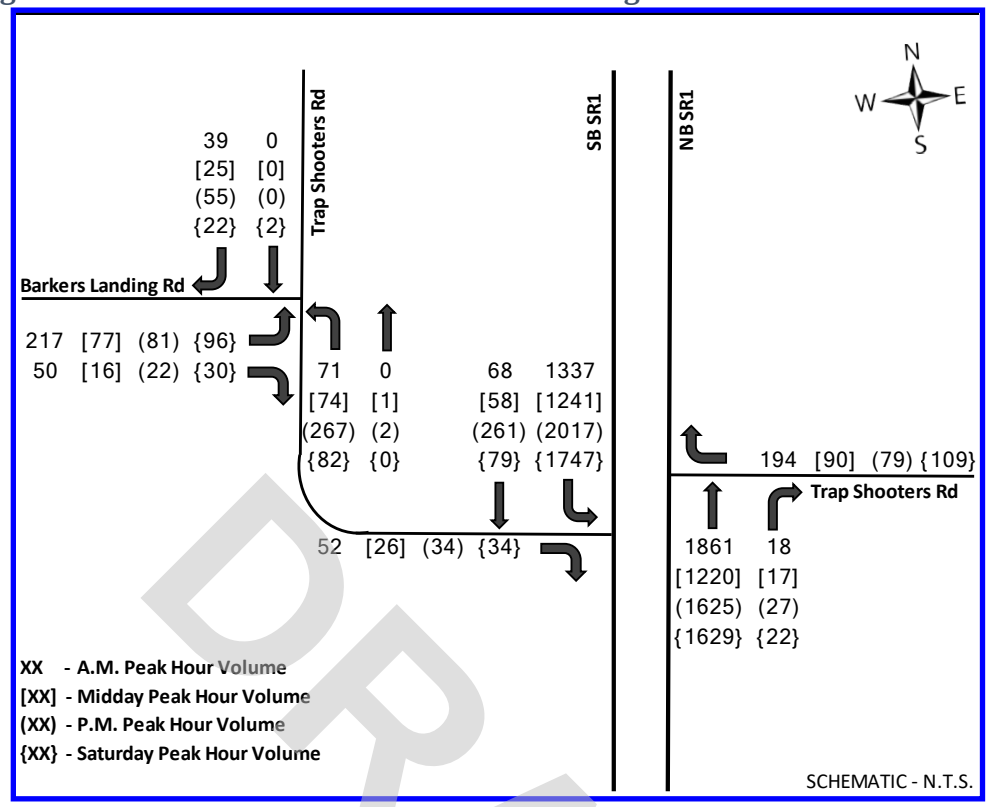


Figure 2: 2022 Summer Saturday Peak Hour Turning Movement Traffic Volumes

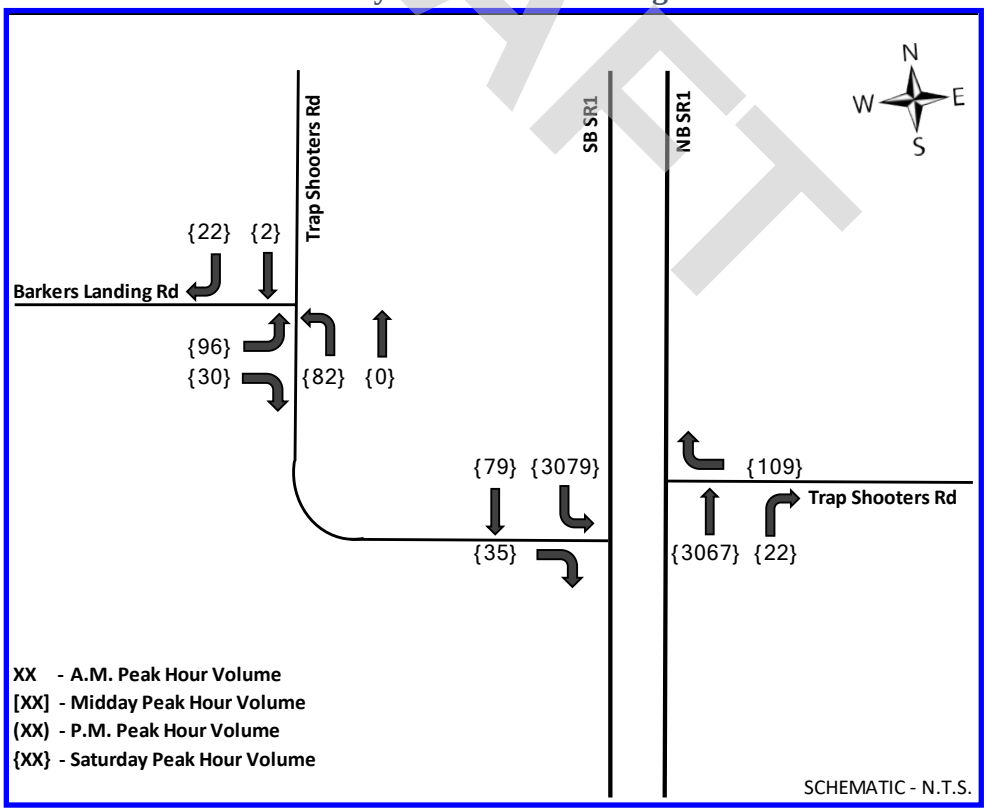


Figure 3: 2028 Non-Summer Peak Hour Turning Movement Traffic Volumes

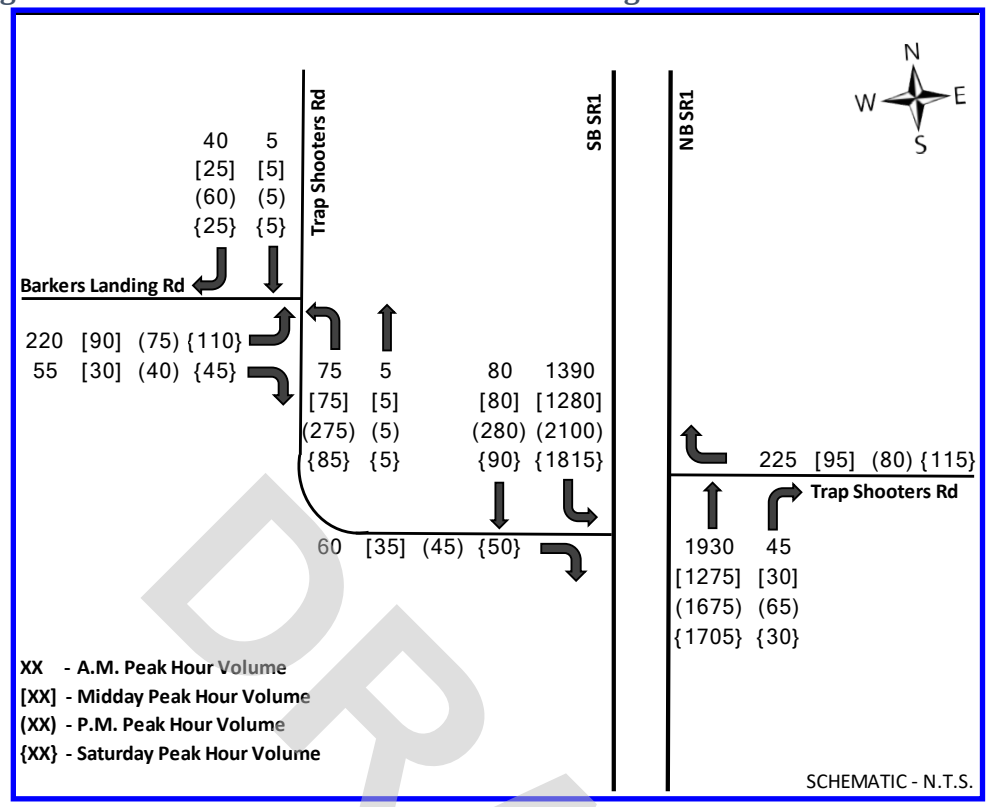


Figure 4: 2050 Non-Summer Peak Hour Turning Movement Traffic Volumes

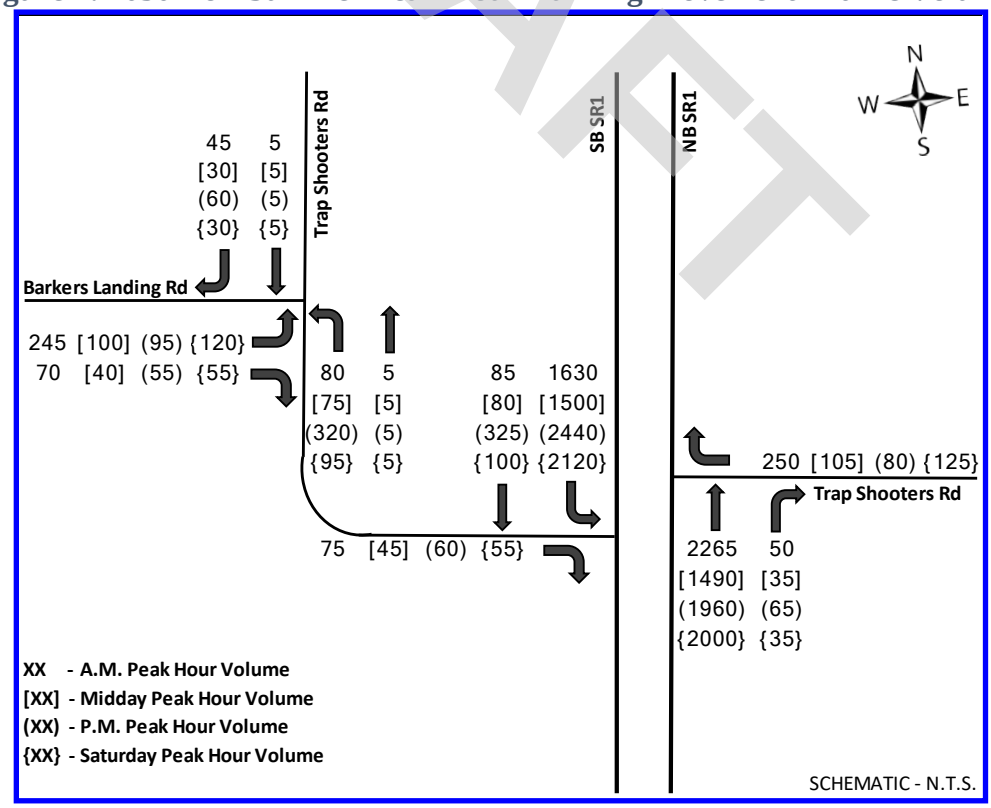


Figure 5: 2028 Summer Saturday Peak Hour Turning Movement Traffic Volumes

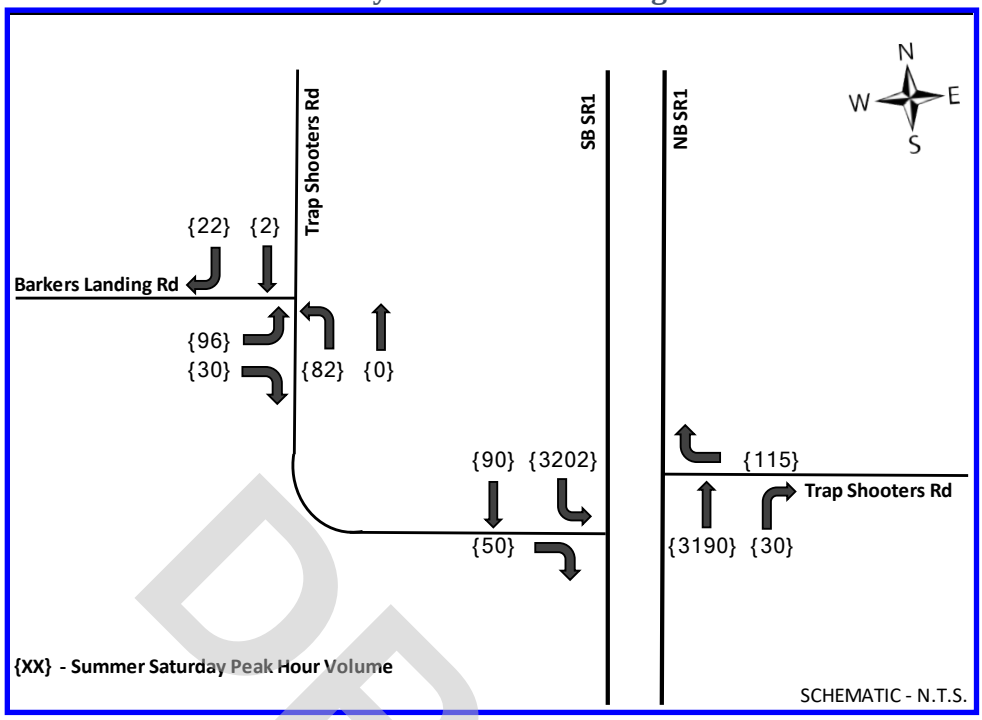
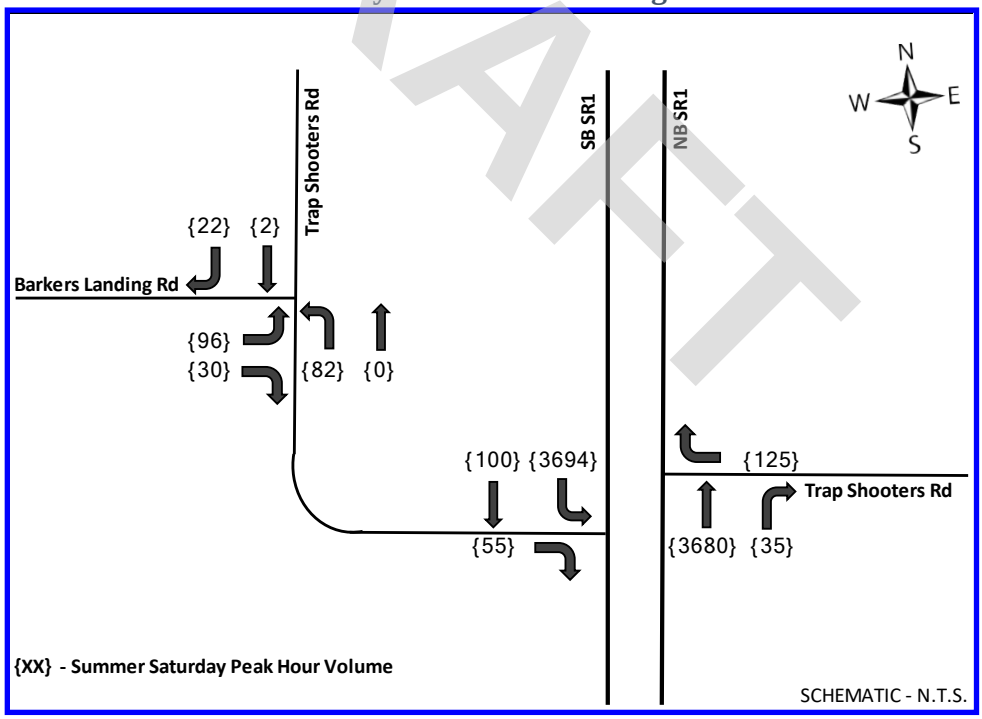


Figure 6: 2050 Summer Saturday Peak Hour Turning Movement Traffic Volumes



Traffic Operational Analysis

Existing Geometric and Traffic Conditions

The intersection of NB SR1 at Trap Shooters Road is comprised of an exit and entrance ramp on a limited access facility, however, due to the stop-controlled condition and absence of an acceleration lane for the entrance ramp, the intersection operates essentially operates as a stop-controlled T-intersection. It was therefore analyzed as two-way stop controlled (TWSC) intersection. While the entrance ramp for SB SR1 has an acceleration lane, the entering traffic is controlled by a yield sign, making the eastbound movement operate like a channelized right-turn at a controlled intersection. The intersection of SB SR1 at Trap Shooters Road was therefore analyzed as such.

HCS Software Version 2022 which utilizes the methodologies of the current Highway Capacity Manual (HCM) Version 7 was used for the traffic operational analysis within the project limits. The measures of effectiveness presented for the existing conditions analysis are average control delay measured in seconds per vehicle, Level of service (LOS) and 95th percentile queues in feet. Per the HCM methodology, for TWSC intersections, no measures of effectiveness are provided for the free movements and approaches, and an overall intersection LOS is not defined either. The LOS criteria for unsignalized analysis are presented in **Table 1**.

As provided in the table, LOS F is defined by delay greater than 50 seconds per vehicle and or volume-to-capacity ratio (V/C) greater than one (1), irrespective of control delay value. The operational analysis results for the three existing study intersections are presented in **Table 2**, **Table 3** and **Table 4**.

Table 1: LOS Criteria for TWSC Intersections

Control Delay (Seconds per Vehicle)	LOS by V/C Ratio	
	V/C ≤ 1.0	V/C > 1.0
0 to 10	A	F
>10 to 15	B	F
>15 to 25	C	F
>25 to 35	D	F
>35 to 50	E	F
>50	F	F

Table 2: Barkers Landing at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions														
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	NBL Trap Shooters Rd	7.5	A	5	7.5	A	5	7.9	A	18	7.4	A	5	7.4	A	5
	EB L/R Bakers Landing Rd	11.9	B	40	10.3	B	13	16.5	C	28	10.5	B	18	10.5	B	18

Table 3: SB SR1 at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions														
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	EBR Trap Shooters Rd	17.4	C	15	16.4	C	8	27.6	D	15	21.5	C	13	93.5	F	53

Table 4: SB SR1 at Trap Shooters Road MOE

Control Type	Movement	Measures of Effectiveness under Existing 2022 Trafic Conditions														
		Weekday AM			Weekday Midday			Weekday PM			Non-Summer Saturday			Summer Saturday		
		Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)	Delay (Sec)	LOS	95th % Queue (ft)
Two-Way Stop	WBR Trap Shooters Rd	87.6	F	198	16.9	C	23	27.1	D	38	35.6	E	70	301.4	F	213

As provided in Table 2, per the analysis, under current traffic and geometric conditions, Trap Shooters Road northbound left-turn movement and the stop-controlled Barkers Landing Road eastbound movements / approach operates at satisfactory LOS C or better for all the non-summer and summer Saturday peak hours analyzed. The highest control delay of 16.5 seconds per vehicle is experienced by the Barkers Landing Road eastbound approach during the non-summer weekday P.M. peak hour.

Per the analysis, under current traffic and geometric conditions, at the intersection of SB SR1 and Trap Shooters Road, the eastbound yield controlled right-turn movement operates at satisfactory LOS D or better for all the non-summer peak hour periods analyzed with the worst delay of 27.1 seconds per vehicle experienced during the weekday P.M. peak hour as given in **Table 3**. Under existing summer traffic conditions, the Trap Shooter's Road eastbound right-turn movement operates at LOS F with average control delay of 93.5 seconds per vehicle.

As shown in Table 4, under current traffic and geometric conditions, per the analysis, Trap Shooters Road westbound movement / approach operates at satisfactory LOS C with 16.9 seconds average control delay, and LOS D with 27.1 seconds average control delay respectively for the non-summer midday and P.M. peak hours. The Trap Shooters Road westbound movement / approach operates at unsatisfactory LOS E with 35.6 seconds average control delay for the non-summer Saturday peak hour. For the non-summer A.M. peak hour, the Trap Shooters Road westbound movement / approach operates at LOS F with 87.6 seconds average control average control delay. During the summer Saturday peak hour, the Trap Shooters Road westbound movement / approach operates at LOS F with 301.4 seconds average control delay. That is an average control delay of more than 5 minutes per vehicle.

While current 95th percentile queues do not appear to be bad per the analysis for current conditions, these queues will get worse and become a problem as the developments in the Magnolia area continue to grow with their associated increase in traffic volumes. The already unacceptable

control delays will deteriorate further and will be exacerbated by this continued growth in developments if no improvements are implemented.

Future Geometric and Traffic Conditions

Since the existing conditions analysis already show unacceptable operational results for the existing intersections, future without improvements (No-Build) was not analyzed. Four improvement alternatives were developed, all of which allow for access to and from SR1 via ramps with AASHTO compliant acceleration and deceleration lanes. Per HCM methodology for freeway facilities, freeway basic segments, ramps merge, and ramps diverge influence areas, the measures of effectiveness presented for future (Build) conditions are density measured in passenger car per mile per lane (pc/mi/ln) and LOS. Merge and diverge influence areas are illustrated in **Figure 6**, and the LOS criteria for them are presented in **Table 5**. Future analysis was for Opening year 2028 and Design Year 2050

Figure 7: Ramps Merge and Diverge Influence Areas

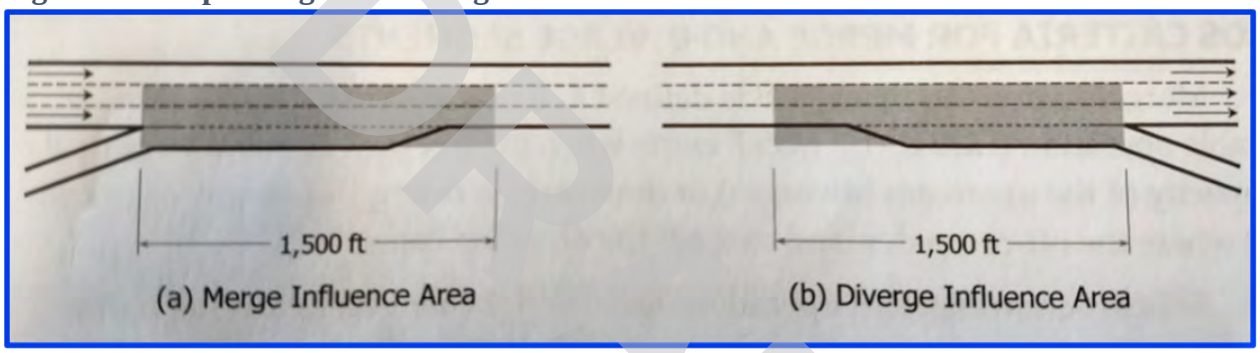


Table 5: Freeway Facilities LOS Criteria

MOE Criteria and Conditions Description			
LOS	Density (pc/mi/ln)		Operational Conditions
	Ramp Merge / Diverge	Basic Freeway Segment	
A	≤10	≤11	Unrestricted operations with smooth merging or diverging
B	>10 - 20	>11 - 18	Merging or diverging are noticeable but with little turbulence
C	>20 - 28	>18 - 26	Speed in the ramp influence area starts to decline & turbulence gets more noticeable
D	>28 - 35	>26 - 35	Turbulence in ramp influence area gets intrusive as most vehicles slow down to accommodate
E	>35	>35 - 45	Operations at or near capacity. Queues form with any small change in demand/traffic stream
F	V/C > 1.0	> 45 or V/C > 1.0	Demand exceeds roadway capacity with queues on both ramps & freeway / highway

There were no significant variations in densities between alternatives for the basic freeway segments and ramps merge/diverge influence areas and therefore there were no differences in LOS between alternatives. LOS for the various segments for Opening Year 2028 and Design Year 2050 for all Alternatives are presented in **Table 6** for northbound and **Table 7** for southbound. For year 2050, SR1 was analyzed with three lanes in each direction.

Table 6: Northbound SR1 Freeway Facilities LOS for Future Conditions

Facility	Opening Year 2028 LOS (2-Lane SR1)				Design Year 2050 LOS (3-Lane SR1)			
	Non-Summer			Summer	Non-Summer			Summer
	AM	PM	Saturday	Saturday	AM	PM	Saturday	Saturday
NB Basic Segment South of Exit Ramp	B	B	B	D	B	B	B	C
NB Exit Ramp Diverge Influence Area	C	B	B	D	B	B	B	C
NB Basic Segment between Exit Ramp & Entrance Ramp	B	B	B	D	B	B	B	C
NB Entrance Ramp Merge Influence Area	C	B	B	C	B	A	B	B
NB Basic Freeway Segment North of Entrance Ramp	C	B	B	D	B	B	B	C

Table 7: Southbound SR1 Freeway Facilities LOS for Future Conditions

Facility	Opening Year 2028 LOS (2-Lane SR1)				Design Year 2050 LOS (3-Lane SR1)			
	Non-Summer			Summer	Non-Summer			Summer
	AM	PM	Saturday	Saturday	AM	PM	Saturday	Saturday
SB Basic Segment North of Exit Ramp	B	C	B	D	A	B	B	C
SB Exit Ramp Diverge Influence Area	B	C	B	D	B	B	B	C
SB Basic Segment between Exit Ramp & Entrance Ramp	B	B	B	D	A	B	B	C
SB Entrance Ramp Merge Influence Area	B	B	B	D	A	B	B	C
SB Basic Freeway Segment South of Entrance Ramp	B	B	B	D	A	B	B	C

As shown in Table 6 and Table 7, all SR1 segments, northbound and southbound would operate at LOS C or better under both 2028 and 2050 peak hour conditions except for 2028 Summer Saturday under 2-Lane directional conditions. Under the 2028 Summer Saturday conditions almost northbound and southbound segments would operate at LOS D except for the northbound Entrance Ramp influence area, which would operate at LOS C.

Travel Time Analysis

To assess travel time changes between each of the four alternatives and the existing geometric conditions, Synchro/SimTraffic 11 was utilized to develop models for each. Two origin-destination (O-D) locations were assessed – Ponderosa Drive and the Town of Magnolia. The travel time changes were calculated based on travel times generated in SimTraffic. The results are presented in **Table 8** for Ponderosa Drive O-D, and **Table 9** for Town of Magnolia O-D.

Table 8: Travel Time Change with Ponderosa Drive Origin-Destination

Travel Time Change (Seconds)	Alt 1 Geometry				Alt 2 Geometry			
	Northbound Trips		Southbound Trips		Northbound Trips		Southbound Trips	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	11.7	20.6	12.5	6.7	0.2	9.2	9.7	5.7
Travel Time Change (Seconds)	**Alt 3 Geometry**				**Alt 4 Geometry**			
	Northbound Trips		Southbound Trips		Northbound Trips		Southbound Trips	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	(22.6)	(15.9)	63.5	9.0	(21.7)	4.5	62.6	10.4

Table 9: Travel Time Change with Town of Magnolia Origin-Destination

Travel Time Change (Seconds)	Alt 1 Geometry				Alt 2 Geometry			
	Northbound Trips		Southbound Trips		Northbound Trips		Southbound Trips	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	11.7	20.6	12.5	6.7	0.2	9.2	9.7	5.7
Travel Time Change (Seconds)	**Alt 3 Geometry**				**Alt 4 Geometry**			
	Northbound Trips		Southbound Trips		Northbound Trips		Southbound Trips	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
XX = Increase; (XX) = Decrease	(72.8)	(72.4)	13.3	(47.5)	(71.9)	(53.2)	12.7	(47.3)

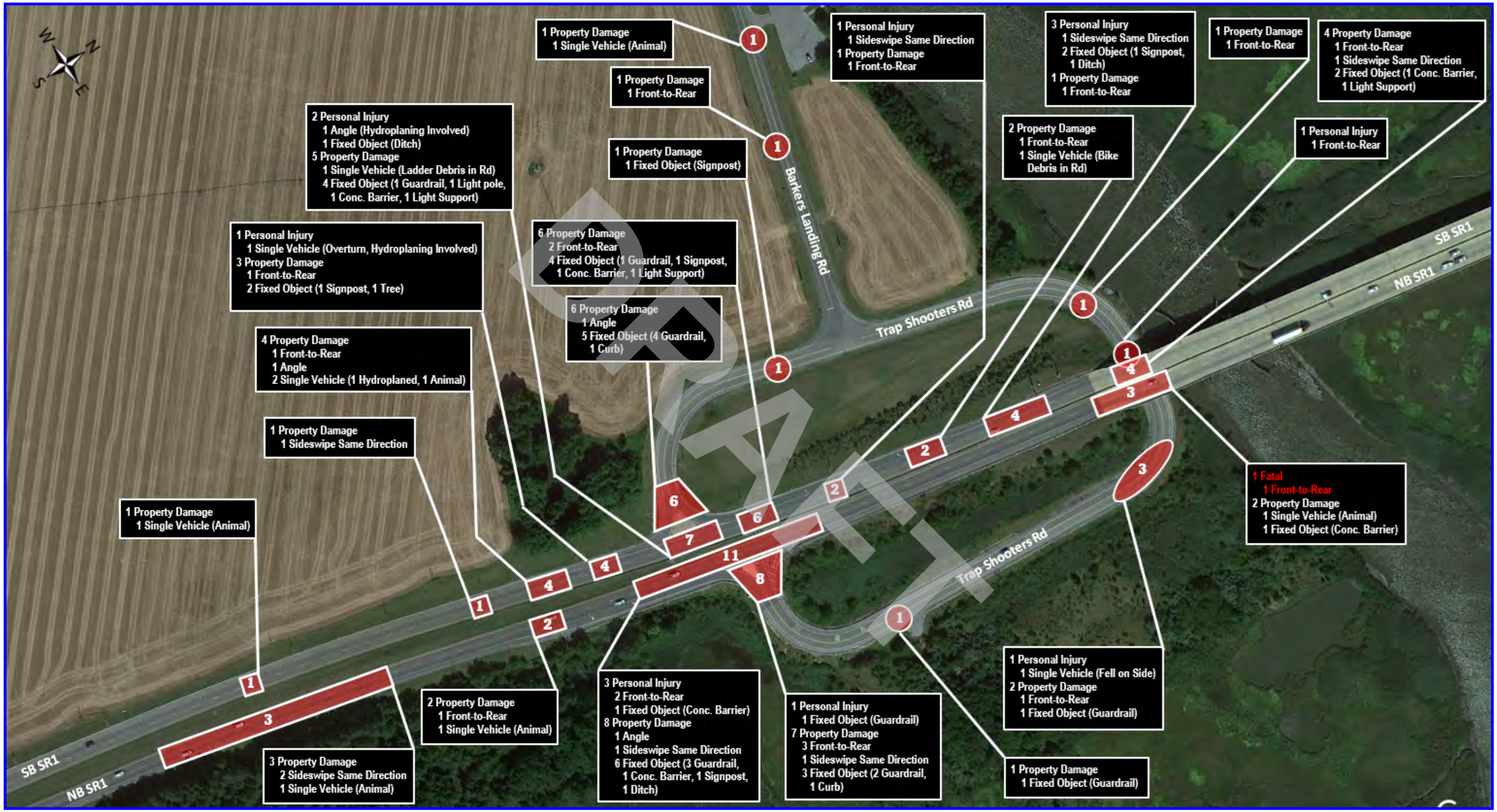
Crash Evaluation

Five-year crash data from October 21, 2017, to October 31, 2022, for NB SR1, SB SR1, Trap Shooters Road and Barkers Landing Road within the project limits was obtained from DelDOT Traffic Safety Section for Evaluation. All reported crashes that occurred on the specified roadways and their intersections were mapped. The Approximate crash locations, number, type and severity of crashes are presented **Figure 1**.

Barkers Landing Road

A total of two (2) crashes were reported as having occurred on Barkers Landing Road for the 5-year period. Both crashes involved property damage only. One crash was a front-to-rear collision, and the other was a vehicle collision with deer in the road.

Figure 8: Crash Map



Trap Shooters Road

A total of Twenty-one (21) crashes were reported as having occurred on Trap Shooters Road for the 5-year period, comprising three (3) personal injury and eighteen (18) property damage only crashes. A total of three (3) people were injured in the injury crashes. Majority of the crashes (13 / 61.9%) were reported as not a collision between two vehicles followed by (3 / 14.3%) each of front-to-front and front-to-rear crashes. One (1 / 4.8%) each of angle crashes and sideswipe same direction crashes were also reported. **Table 10** presents annual and five-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI).

Table 10: Trap Shooters Road Crash Type and Severity

Collision Type	Crash Severity / Classification															Crash Severity / Classification			
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021			October 31, 2021 - October 31, 2022			5-Year Totals			
Front to Front	0	1	1	0	0	0	1	0	1	0	0	0	1	0	1	2	1	3	14.3%
Front to Rear	0	0	0	1	0	1	1	0	1	1	0	1	0	0	0	3	0	3	14.3%
Angle	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	4.8%
Sideswipe, Opposite Direction	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4.8%
Not a Collision Between Two Vehicles	4	1	5	1	1	2	5	0	5	1	0	1	0	0	0	11	2	13	61.9%
Total	5	2	7	3	1	4	7	0	7	2	0	2	1	0	1	18	3	21	100.0%

Figure 9: Trap Shooters Road Annual Crashes

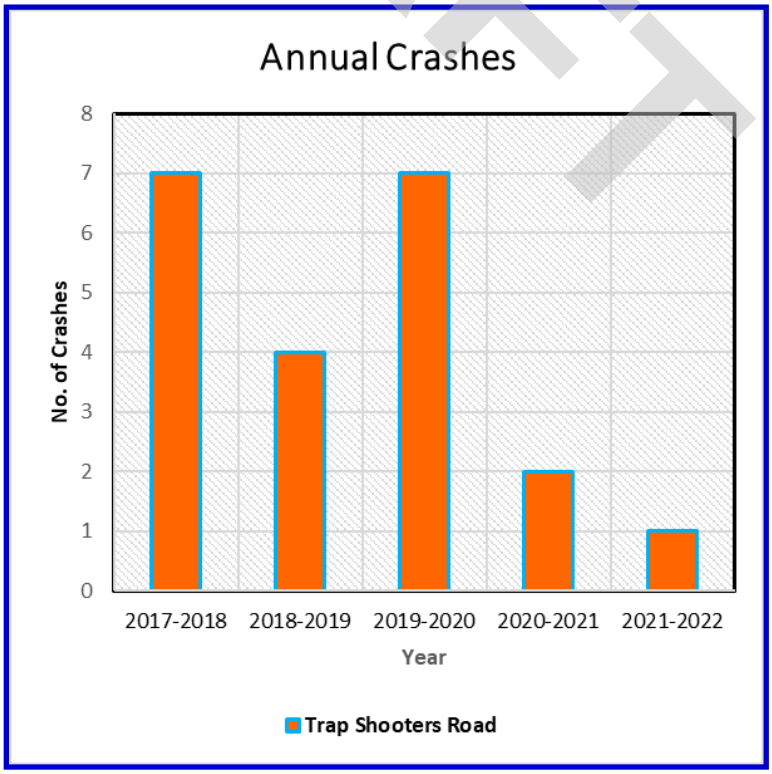
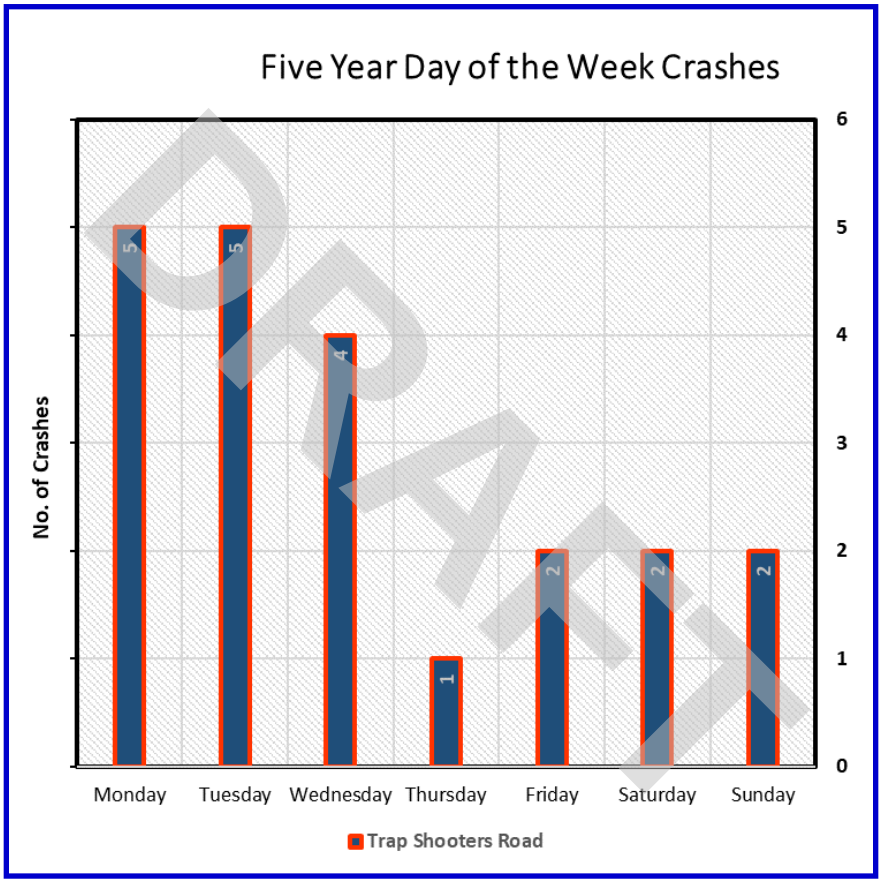


Figure 9 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, seven (7), was reported during the 2017–2018 and 2019–2020 period. Four (4) crashes were reported for the 2018–2019 period, approximately 42.9% lower than both the prior and the following 12-month period. For the 2020–2021 period, reported crashes dropped approximately 71.4% from seven (7) to two (2). Reported crashes dropped 50.0% from two (2) the preceding 12-month period to one during the most recent one-year period from October 31, 2021, to October 31, 2022. Reported crashes for Trap Shooters Road appears therefore to be on a downward trend.

The five-year crashes by day of the week are presented in **Figure 10** and shows that majority of crashes (14 / 66.7%) were reported to have occurred on weekdays from Monday through Wednesday. The remaining crashes were almost evenly spread over the rest of the days.

Figure 10: Trap Shooters Road Day of the Week Crashes



All reported crashes by time of day are presented in **Figure 11**. As shown, crashes for 5-year period are spread between 4:00 A.M., through the entire day, to midnight, but are highest between 4:00 P.M. and 7:00 P.M., corresponding with the higher volume P.M. hours. Crashes therefore appear to be higher during the hours of increased weekday traffic activity as is logically expected for a suburban collector road.

Figure 11: Trap Shooters Road Time of Day Crashes

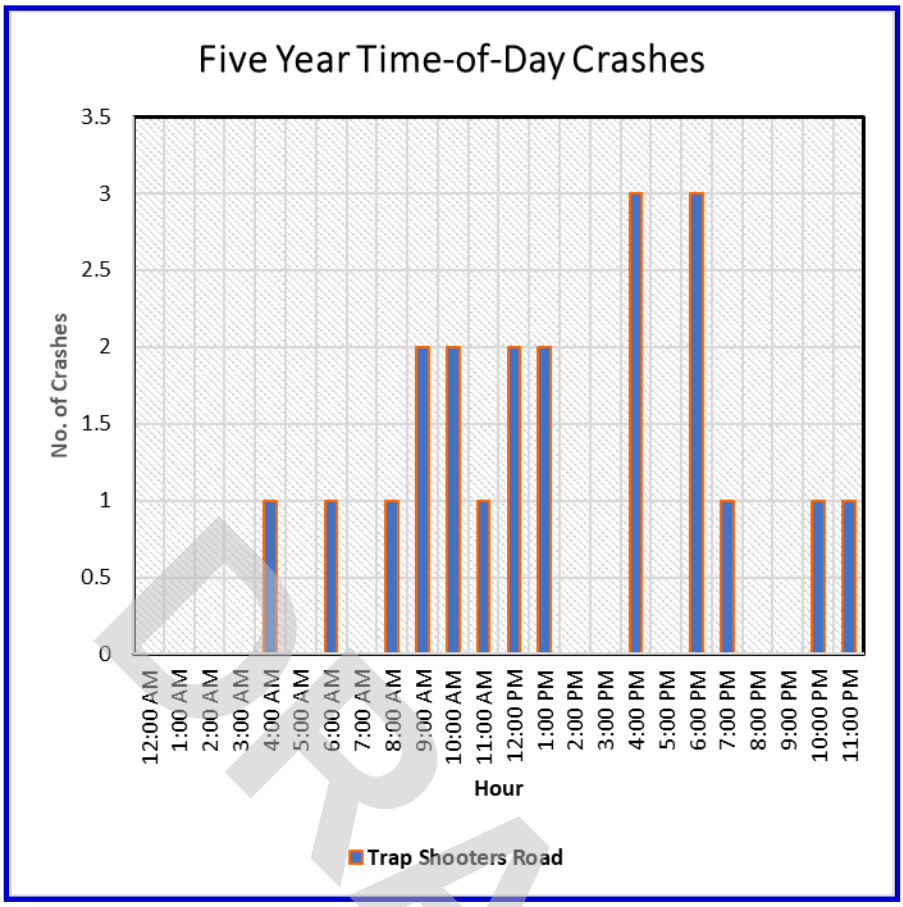


Table 11: Trap Shooters Road Provided Reasons for Crashes

Primary Reason for Crash		
Description	**No. of Crashes**	**% Crash**
Animal in Roadway - Deer	1	4.8%
Speeding	1	4.8%
Following too Close	2	9.5%
Driving in a Careless or Reckless Manner	6	28.6%
Driver Inattention, Distraction, or Fatigue	5	23.8%
Improper Passing	1	4.8%
Other Environmental Circumstances - Weather and/or Glare	2	9.5%
Other	1	4.8%
Unknown	2	9.5%
Total	**21**	**100.0%**

The primary contributing factors for crashes within the study limits are summarized in **Table 11**. As provided in the table, “Driving in a Careless or Reckless Manner” was the most frequent reason (6 / 28.6%) provided for reported crashes. This was followed closely by “Driver Inattention, Distraction, or Fatigue” (5 / 23.8%) and “Following too Close”, “Other Environmental Circumstances” and “Unknown” (2 / 9.5% each) were the next most frequent reasons. Together these accounted for nineteen (19), approximately 81% out of the total of the twenty-one (21) reported crashes. With exception of “Speeding” which accounted for one (1 / 4.8%) of all crashes, the attributed

reasons in the preceding, together with the various others provided in **Table 11**, are driver behaviors and circumstances that are not necessarily susceptible to correction with physical improvements measures.

As shown in **Table 12**, majority of the reported crashes (17 / 81%) occurred during daylight and dark but lighted conditions. It appears therefore that lighting may probably not be a significant contributing factor associated with the frequency of crashes within the study limits. Majority of the reported crashes (12 / 57.1%) on Trap Shooters Road occurred under wet and snow-covered road surface conditions. It is likely therefore that the road surface conditions may be a significant contributing factor to the frequency of crashes on Trap Shooters Road. As presented in **Table 12**, a little over half the reported crashes on Trap Shooters Road (11 / 52.4%) occurred under clear and cloudy, i.e., no-precipitation weather conditions while a little less than half of the reported crashes (10 / 47.6%) occurred during rain and snow i.e., precipitation weather conditions. It is probable therefore that weather conditions may have contributed to the frequency of reported crashes on Trap Shooters Road.

Table 12: Trap Shooters Road Lighting, Surface and Weather Conditions

Lighting Conditions		
Description	No. of Crashes	% of Total Crashes
Daylight	16	76.2%
Dark-Lighted	1	4.8%
Dark-Not Lighted	3	14.3%
Dawn	1	4.8%
Total	**21**	**100.0%**

Surface Conditions		
Description	No. of Crashes	% of Total Crashes
Dry	9	42.9%
Wet	11	52.4%
Snow	1	4.8%
Total	**21**	**100.0%**

Weather Conditons		
Description	No. of Crashes	% of Total Crashes
Clear	9	42.9%
Cloudy	2	9.5%
Rain	9	42.9%
Snow	1	4.8%
Total	**21**	**100.0%**

Southbound SR1

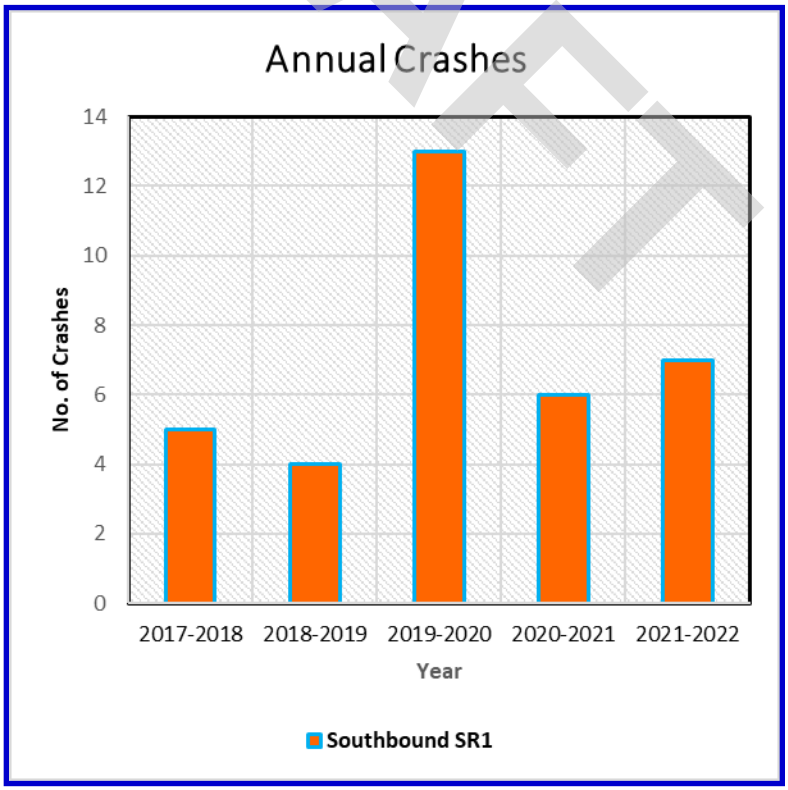
A total of Thirty-five (35) crashes were reported as having occurred on SB SR1 for the 5-year period, comprising seven (7) personal injury and twenty-eight (28) property damage only crashes. A total of eight (8) people were injured in the seven injury crashes. Majority of the crashes (21 / 60.0%) were reported as not a collision between two vehicles followed by (8 / 22.9%) front-to-front crashes. Four (4 / 11.4%) sideswipe same direction crashes and two (2 / 5.7%) angle crashes were also reported. **Table 13** presents annual and three-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI).

Table 13: Southbound SR1 Crash Type and Severity

Collision Type	Crash Severity / Classification															Crash Severity / Classification			
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021			October 31, 2021 - October 31, 2022			5-Year Totals			
Front to Rear	3	0	3	1	0	1	1	0	1	1	0	1	2	0	2	8	0	8	22.9%
Angle	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	1	2	5.7%
Sideswipe, Same Direction	0	0	0	0	0	0	1	1	2	1	0	1	0	1	1	2	2	4	11.4%
Not a Collision Between Two Vehicles	2	0	2	2	1	3	7	1	8	3	1	4	3	1	4	17	4	21	60.0%
Total	5	0	5	3	1	4	10	3	13	5	1	6	5	2	7	28	7	35	100.0%

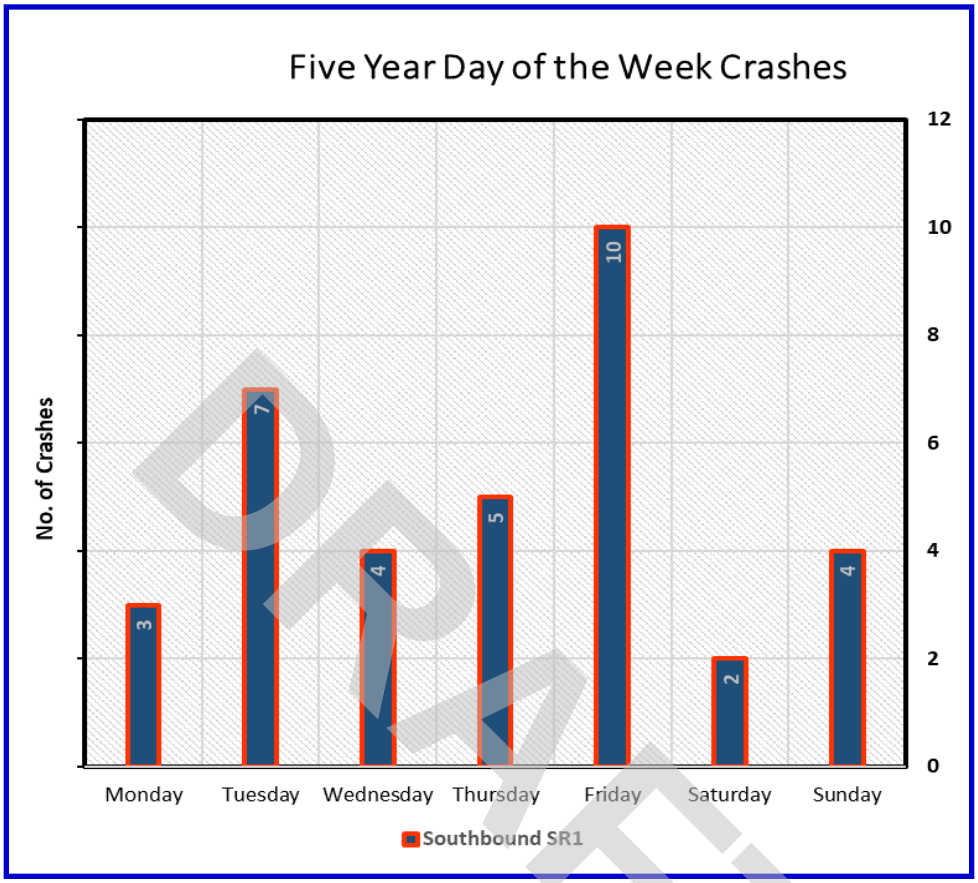
Figure 12 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, thirteen (13), was reported during the 2019–2020 period. Five (5) crashes were reported for the 2017–2018 period, approximately 61.5% lower than 2019–2020 period. For the 2018–2019 period, reported crashes dropped from five (5) to four (4), a 20% decrease. For the 2020–2021 period, reported crashes dropped approximately 53.8% from thirteen (13) to six (6). During the most recent one-year period from October 31, 2021, to October 31, 2022, reported crashes increased from six (6) for the preceding 12-month period to seven (7), i.e., by approximately 16.7%. While reported crashes have dropped significantly since the 2019-2020 period, it appears crash frequency is on SB SR1 is on an upward trend.

Figure 12: Southbound SR1 Annual Crashes



The five-year crashes by day of the week are presented in **Figure 13** and shows that Friday is the day with the highest reported number (10 / 28.6%) of crashes on SB SR1. Tuesday was the day with the next highest number (7 / 20%) of reported crashes. Saturday was the day with the lowest number (2 / 53.7%) of reported crashes. The remaining crashes were almost evenly spread over the rest of the days.

Figure 13: Southbound SR1 Time of Day Crashes



All reported crashes on SB SR1 by time of day are presented in **Figure 14**. As shown, crashes for the 5-year period are spread between 3:00 A.M. to 11:00 P.M. Per the data crashes appear to increase from 8:00 A.M. through 1:00 P.M., peaking during the hour beginning at noon with six (6 / 17.1%) reported crashes corresponding with the higher volume midday peak hours.

Figure 14: Southbound SR1 Time of Day Crashes

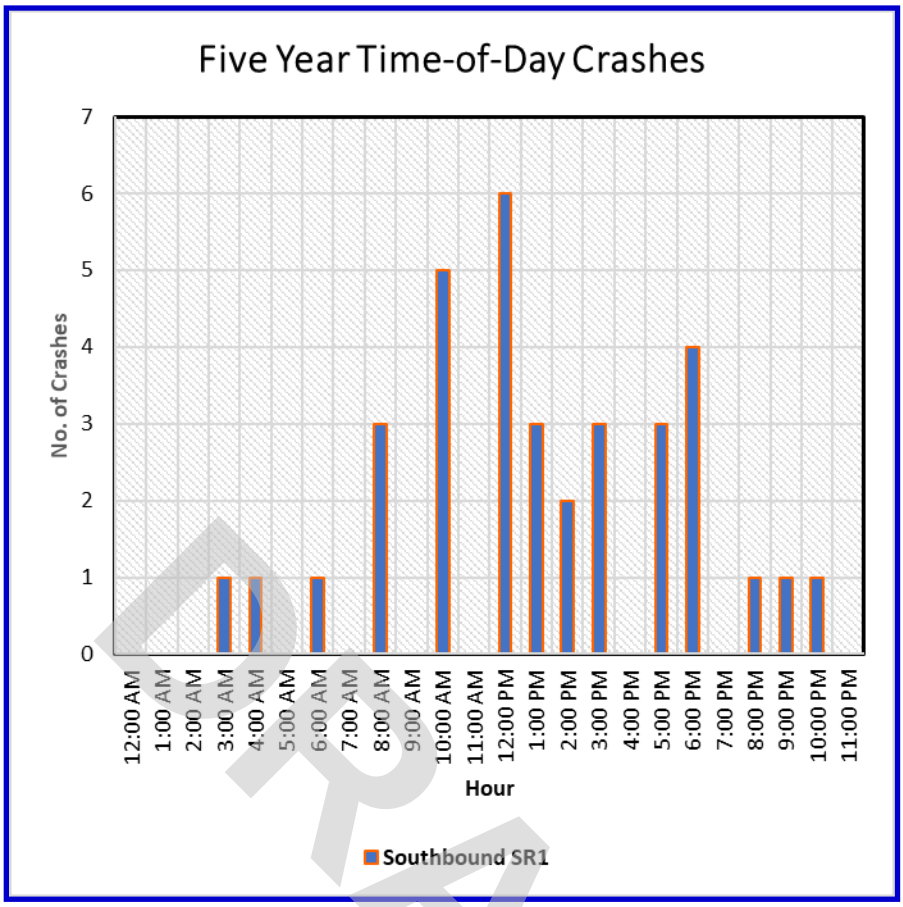


Table 14: Southbound SR1 Provided Reasons for Crashes

Primary Reason for Crash		
Description	**No. of Crashes**	**% Crash**
Animal in Roadway - Deer	2	5.7%
Failure to Yield Right of Way	1	2.9%
Following too Close	4	11.4%
Driving in a Careless or Reckless Manner	6	17.1%
Driver Inattention, Distraction, or Fatigue	7	20.0%
Driving Under the Influence	1	2.9%
Improper Lane Change	1	2.9%
Other Improper Driving	1	2.9%
Other Environmental Circumstances - Weather and/or Glare	7	20.0%
Roadway circumstances - debris; holes; work zone;	2	5.7%
Other	2	5.7%
Unknown	1	2.9%
Total	**35**	**100.0%**

The primary contributing factors for crashes on SB SR1 within the study limits are summarized in **Table 9**. As provided in the table, “Driver Inattention, Distraction, or Fatigue” and “Other Environmental Circumstances” (7 / 20.0% each) were the most frequent reason provided for reported crashes on SB SR1. This was followed closely by

"Driving in a Careless or Reckless Manner" (6 / 17.1%). "Following too Close" was the next most frequent reason for reported crashes. Together these accounted for twenty-four (24), approximately 68% out of the total of the thirty-five (35) total reported crashes. The attributed reasons in the preceding, together with the various others provided in **Table 14**, are driver behaviors and circumstances that are not necessarily susceptible to correction with physical improvements/measures. The two crashes reported under roadway circumstances occurred as a result of a bicycle in the roadway that may have fallen off a vehicle carrying it and was not a result of holes in the road or a work zone.

As shown in **Table 15**, majority of the reported crashes (32 / 91.4%) occurred during daylight and dark but lighted conditions. It appears therefore that lighting may probably not be a significant contributing factor associated with the frequency of crashes on SB SR1within the study limits. A little over half of the reported crashes (18 / 51.4%) on SB SR1 occurred on road surface that was wet or icy / frosty or snow-covered or with pounding, while the remaining crashes (17/ / 48.6%) occurred under dry road surface conditions. As provided in **Figure 8**, hydroplaning was involved in two (2) of the reported single vehicle crashes. It is likely therefore that the road surface conditions may be a significant contributing factor to the frequency of crashes on SB SR1. As presented in **Table 15**, Nineteen (19 / 54.3%) of reported crashes on SB SR1 occurred under clear and cloudy, i.e., no-precipitation weather conditions while sixteen (16 / 47.6%) of the reported crashes occurred during rain and snow i.e., precipitation weather conditions. It is probable therefore that weather conditions may have contributed to the frequency of reported crashes on SB SR1.

Table 15: Southbound SR1 Lighting, Surface and Weather Conditions

Lighting Conditions		
Description	**No. of Crashes**	**% of Total Crashes**
Daylight	27	77.1%
Dark-Lighted	5	14.3%
Dark-Not Lighted	2	5.7%
Dusk	1	2.9%
Total	**35**	**100.0%**

Surface Conditions		
Description	**No. of Crashes**	**% of Total Crashes**
Dry	17	48.6%
Wet	15	42.9%
Ice/Frost	1	2.9%
Snow	1	2.9%
Water (Standing, Moving)	1	2.9%
Total	**35**	**100.0%**

Weather Conditons		
Description	**No. of Crashes**	**% of Total Crashes**
Clear	17	48.6%
Cloudy	2	5.7%
Rain	14	40.0%
Snow	2	5.7%
Total	**35**	**100.0%**

Northbound SR1

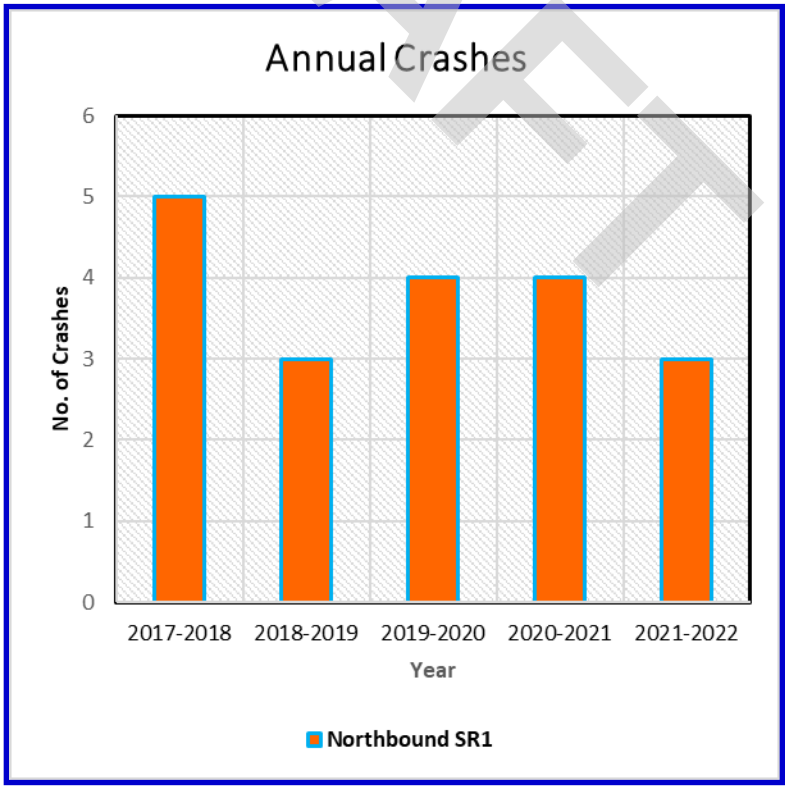
A total of Nineteen (19) crashes were reported as having occurred on NB SR1 for the 5-year period, comprising one (1) Fatal, three (3) personal injury and fifteen (155) property damage only crashes. One person died in the fatal crash and a total of eleven (11) people were injured in the three injury crashes. Majority of the crashes (11 / 57.9%) were reported as not a collision between two vehicles followed front-to-front and sideswipe same direction crashes of which three each (3 / 15.8%) were reported. There remainder of the reported crashes comprised one (1 / 5.3%) front-to-front crash which resulted in the fatality and one (1 / 5.3%) angle crash. **Table 16** presents annual and three-year summary of the types of crashes by severity i.e., Property Damage (PD) and Personal Injury (PI) and Fatal (F).

Table 16: Southbound SR1 Crash Type and Severity

Collision Type	Crash Severity / Classification																Crash Severity / Classification				
	PD	PI	Total	PD	PI	Total	PD	PI	Total	PD	PI	F	Total	PD	PI	Total	PD	PI	F	Total No. of Crashes	% of Total Crashes
	October 31, 2017 - October 31, 2018			October 31, 2018 - October 31, 2019			October 31, 2019 - October 31, 2020			October 31, 2020 - October 31, 2021				October 31, 2021 - October 31, 2022			5-Year Totals				
Front to Front	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	5.3%
Front to Rear	0	0	0	0	0	0	1	1	2	0	0	0	0	0	1	1	1	2	0	3	15.8%
Angle	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	5.3%
Sideswipe, Same Direction	2	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	3	0	0	3	15.8%
Not a Collision Between Two Vehicles	3	0	3	3	0	3	1	0	1	2	0	0	2	1	1	2	10	1	0	11	57.9%
Total	5	0	5	3	0	3	3	1	4	3	0	1	4	1	2	3	15	3	1	19	100.0%

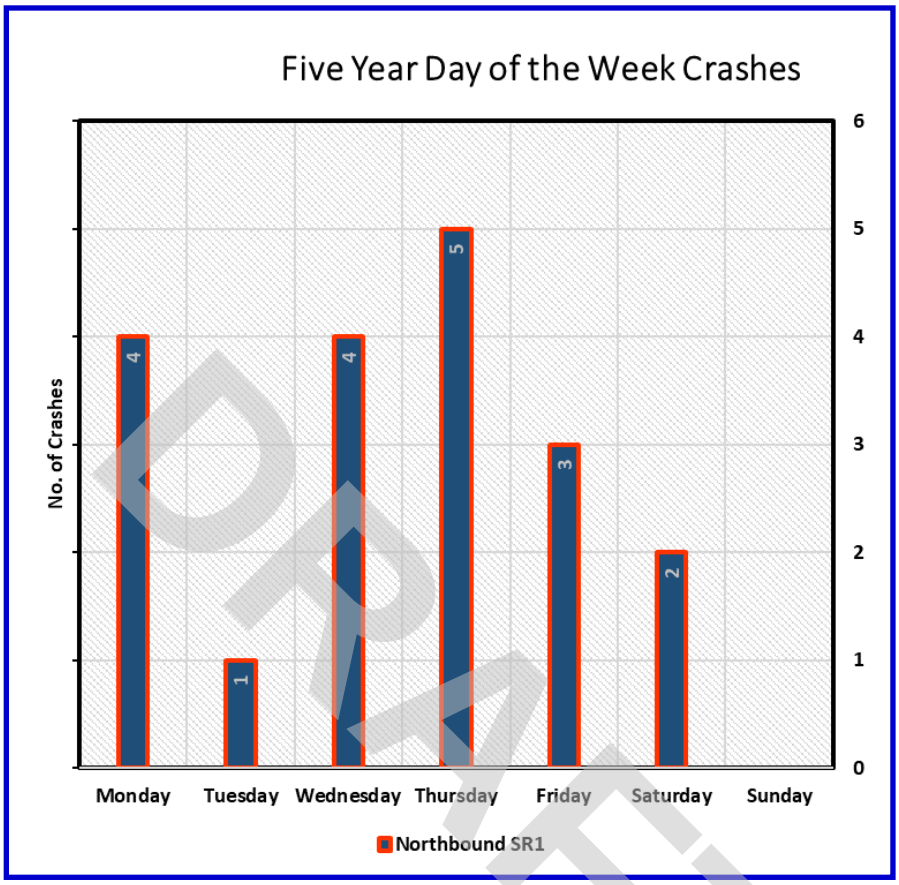
Figure 15 presents a graphical representation of the annual crashes. As provided in the figure, the highest number of annual crashes, five (5), was reported during the 2017–2018 period. Three (3) crashes were reported for the 2018–2019 period, 40% lower than the preceding year. For the 2019–2020 period, reported crashes increased from three (3) to four (4), a 33.3% increase. For the 2020–2021 period, reported crashes remained the same as for the preceding year. During the most recent one-year period from October 31, 2021, to October 31, 2022, reported crashes decreased from four (4) for the preceding 12-month period to seven (3), a 25% decrease. It appears from the data that crash frequency on NB SR1 has remained lower for the last four years than they were for the 2017-2018 period and have not fluctuated significantly.

Figure 15: Northbound SR1 Annual Crashes



The five-year crashes by day of the week are presented in **Figure 16** and shows that Thursday is the day with the highest reported number (5 / 26.3%) of crashes on NB SR1. Monday and Wednesday were the days with the next highest number (4 / 21.1%) of reported crashes. No crashes were reported as occurring on Sunday. Three (3 / 15.8%) crashes occurred on Friday, two (2 / 10.5%) on Saturday and one (1 / 5.2%) on Tuesday.

Figure 16: Northbound SR1 Time of Day Crashes



All reported crashes on NB SR1 by time of day are presented in **Figure 17**. As shown, for the 5-year period there appears to be one crash for the most part for the hours of the day that crashes were reported except for three (3) distinct peaks. For the hour beginning at midnight and that beginning at 11:00 A.M., there were 3 reported crashes each. For the hour beginning at 10:00 A.M., there were two (2) reported crashes.

Figure 17: Northbound SR1 Time of Day Crashes

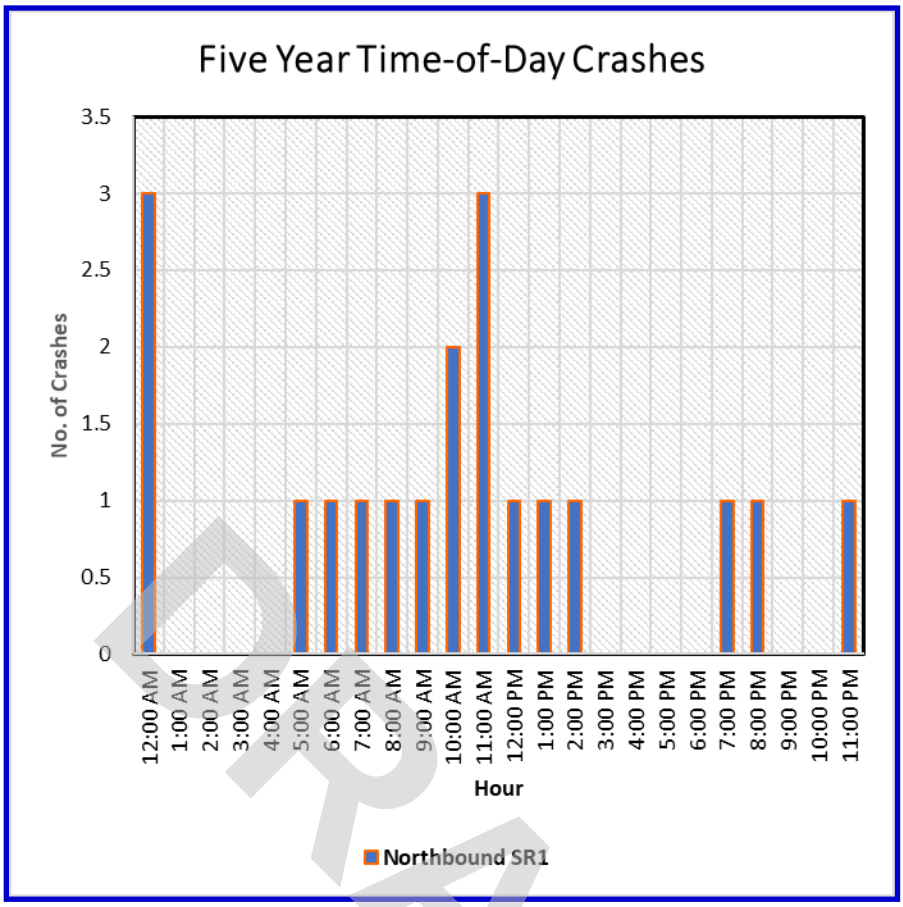


Table 17: Northbound SR1 Provided Reasons for Crashes

Primary Reason for Crash		
Description	**No. of Crashes**	**% Crash**
Animal in Roadway - Deer	3	15.8%
Failure to Yield Right of Way	1	5.3%
Driving in an Aggressive Manner	1	5.3%
Driving in a Careless or Reckless Manner	2	10.5%
Driver Inattention, Distraction, or Fatigue	1	5.3%
Driving Under the Influence	2	10.5%
Improper Lane Change	3	15.8%
Other Environmental Circumstances - Weather and/or Glare	2	10.5%
Other	1	5.3%
Unknown	3	15.8%
Total	**19**	**100.0%**

There does not appear to be wide variations in the number of crashes reported for each of the primary contributing factors for crashes on NB SR1 within the study limits as summarized in **Table 12**. As provided in the table, “Animal in Roadway”, “Improper Lane Change” and “Unknown” reasons were the most frequent with three (3 / 15.8%) each. The next most frequent were “Driving in a Careless or Reckless Manner”, “Driving Under the Influence” and “Other Environmental Circumstances” with two (2 / 10.5% each) reported. were the most frequent reason provided

for reported crashes on SB SR1. This was followed closely by (6 / 17.1%). There was one (1 / 5.3%) crash reported for each of the other reasons provided in the table. The attributed reasons provided in **Table 17**, are driver behaviors and circumstances that are not necessarily susceptible to correction with physical improvements/measures.

As shown in **Table 18**, majority of the reported crashes (14 / 73.7%) occurred during daylight and dark but lighted conditions. It appears therefore that lighting may probably not be a significant contributing factor associated with the frequency of crashes on NB SR1within the study limits. Twelve (12) of the reported crashes, 63.2%, occurred under dry road surface conditions on NB SR1. Seven (7 / 36.8%) occurred on road surface that was wet or snow-covered or slushy. It is likely therefore that the road surface conditions may to some extent be a contributing factor to the frequency of crashes on NB SR1. As presented in **Table 18**, fifteen (15 / 78.9%) of reported crashes on NB SR1 occurred under clear and cloudy, i.e., no-precipitation weather conditions while four (4 / 21.1%) of the reported crashes occurred during rain and snow i.e., precipitation weather conditions. It is probable therefore that weather conditions may be a lesser contributing factor to the frequency of reported crashes on NB SR1.

Table 18: Northbound SR1 Lighting, Surface and Weather Conditions

Lighting Conditions		
Description	No. of Crashes	% of Total Crashes
Daylight	11	57.9%
Dark-Lighted	3	15.8%
Dark-Not Lighted	2	10.5%
Dawn	3	15.8%
Total	19	100.0%

Surface Conditions		
Description	No. of Crashes	% of Total Crashes
Dry	12	63.2%
Wet	4	21.1%
Snow	2	10.5%
Slush	1	5.3%
Total	19	100.0%

Weather Conditons		
Description	No. of Crashes	% of Total Crashes
Clear	11	57.9%
Cloudy	4	21.1%
Rain	1	5.3%
Snow	3	15.8%
Total	19	100.0%

Crash Rates

Crash rates for the length of the study roadways within the study area were computed for 2018, 2019, 2020 and 2021and compared to the 2018, 2019, 2020 and 2021 crash rates obtained from DelDOT for roadways with similar characteristics in Kent County and statewide. The entire length of Trap Shooters Road was considered as being with the study length. The rates were computed for the years identified for which the five-year crash data includes a full calendar year in addition to current availability of annual average daily traffic (AADT) from DelDOT. Since the crash rates for Kent County and State of Delaware are based on calendar year data, this allows for a fair comparison. The crash rates are measured in crashes per million vehicle miles travelled (C/MVMT).

Available DelDOT gateway AADT for SR1 is bidirectional. Based on Wavetronix device data in the vicinity of the study area, NB SR1 and SB SR1 diurnal traffic volumes average out close to even. The directional AADT were therefore assigned according to a 50% directional distribution.

SR1 (northbound and southbound) is functionally classified as Other Expressway & Freeway. Northbound SR1 and Southbound SR1 crash rates were compared to the crash rates for similar Other Expressways and Freeway in Kent County and statewide. Trap Shooters Road and Barkers Landing Road are both two-lane roadways classified as Major Collectors. Since the current setting in which these two roads are located is more rural than urban, their crash rates were compared to the crash rates for similar Rural Major Collectors in Kent County and statewide. **Table 19**, **Table 20**, **Table 21** and **Table 22** respectively present the 2018, 2019, 2020 and 2021 crash rates for the study roadways and the 2018, 2019, 2020 and 2021 crash rates for similar roadways in Kent County and statewide.

Table 19: 2018 Study Roadways Crash Rate

Road	Functional Class	2018 AADT	No of Crashes (2018)	Length	Roadway Crash Rate (C/MVMT) (2018)	2018 Kent County Crash Rate (C/MVMT)	2018 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	18,664	4	0.65	**0.90**	0.77	0.67
Southbound SR1	Other Expressway & Freeway	18,664	5	0.65	**1.13**	**0.77**	0.67
Trap Shooters Rd	Rural Major Collectorl	1,784	7	0.44	**24.43**	**2.47**	2.88
Barkers Landing Rd	Rural Major Collectorl	1,898	2	0.16	**18.04**	**2.47**	2.88

Table 20: 2019 Study Roadways Crash Rate

Road	Functional Class	2019 AADT	No of Crashes (2019)	Length	Roadway Crash Rate (C/MVMT) (2019)	2019 Kent County Crash Rate (C/MVMT)	2019 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	18,808	4	0.65	**0.90**	0.17	0.13
Southbound SR1	Other Expressway & Freeway	18,808	5	0.65	**1.12**	**0.17**	0.13
Trap Shooters Rd	Rural Major Collectorl	1,847	5	0.44	**16.86**	**0.75**	0.76
Barkers Landing Rd	Rural Major Collectorl	1,989	0	0.16	**0.00**	**0.75**	0.76

Table 21: 2020 Study Roadways Crash Rate

Road	Functional Class	2020 AADT	No of Crashes (2020)	Length	Roadway Crash Rate (C/MVMT) (2020)	2020 Kent County Crash Rate (C/MVMT)	2020 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	14,962	3	0.65	**0.85**	0.18	0.15
Southbound SR1	Other Expressway & Freeway	14,962	13	0.65	**3.66**	**0.18**	0.15
Trap Shooters Rd	Rural Major Collectorl	1,468	5	0.44	**21.21**	**0.54**	0.67
Barkers Landing Rd	Rural Major Collectorl	1,581	0	0.16	**0.00**	**0.54**	0.67

Table 22: 2020 Study Roadways Crash Rate

Road	Functional Class	2021 AADT	No of Crashes (2021)	Length	Roadway Crash Rate (C/MVMT) (2021)	2021 Kent County Crash Rate (C/MVMT)	2021 State of Delaware Crash Rate (C/MVMT)
Northbound SR1	Other Expressway & Freeway	19,533	5	0.65	**1.08**	0.15	0.14
Southbound SR1	Other Expressway & Freeway	19,533	8	0.65	**1.73**	**0.15**	0.14
Trap Shooters Rd	Rural Major Collectorl	1,714	2	0.44	**7.27**	**0.54**	0.67
Barkers Landing Rd	Rural Major Collectorl	2,018	0	0.16	**0.00**	**0.54**	0.67

The ratio of each study roadway crash rate to the rate for Kent County and the State of Delaware for similar roadways in 2018, 2019, 2020 and 2021 were also computed. The 2018, 2019, 2020 and 2021 crash rate comparisons are respectively provided in **Table 23**, **Table 24**, **Table 25** and **Table 26**.

Table 23: 2028 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2018 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2018 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	**1.17**	**1.35**
Southbound SR1	**1.47**	**1.69**
Trap Shooters Rd	**9.89**	**8.48**
Barkers Landing Rd	**7.31**	**6.27**

Table 24: 2019 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2019 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2019 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	5.27	6.90
Southbound SR1	6.59	8.62
Trap Shooters Rd	22.47	22.18
Barkers Landing Rd	0.00	0.00

Table 25: 2020 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2020 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2020 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	4.70	5.63
Southbound SR1	20.35	24.41
Trap Shooters Rd	39.27	31.65
Barkers Landing Rd	0.00	0.00

As provided in the tables, the 2018 crash rates for all the study roadways are higher than those for similar roadways in the County and Statewide. For 2019, 2020 and 2021, no crashes were reported on Barkers Landing Road for the segment assessed as part of this study, therefore crash rates were zero, lower than for the Kent County and statewide. As the ratios show, for NB SR1, SB SR1 and Trap Shooters Road, the crash rates for 2019, 2020 and 2021 are much higher than for similar roadways in Kent County and statewide.

Northbound SR1

As provided in **Table 23** through **Table 26**, the NB SR1 crash rates ratios to the Kent County and statewide rates increased sharply in 2019 compared to the 2018 ratios. The 2020 ratios dropped a little compared to the 2019 ratios, then increased more than they dropped for 2021.

Table 26: 2021 Study Roadways Crash Rates Ratio to County and State Rates

Functional Class	Ratio of 2021 Roadway Crash Rate to Similar Roads in Kent County	Ratio of 2021 Roadway Crash Rate to Similar Roads Statewide
Northbound SR1	**7.19**	**7.71**
Southbound SR1	**11.51**	**12.33**
Trap Shooters Rd	**13.45**	**10.84**
Barkers Landing Rd	**0.00**	**0.00**

Southbound SR1

As provided in **Table 23** through **Table 26**, the SB SR1 crash rates ratios to the Kent County and statewide rates increased sharply in 2019 compared to the 2018 ratios. The 2020 rates increased steeply from the 2019 6.59 times the Kent County rate of 0.17 and 8.62 times the statewide rate of 0.13, to 22.47 times the Kent County rate of 0.18 and 22.18 times the statewide rate of 0.15. For 2021, the ratios dropped almost halve, but the crash rate was still 11.51 times the Kent County rate of 0.15 and 12.33 times the statewide rate of 0.14.

Trap Shooters Road

As provided in **Table 23** through **Table 26**, the Trap Shooters crash rates ratios to the Kent County and statewide rates increased steeply in 2019 compared to the 2018 ratios. The 2019 rates increased from the 2018 9.89 times the Kent County rate of 2.47 and 8.48 times the statewide rate of 2.88, to 22.47 times the Kent County rate of 0.75 and 22.18 times the statewide rate of 0.76. The 2020 rates again increase sharply from the 2019 rates to 39.27 times the Kent County rate of 0.54 and 31.65 times the statewide rate of 0.67. For 2021, the ratios dropped, but the crash rate was still 13.45 times the Kent County rate of 0.54 and 10.84 times the statewide rate of 0.67.

Safety Improvement / Crash Reduction Benefit

Crashes for calendar year 2018 through 2021 was used to assess the safety benefits of the proposed improvements in terms of their potential for crash reduction. Only crashes susceptible to correction with the geometric improvements were included in the assessment. All four proposed alternatives allow for access to and from SR1 via ramps with AASHTO compliant acceleration and deceleration lanes, therefore the crash reduction potential would be the same irrespective of the alternative that is selected and built. The 2010 AASHTO Highway Safety Manual was used to determine the crash modification factor (CMF) used in computing the potential crash reduction. Estimated annual monetary value of the reduction in crashes was obtained using the US Department of transportation (USDOT) suggested 2021 base year dollar rates. The results

are summarized in **Table 27**. As provided in the table, the project would yield an estimated annual crash reduction benefit of approximately $3.5 million.

Table 27: Project Estimated Annual Safety Improvement / Crash Reduction Benefit

	No. of Vehicles involved in Property Damage Crashes	Injury Crashes	Fatal Crashes	Annual Crash Reduction Benefit
2018 through 2021 Calendar Years*	72	11	1	
HSM CMF	0.84	0.84	0.84	
Crashes after Project	60.48	9.24	0.84	
Annual Crash Reduction	15.12	2.31	0.21	
USDOT Monetized Value per crash**	$4,800.00	$307,800.00	$13,046,800.00	
Annual Crash Benefit Reduction	$72,576.00	$711,018.00	$2,739,828.00	$3,523,422.00