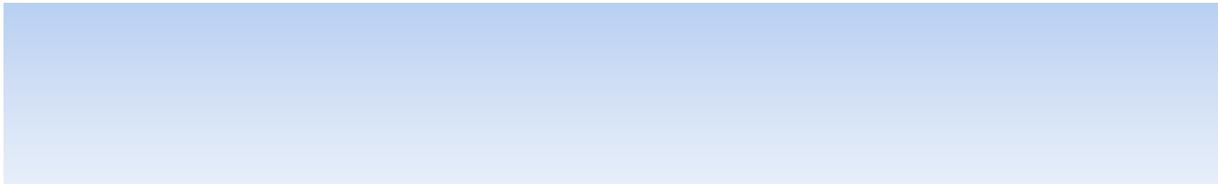


**DRAFT: recommendations still under review & other measures could be utilized**

# **First State National Historical Park Pedestrian Safety Analysis**



---

# **First State National Historical Park Pedestrian Safety Analysis**

---

**DRAFT Report**

**July 2019**

*Prepared for:*

National Park Service

5275 Leesburg Pike, MS-NWRS

Falls Church, VA 22041

# TABLE OF CONTENTS

## FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

<i>List of Figures</i> .....	<i>III</i>
<i>1. Introduction</i> .....	<i>8</i>
1.1 Project Overview .....	8
1.2 Background.....	8
1.3 Pedestrian Safety Analysis Process .....	9
<i>2. Stakeholder Coordination</i> .....	<i>10</i>
2.1 Stakeholder Kick-Off Meeting.....	10
2.2 Stakeholder Close-Out Meeting.....	10
<i>3. Existing Conditions</i> .....	<i>12</i>
3.1 Beaver Valley Video Study .....	12
<i>4. Findings and Observations</i> .....	<i>14</i>
4.1 Site 1: Beaver Valley Road Crossing.....	14
4.2 Site 2: Beaver Valley Road and Beaver Dam Road Intersection .....	17
4.3 Site 3: Beaver Dam Road Crossing .....	20
4.4 Site 4: Beaver Valley Road Crossing.....	23
4.5 Site 5 & 6: Trail Along Brandywine Creek Road and Trail Crossing .....	26
4.6 Site 7: Ramsey Road Crossing.....	29
4.7 Site 8: Ramsey Road Crossing.....	33
4.8 Site 9: Ramsey Road Crossing.....	35
4.9 Site 10: Ramsey Road Crossing.....	37
4.10 Site 11: Thompsons Bridge Road and Woodlawn Road Crossing .....	40
4.11 Site 12: Thompsons Bridge Road Crossing.....	43
4.12 Site 13: Woodlawn Road Crossing.....	46
<i>5. Recommendations and Preliminary Cost Estimates</i> .....	<i>51</i>
5.1 Short-Term Safety Recommendations.....	52
5.2 Long-Term Safety Recommendations .....	70



## **TABLE OF CONTENTS**

### **FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS**

*Appendix A – Cost Estimate Detail* ..... 75

# TABLE OF CONTENTS

## FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

### List of Figures

Figure 1. First State National Historical Park Beaver Valley Location.....	8
Figure 2. Pedestrian Safety Analysis Site Locations.....	9
Figure 3 - Partners Working Together During Field Review.....	10
Figure 4. Beaver Valley Video Study Camera Locations (2017).....	13
Figure 5. Site 1 - Beaver Valley Road Crossing.....	14
Figure 6. Site 1 - Trailheads Map View.....	15
Figure 7. Site 1 - North Trailhead.....	15
Figure 8. Site 1 - South Trailhead.....	16
Figure 9. Southwest Bound Approach to Trailheads.....	16
Figure 10. Northeast Bound Approach to Trailheads.....	16
Figure 11. Site 2 - Beaver Valley Road and Beaver Dam Road Intersection.....	17
Figure 12. Site 2 – South Trailhead and Driveway.....	18
Figure 13. Site 2 - Cyclist Rider Behavior.....	18
Figure 14. Site 2 - Lateral Sight Distance from South Trailhead.....	18
Figure 15. Site 2 – West Trailhead.....	19
Figure 16. Site 2 - Facing SW (200 Feet from Trailhead Crossing).....	19
Figure 17. Site 3 - Beaver Dam Road Crossing.....	20
Figure 18. Site 3 - North Trailhead Facing West (200 Feet Away).....	21
Figure 19. Site 3 - South Trailhead Facing Northeast (200 Feet Away).....	21
Figure 20. Site 3 - Facing North Trailhead.....	21
Figure 21. Site 3 - Facing South Trailhead.....	22
Figure 22. Site 3 - Steep Roadsides.....	22

# TABLE OF CONTENTS

## FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

Figure 23. Site 4 - Beaver Valley Road Crossing.....	23
Figure 24. Site 4 - Facing West at Trail Crossing.....	24
Figure 25. Site 4 - Facing South Trailhead .....	24
Figure 26. Site 4 - Facing Southeast from 200 Feet.....	24
Figure 27. Site 4 – Facing Northwest from 200 Feet .....	25
Figure 28. Site 5 (orange) and Site 6 (blue) - Trails Along Brandywine Creek Road .....	26
Figure 29. Sites 5 & 6 - Facing Northwest 200 Feet from Trail Heads.....	27
Figure 30. Sites 5 & 6 - Facing Southeast 200 Feet from Trail Heads .....	27
Figure 31. Site 5 - Trail Head Facing North.....	27
Figure 32. Site 5 – Trail Head Facing Southeast .....	28
Figure 33. Site 6 – Trail Head Facing West.....	28
Figure 34. Site 5 and 6 Existing Crosswalk .....	28
Figure 35. Site 7 - Ramsey Road Crossing .....	29
Figure 36. Site 7 - Facing North Trail Head.....	30
Figure 37. Site 7 - Facing South Trail Head.....	30
Figure 38. Site 7 - Centerline Marking at Curve .....	30
Figure 39 - Pickup Truck Crossing Centerline .....	31
Figure 40 - Box Truck Crossing Centerline .....	31
Figure 41 - Pickup Truck with Trailer Crossing Centerline.....	31
Figure 42. Site 7 – Facing West 50 Feet from Trail Head Crossing.....	32
Figure 43. Roadside Condition Approaching Site 7.....	32
Figure 44. Site 7 – Facing South 350 Feet from Trail Head Crossing .....	32
Figure 45. Site 8 - Ramsey Road Crossing .....	33

# TABLE OF CONTENTS

## FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

Figure 46. Site 8 - Facing North Trail Head.....	34
Figure 47. Site 8 - Facing South Trailhead .....	34
Figure 48. Site 8 – Facing West 200 Feet from North Trailhead.....	34
Figure 49. Site 8 – Facing East 200 Feet from South Trail Head .....	35
Figure 50. Site 9 - Ramsey Road Crossing .....	35
Figure 51. Site 9 - Facing South Trailhead .....	36
Figure 52. Site 9 - Facing North Trailhead .....	36
Figure 53. Site 9 – Facing West 200 Feet from North Trail Head.....	36
Figure 54. Site 9 – Facing East 200 Feet from South Trail Head .....	37
Figure 55. Site 10 - Ramsey Road Crossing .....	37
Figure 56. Site 10 - Facing North Trailhead .....	38
Figure 57. Road Edge Rutting at North Trailhead .....	38
Figure 58. Site 10 - South Trailhead .....	38
Figure 59. Site 10 – Steep Grade of South Trailhead.....	39
Figure 60. Site 10 – Facing East 200 Feet from Trailhead Crossing .....	39
Figure 61. Site 10 – Facing West 200 Feet from Trail Head Crossing.....	39
Figure 62. Site 11 - Thompsons Bridge Road and Woodlawn Road Crossing .....	40
Figure 63. Site 11 - Facing Northwest Trail Head .....	41
Figure 64. Site 11 - Facing Northeast and Southeast Trail Heads .....	41
Figure 65. Site 11 – Facing Northeast 200 Feet from Trail Head.....	41
Figure 66. Site 11 – Facing Southwest Along DE-92 (200 Feet from Trail Heads) .....	42
Figure 67. Approaching Site 11 from Eastbound DE-92.....	42
Figure 68. Site 11 Intersection Westbound DE-92 .....	42

# TABLE OF CONTENTS

## FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

Figure 69. Site 12 - Thompsons Bridge Road .....	43
Figure 70. Site 12 - Facing North Trailhead .....	44
Figure 71. Site 12 - Facing South Trailhead .....	44
Figure 72. Site 12 – Facing NE 200 Feet from Trailheads .....	44
Figure 73. Site 12 – Facing SW 200 Feet from Trail Heads .....	45
Figure 74. Road User Mix Along DE-92.....	45
Figure 75. Site 12 - North Trail Shares Farm Driveway.....	45
Figure 76. Site 13 - Woodlawn Road Crossing .....	46
Figure 77. Site 13 – Facing NW 200 Feet from North Trailhead .....	47
Figure 78. Site 13 – Facing SE 200 Feet from South Trailhead .....	47
Figure 79. Site 13 - Facing Eastern Trailhead .....	47
Figure 80. Site 13 - Facing Northern Trailhead.....	48
Figure 81. Site 13 – Facing Southern Trailhead .....	48
Figure 82. Driveway at Southern Trailhead .....	48
Figure 83. Site 7 – Facing West 200 Feet from Trail Head Crossing .....	49
Figure 84 - Roadside Facing East on Ramsey Road .....	49
Figure 85. Existing Geogrid System .....	49
Figure 86 - Brandwine Creek Roadside (Site 6).....	50
Figure 87 - Brandywine Creek Roadside (Site 5).....	50
Figure 88. Advance Warning Signage and Crosswalks.....	52
Figure 89 - Concrete Grid Detail from Blue Ridge Parkway CTIP Project.....	67

## LIST OF ACRONYMS

### FIRST STATE NATIONAL HISTORICAL PARK PEDESTRIAN SAFETY ANALYSIS

Acronym	Definition
<b>FHWA</b>	Federal Highway Administration
<b>FLAP</b>	Federal Lands Access Program
<b>FRST</b>	First State National Historical Park
<b>DelDOT</b>	Delaware Department of Transportation
<b>MUTCD</b>	Manual on Uniform Traffic Control Devices
<b>NPS</b>	National Park Service
<b>PedSA</b>	Pedestrian Safety Analysis

# 1. Introduction

## 1.1 Project Overview

In 2018 the NPS applied for the Federal Lands Access Program (FLAP) grant. The Federal Highway Administration (FHWA), Eastern Federal Lands Division (EFL) and Delaware Department of Transportation (DelDOT) partnered with National Park Service (NPS) to achieve the goal of improving safety and accessibility by conducting a Pedestrian Safety Analysis.

The overall focus is to perform a pedestrian safety analysis (PedSA) on the thirteen (13) selected multi-use trail crossings at the Beaver Valley unit of First State National Historical Park (FRST) in Delaware and Pennsylvania. The analysis will provide important information regarding existing infrastructure and operational conditions of the crossings, as well as provide recommendations to improve safety conditions with future roadway projects or other improvements.

## 1.2 Background

The Beaver Valley region of the FRST park is located west of US Route 202 in Delaware and Pennsylvania as shown in Figure 1. The multi-use trail locations are located on Beaver Dam Road, Beaver Valley Road, Ramsey Road, Brandywine Creek Road, Woodlawn Road, and Delaware Route 92. The 13 sites are indicated by a star in Figure 2 and are labeled in order from north to south.

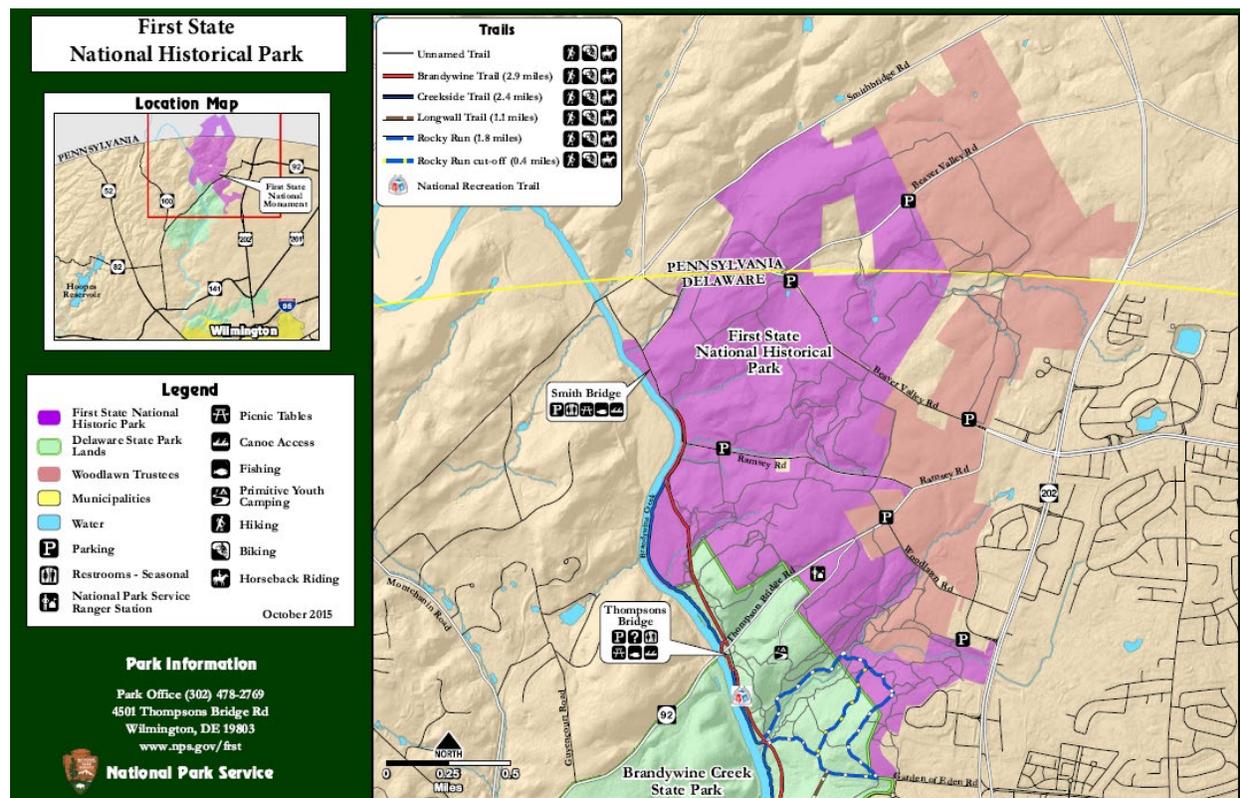
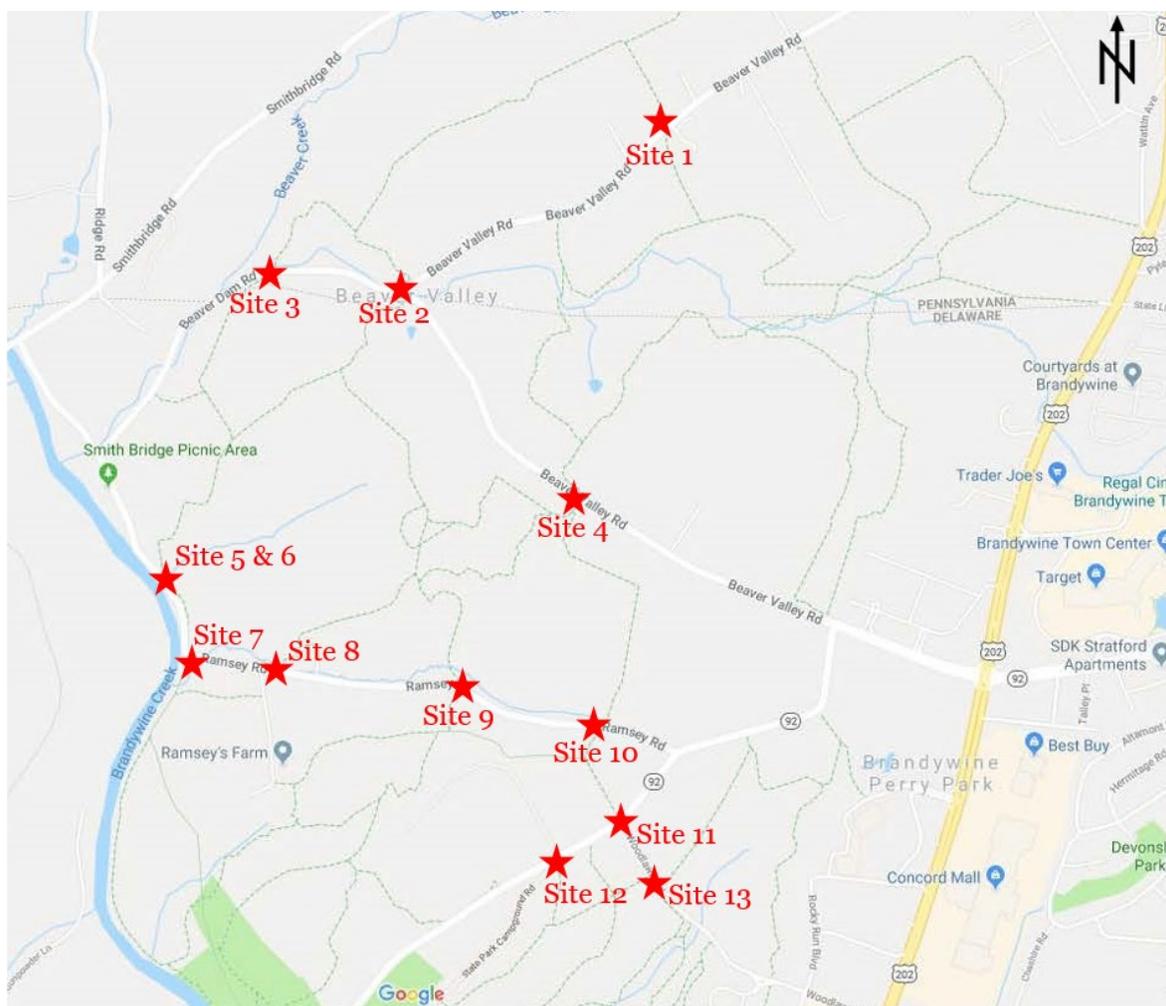


Figure 1. First State National Historical Park Beaver Valley Location



*Figure 2. Pedestrian Safety Analysis Site Locations*

### 1.3 Pedestrian Safety Analysis Process

The FRST PedSA process started with video collection within Beaver Valley study area. Review of the videos from the five camera locations and documenting findings took several weeks. A kickoff meeting took place on April 25, 2019 to review the locations and discuss preliminary findings. The PedSA took place on June 4, 2019 where the team collected site information and measurements. This report completes the PedSA process with a formal report that documents the data gathered from video for the sites, observations and findings during the field visit, and provides suggested improvements. The report also presents preliminary cost estimates for these suggested improvements.

## 2. Stakeholder Coordination

### 2.1 Stakeholder Kick-Off Meeting

The FRST PedSA team worked in close coordination with the NPS and the DelDOT Transportation Engineer. The field review was done on June 4<sup>th</sup>, 2019. The PedSA team conducted a kickoff meeting on April 25<sup>th</sup> via web conference. At this meeting, all stakeholders provided input and voiced safety concerns. Following the kickoff meeting, Eastern Federal Lands Highway Division (EFLHD), DelDOT and NPS staff performed a field review of the multi-use trails. The team documented the existing conditions assessing possible recommendations to present as suggested improvements for each location. Participants of the different meetings and field review are identified in Table 1.



*Figure 3 - Partners Working Together During Field Review*

### 2.2 Stakeholder Close-Out Meeting

EFL presented the team's findings and suggested improvements during the close-out meeting. Suggested improvements were presented in the form of short term and long-term recommendations.

*Table 1. PedSA Meetings and Field Review Participants*

Participants	Title	Kickoff Meeting 04/25/2019	Field Review 06/04/2019	Findings Presentation 10/2019
<b>NPS</b>				
Alan McLoughlin	Facility Operations Specialist	X	X	
Daniel Hodgson	Superintendent	X		
<b>FHWA</b>				
Isbel Ramos-Reyes	Team Lead - Highway Safety and Operations	X	X	
Keith Sinclair	Resource Center – Safety Engineer	X		
Darlisa Thomas	Civil Engineer-Highway Safety	X		
Yanira Rivera	PDP-Civil Engineer	X	X	
Jemesia Jefferson	Pathways Intern		X	
<b>DeIDOT</b>				
Michael Hahn	DeIDOT Planning & Byways	X	X	
Paul Moser	Bicycle and Pedestrian Planner	X	X	

### 3. Existing Conditions

This section presents the existing conditions information gathered for each location reviewed as part of the PedSA.

#### 3.1 Beaver Valley Video Study

In order to have a better understanding of the trail and the behaviors of the intersecting road users, a video study was performed in 2017. Cameras were mounted in five locations and are annotated in Figure 4. The video was recorded during Fridays, Saturdays, and Sundays from 7:30 a.m. to 6 p.m. between August 11<sup>th</sup> through 27<sup>th</sup>. The findings from the videos are included in Section 4, Findings and Observations.

#### Traffic and Crash Data:

Traffic volume statistics for the subject sites were researched from both Delaware and Delaware Valley Regional Planning Commission sites. The following table provides the traffic volume information gathered for this study. No crash data were unavailable for these sites, however typical crash types were discussed in the field visit with park partners.

*Table 2 - Summary of Traffic Volumes by Site and Road*

Site	Road Name	AADT, vpd (2018)	State	County
1	Beaver Valley Rd	unknown	PA	Delaware
2	Beaver Valley Rd	722	DE	New Castle
2	Beaver Dam Rd	2071*	PA	Delaware
3	Beaver Dam Rd	2071*	PA	Delaware
4	Beaver Valley Rd	2265	DE	New Castle
5 & 6	Brandywine Creek Rd	497	DE	New Castle
7	Ramsey Rd	497	DE	New Castle
8	Ramsey Rd	497	DE	New Castle
9	Ramsey Rd	497	DE	New Castle
10	Ramsey Rd	497	DE	New Castle
11	Thompsons Bridge Rd (92)	10528	DE	New Castle
11	Woodlawn Rd	1434	DE	New Castle
12	Thompsons Bridge Rd	10528	DE	New Castle
13	Woodlawn Rd	1434	DE	New Castle

\* Based on 2016 traffic data

#### Visitation and Road Users of the Park:

Visitors go to the park for hiking, fishing, mountain biking, swimming, horseback riding, and other recreational activities. Every year the park hosts several events including “Ramsey’s Revenge”, a mountain biking event, three equestrian races, three 5K runs, and an endurance run. During the summer, fishing, picnicking, and swimming are very popular activities making the Brandywine Creek area very congested. These recreational opportunities attract pedestrians, cyclists, mountain bikers, equestrians, as well as vehicular traffic.



- Camera Locations
- Roadways
  - Centerline
- Trails and Pathways
  - Pedestrian Trail
  - Multi-Use Trail or Pathway
  - Multi-Use Trail with Horseback Riding
  - Pedestrian Trail with Horseback Riding
- Google Satellite

*Figure 4. Beaver Valley Video Study Camera Locations (2017)*

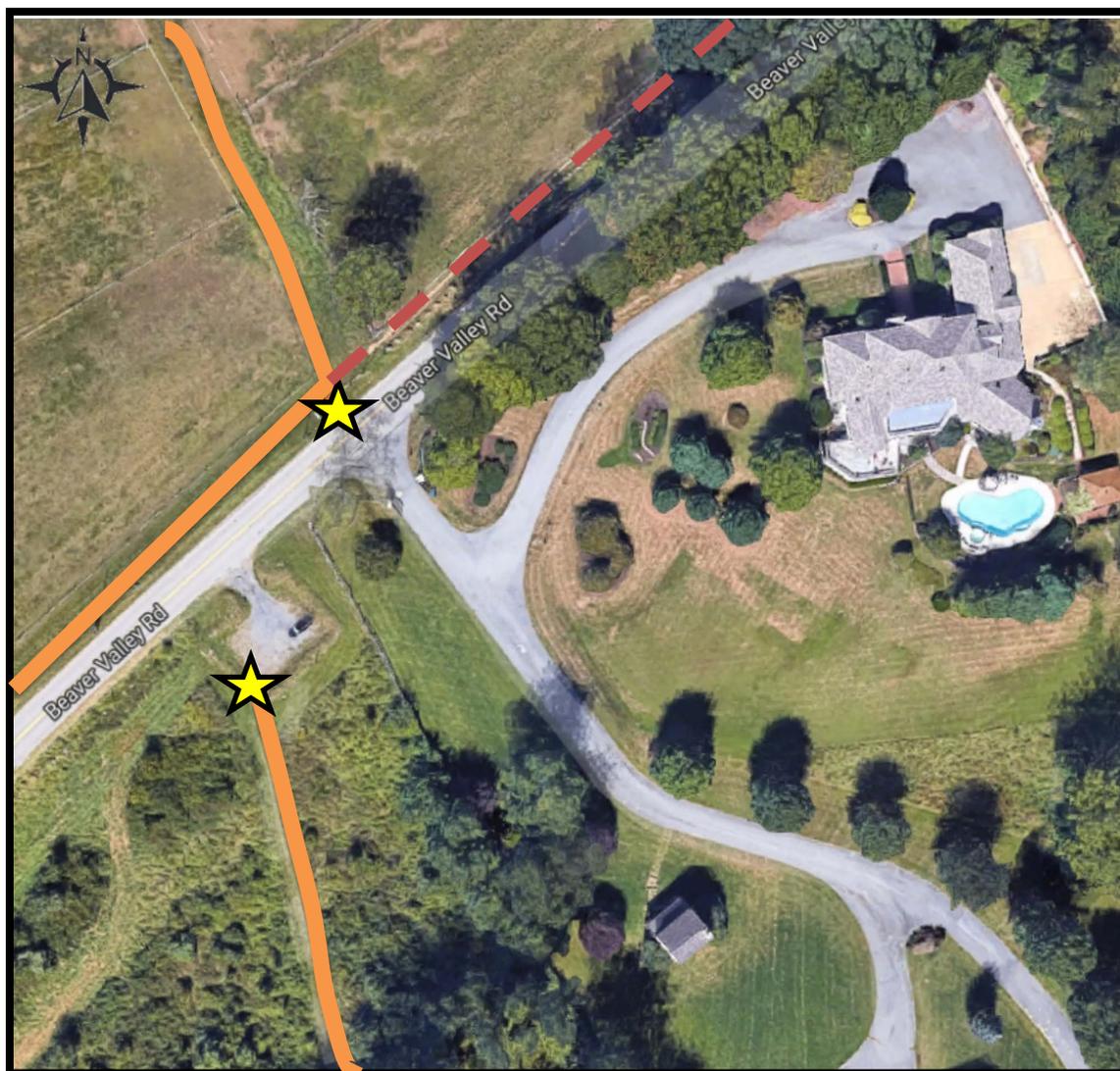


## 4. Findings and Observations

The kickoff meeting with stakeholders took place on April 25, 2019 via web conference. After its conclusion, the PedSA team performed a field review of the thirteen multi-use trail crossings. The following section describes the team's field observations and the safety issues found at these locations.

### 4.1 Site 1: Beaver Valley Road Crossing

There are two trailheads on this site. The map in Figure 5 shows the north and south trailheads. The northern trailhead (39.843928 N, 75.555433 W) faces a private driveway, so it is important to keep trail users from accidentally entering the private property. The south trailhead (39.843520 N, 75.555599W) currently ends at the southwest end of a gravel parking lot. The path indicated by the red dashed line is not currently part of the NPS trail system, however may be part of a NPS trail expansion in the future. This site is located in Delaware County, Pennsylvania.

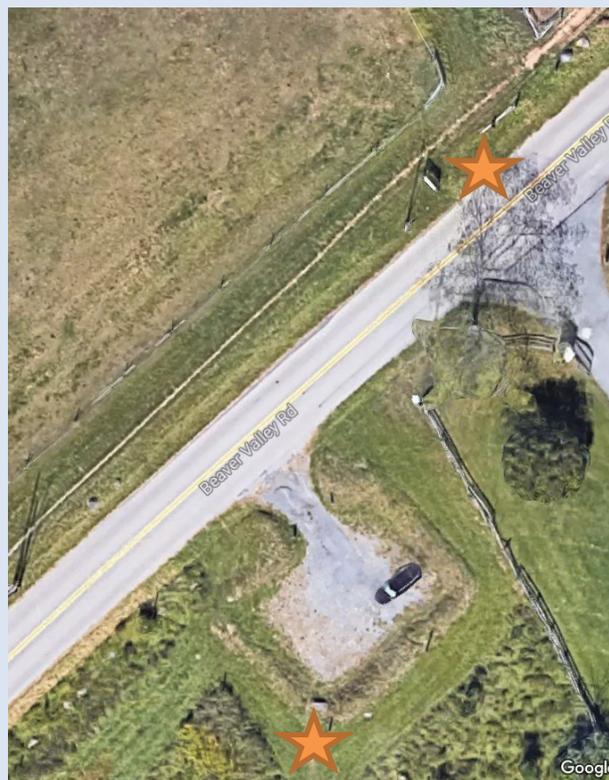


*Figure 5. Site 1 - Beaver Valley Road Crossing*

## *Observations*

## *Pictures*

*1. The two trailheads are not connected and cross a 20 foot 7-inch-wide uncontrolled active route known as Beaver Valley Road.*



*Figure 6. Site 1 - Trailheads Map View*

*2. The north trailhead is a grassed path that intersects Beaver Valley Road and is currently aligned with a private driveway. There is no crosswalk pavement marking or advance warning signage, see Figure 7.*



*Figure 7. Site 1 - North Trailhead*

3. The south trailhead ends at the southern corner of a gravel parking area that fronts Beaver Valley Road, see Figure 8. There is no crosswalk pavement marking or advance warning signage at this location.



**Figure 8. Site 1 - South Trailhead**

4. Driving southwest bound towards the trailheads, lateral visibility to the left is limited. The visibility is limited due to the horizontal curve and vegetation. Figure 9 shows the view of the trailheads from approximately 200 feet facing southwest.



**Figure 9. Southwest Bound Approach to Trailheads**

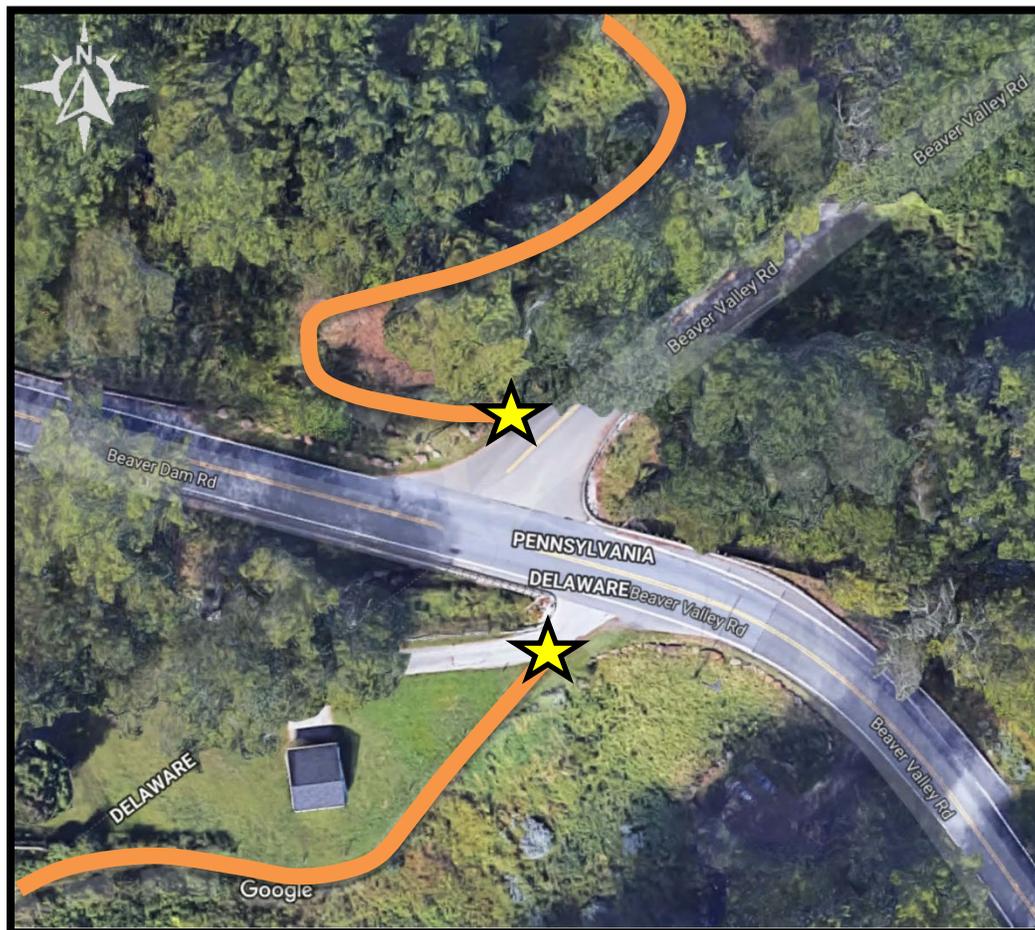
5. Lateral visibility for drivers headed northeast can potentially be limited due to the vegetation. Figure 10 shows the northeast approach from approximately 200 feet from the north trailhead.



**Figure 10. Northeast Bound Approach to Trailheads**

## 4.2 Site 2: Beaver Valley Road and Beaver Dam Road Intersection

There are two trailheads on this site. The map in Figure 11 shows the west (39.839325 N, 75.564890 W) and south (39.839120 N, 75.564730 W) trailheads located on an angled t-intersection. This eastern portion of this site lies in New Castle County, Delaware and the western portion lies in Delaware County, Pennsylvania.



*Figure 11. Site 2 - Beaver Valley Road and Beaver Dam Road Intersection*

## *Observations*

## *Pictures*

1. The south trailhead crosses a residential driveway as shown in Figure 12. This property is owned by NPS, but is leased out. Video footage showed people cutting through the driveway to cross Beaver Valley Road and drivers cutting diagonally to and from the driveway.



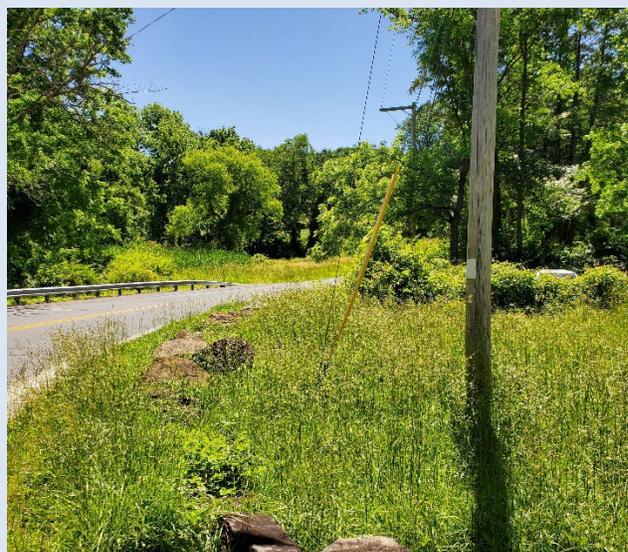
*Figure 12. Site 2 – South Trailhead and Driveway*

2. In the video study, there were various trail crossing maneuvers across the unprotected, stop-controlled, 3-leg intersection. Pedestrians and cyclists were seen cutting diagonally due to the trail ending on opposite ends, from northeast to southwest. This route has a width of 24 feet 5 inches with 2 feet 6 inches of shoulder on both sides.



*Figure 13. Site 2 - Cyclist Rider Behavior*

3. NB Beaver Valley Road's crossing sight distance is obstructed by horizontal curve and vegetation.



*Figure 14. Site 2 - Lateral Sight Distance from South Trailhead*

4. Video showed large vehicles driving WB on Beaver Valley Road, stop mid-turn, reverse onto the NB lane of Beaver Dam Road, and then turn around headed EB on Beaver Valley Road; is intersection too small to turn?



**Figure 15. Site 2 – West Trailhead**

5. SW Beaver Valley Road's stop sign is obstructed by vegetation as shown in Figure 16.



**Figure 16. Site 2 - Facing SW (200 Feet from Trailhead Crossing)**

### 4.3 Site 3: Beaver Dam Road Crossing

There are two trailheads on this site as shown in the map in Figure 17. The north trailhead (39.839880 N, 75.568684 W) and south trailhead (39.839528 N, 75.570547 W) are located on a heavily wooded roadway where visibility is affected by the canopy effect of the trees. This site is located in Delaware County, Pennsylvania.



*Figure 17. Site 3 - Beaver Dam Road Crossing*

## Observations

## Pictures

1. There is a lack of connectivity between the two trailheads. The approximate road width is about, edge of pavement to edge of pavement.

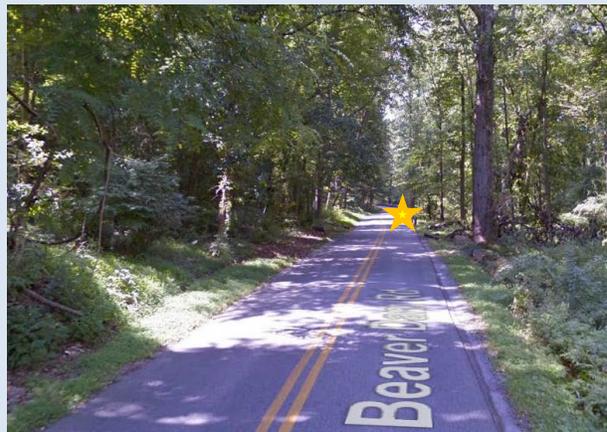


Figure 18. Site 3 - North Trailhead Facing West (200 Feet Away)

2. There are no advance warning signs, lighting, or pavement markings to indicate trail crossings.



Figure 19. Site 3 - South Trailhead Facing Northeast (200 Feet Away)

3. Limited sight distance from north trailhead.



Figure 20. Site 3 - Facing North Trailhead

4. *The south trailhead is on a steep slope with limited sight distance, see Figure 21.*



*Figure 21. Site 3 - Facing South Trailhead*

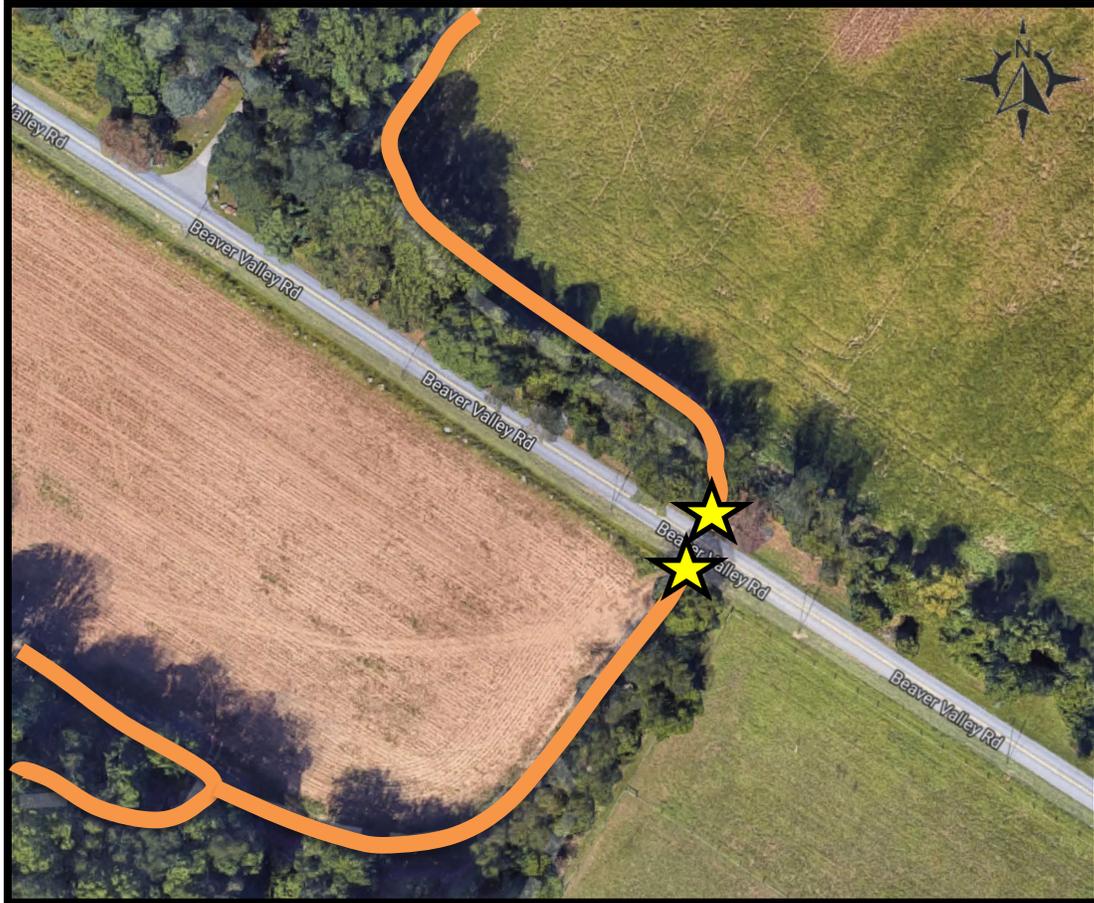
5. *Roadsides in this general area are steep as shown in Figure 22.*



*Figure 22. Site 3 - Steep Roadsides*

#### 4.4 Site 4: Beaver Valley Road Crossing

Site 4 contains two trailheads adjacent to farmland on Beaver Valley Road, as shown in Figure 23. The north trailhead (39.833690 N, 75.558478 W) and south trailhead (39.833628 N, 75.558542 W) are located in New Castle County, Delaware.



*Figure 23. Site 4 - Beaver Valley Road Crossing*

### *Observations*

### *Pictures*

1. This is a 16 foot 11-inch-wide, (edge of pavement to edge of pavement) uncontrolled trail crossing on an active route. Heavy traffic was observed in the video study. Many drivers seemed to be speeding in the video footage.



**Figure 24. Site 4 - Facing West at Trail Crossing**

2. There is a farm access road adjacent to the south trailhead, see Figure 25.



**Figure 25. Site 4 - Facing South Trailhead**

3. Viewing the crossing from 200 feet away, facing southeast there is vegetation to the left and farmland to the right as depicted in Figure 26.



**Figure 26. Site 4 - Facing Southeast from 200 Feet**

4. *The crossing does not have lighting, striping, or advance warning signs from either direction to indicate pedestrian or wildlife crossings. Deer were observed crossing the roadway in the video study.*



**Figure 27. Site 4 – Facing Northwest from 200 Feet**

#### 4.5 Site 5 & 6: Trail Along Brandywine Creek Road and Trail Crossing

The trail along Brandywine Creek Road is Site 5 and the trail that crosses the road and borders Brandywine Creek is Site 6. The north trailhead (39.831483 N, 75.573429 W) and south trailhead (39.831313 N, 75.573282 W) of Site 5 and the trailhead (39.831358 N, 75.573425 W) of Site 6 are located in New Castle County, Delaware and are depicted in Figure 28.



*Figure 28. Site 5 (orange) and Site 6 (blue) - Trails Along Brandywine Creek Road*

**Observations**

**Pictures**

1. The site 5 trail runs parallel to Brandywine Creek Road and over a rock bridge abutment. This trail is unprotected from an active route.



**Figure 29. Sites 5 & 6 - Facing Northwest 200 Feet from Trail Heads**

2. Site 6 trail crosses a 16 foot 8-inch-wide uncontrolled, active route.



**Figure 30. Sites 5 & 6 - Facing Southeast 200 Feet from Trail Heads**

3. Trailheads adjacent to (Figure 31) and right up against stone abutments (Figure 32 and Figure 33). Geo-grid has previously been placed at these locations to stabilize the “shoulder area” and is failing in some areas.



**Figure 31. Site 5 - Trail Head Facing North**



*Figure 32. Site 5 – Trail Head Facing Southeast*



*Figure 33. Site 6 – Trail Head Facing West*

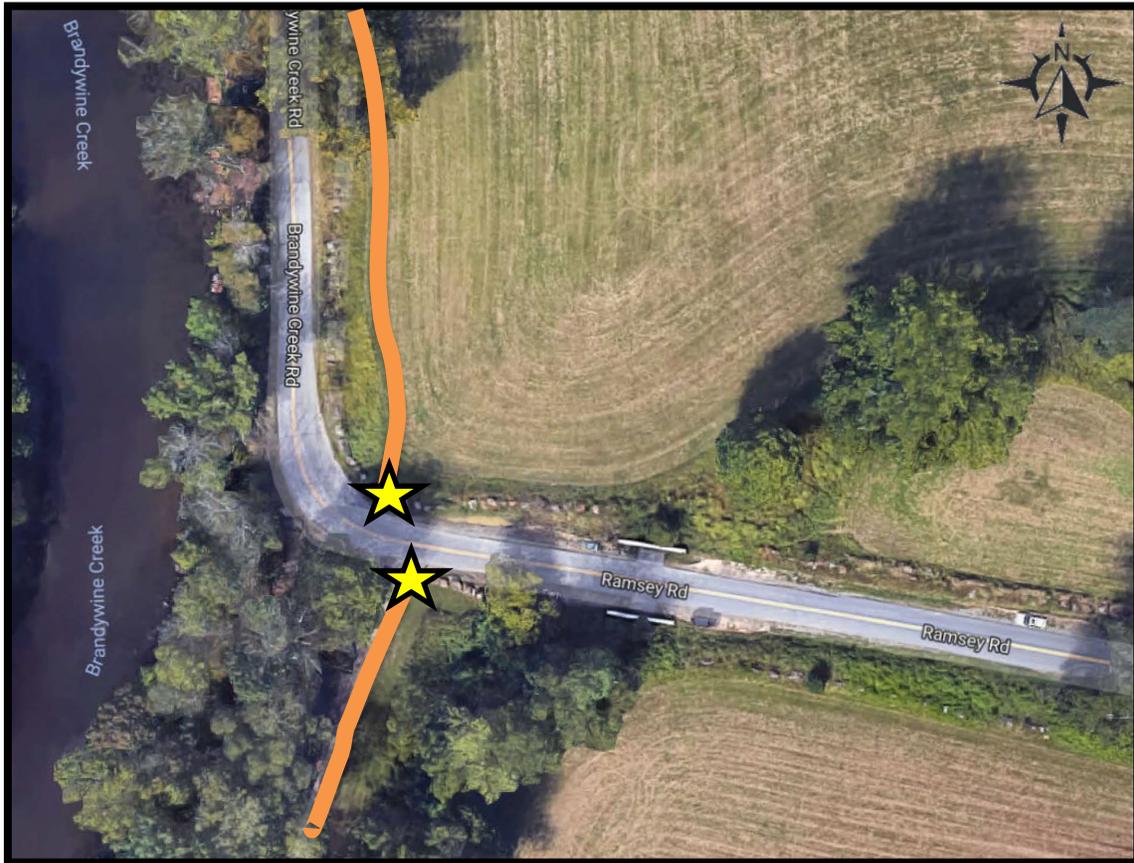
4. The existing crosswalk is faded and difficult to see (Figure 34).



*Figure 34. Site 5 and 6 Existing Crosswalk*

#### 4.6 Site 7: Ramsey Road Crossing

There are two trailheads that cross Ramsey Road in site 7. It is located near a horizontal curve as shown in Figure 35. The south trailhead (39.829348 N, 75.572478 W) and north trailhead (39.829447 N, 75.572520 W) are located approximately 750 feet from Woodlawn Parking lot on Ramsey Road in New Castle County, Delaware. This site is nearby agricultural lands that are leased out to Stuart Farms.



*Figure 35. Site 7 - Ramsey Road Crossing*

## *Observations*

## *Pictures*

 The trail crosses near a critical horizontal curve between Brandywine Creek Road and Ramsey Road, an uncontrolled, active route as shown in Figure 36 and Figure 37. Video study showed various “near misses” between vehicles and pedestrians at this location.

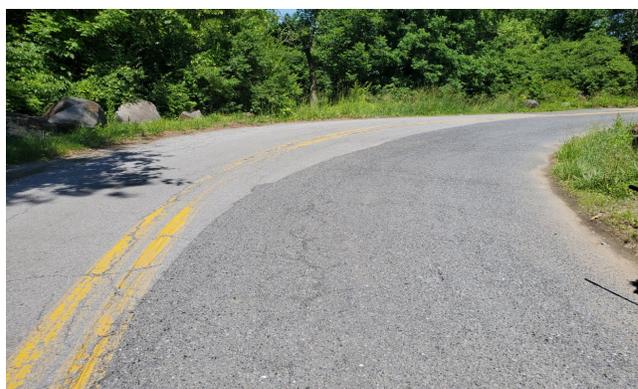


*Figure 36. Site 7 - Facing North Trail Head*



*Figure 37. Site 7 - Facing South Trail Head*

2. The centerline marking at the curve was off-centered, making the lanes different widths. Several vehicles were seen crossing the centerline to make the turn as can be seen in Figure 39 through Figure 41.



*Figure 38. Site 7 - Centerline Marking at Curve*



*Figure 39 - Pickup Truck Crossing Centerline*



*Figure 40 - Box Truck Crossing Centerline*



*Figure 41 - Pickup Truck with Trailer Crossing Centerline*

3. *This trail crossing is popular for many different types of trail users.*



*Figure 42. Site 7 – Facing West 50 Feet from Trail Head Crossing*



*Figure 43. Roadside Condition Approaching Site 7*

4. *Curve signing is inadequate for the tight turn on Brandywine Creek Road to Ramsey Road, see Figure 44.*



*Figure 44. Site 7 – Facing South 350 Feet from Trail Head Crossing*

#### 4.7 Site 8: Ramsey Road Crossing

This site contains two trailheads. The north trailhead (39.829125 N, 75.569379 W) ends at the northeast corner of Woodlawn Parking Lot and the south trailhead (39.829008 N, 75.569967 W) crosses just west of the parking lot entrance as shown in Figure 45. This site is located in New Castle County, Delaware.



*Figure 45. Site 8 - Ramsey Road Crossing*

## Observations

## Pictures

1. “Woodlawn Parking Lot” is a NPS-owned gravel parking lot and typically used to access this trail.



**Figure 46. Site 8 - Facing North Trail Head**

2. The driveway depicted in Figure 47 is used by agricultural land lessee and park visitors. (1/8 mile up the driveway is another trailhead)



**Figure 47. Site 8 - Facing South Trailhead**

3. The trail crosses a 21 foot 4-inch-wide uncontrolled, active route on Ramsey Road. The north trailhead and south trailhead are disconnected.



**Figure 48. Site 8 – Facing West 200 Feet from North Trailhead**

4. There is no advanced warning signals or pavement markings for the trail crossing as shown in Figure 49.



Figure 49. Site 8 – Facing East 200 Feet from South Trail Head

#### 4.8 Site 9: Ramsey Road Crossing

Site 9 is located on Ramsey Road and there are two unaligned trailheads north (39.828699 N, 75.563323 W) and south (39.828267 N, 75.562500 W) of a horizontal curve, as seen in Figure 50. Site 9 is located in New Castle County, Delaware.



Figure 50. Site 9 - Ramsey Road Crossing

## Observations

## Pictures

1. South trailhead is located on the bottom of a slope of a single-track trail. (See Figure 51).

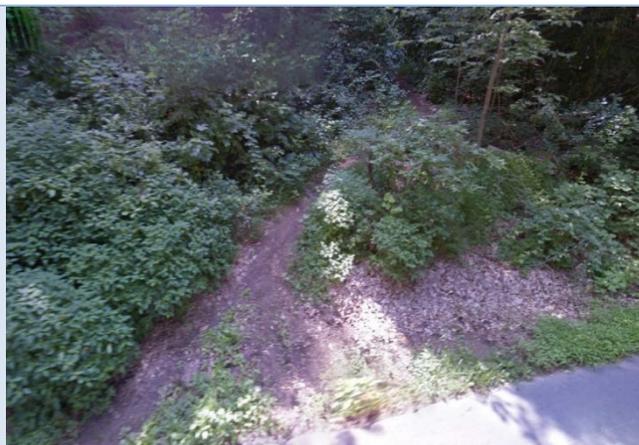


Figure 51. Site 9 - Facing South Trailhead

2. Visitors typically travel from the south trailhead, along the road side and cross the roughly 21-foot wide active route to the unaligned north trailhead, through the cable gate to access this wider trail. (See Figure 52)



Figure 52. Site 9 - Facing North Trailhead

3. Site is considered “high risk” by the NPS due to the limited sight distance for road and trail users.



Figure 53. Site 9 – Facing West 200 Feet from North Trail Head



*Figure 54. Site 9 – Facing East 200 Feet from South Trail Head*

#### 4.9 Site 10: Ramsey Road Crossing

Site 10 contains two trailheads that cross Ramsey Road as depicted in Figure 55. The northern trailhead (39.827488 N, 75.557789 W) and southern trailhead (39.827446 N, 75.557814 W) are located in New Castle County, Delaware.



*Figure 55. Site 10 - Ramsey Road Crossing*

## Observations

 Trail crosses a roughly 21-foot-wide, uncontrolled active route and trailheads are hidden to oncoming traffic.

## Pictures



*Figure 56. Site 10 - Facing North Trailhead*

2. A drop-off of approximately 9 inches was estimated between the road edge and the north trailhead as shown in Figure 57.

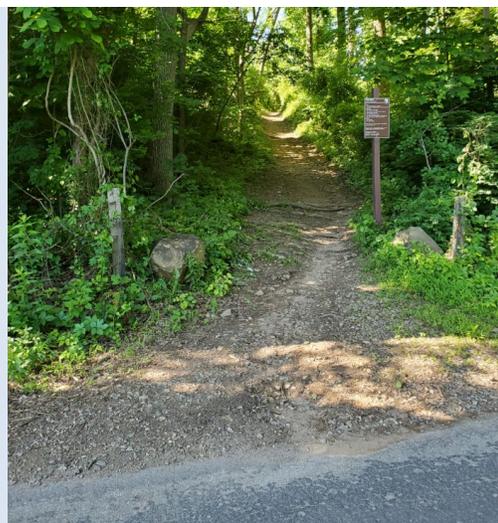


*Figure 57. Road Edge Rutting at North Trailhead*

2. Gravel runs into the roadway from the bottom of the steep slope of the south trailhead as seen in Figure 58 and Figure 59.



*Figure 58. Site 10 - South Trailhead*



**Figure 59. Site 10 – Steep Grade of South Trailhead**

*3. Video footage shows numerous instances where horses, cyclists, and pedestrians had a “traffic jam”. Pedestrian traffic is lighter in this site compared to other sites, but several times pedestrians were walking in the roadway.*



**Figure 60. Site 10 – Facing East 200 Feet from Trailhead Crossing**

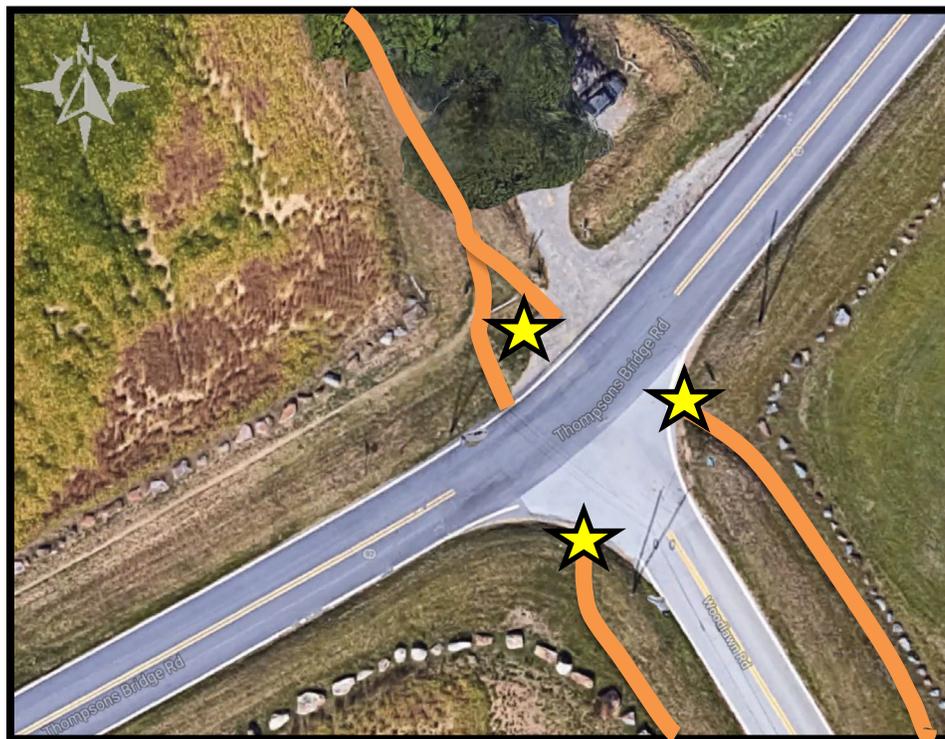
*4. When cyclists use the roadway, vehicles will drive around them into opposing traffic; video shows “near misses” with vehicles.*



**Figure 61. Site 10 – Facing West 200 Feet from Trail Head Crossing**

#### 4.10 Site 11: Thompsons Bridge Road and Woodlawn Road Crossing

Site 11 contains three trailheads along the t-intersection between Thompsons Bridge Road (DE-92) and Woodlawn Road. The eastern trailhead (39.824853 N, 75.557086 W) is adjacent to a recreational area owned and maintained by the County, and the northern trailhead (39.824938 N, 75.557255 W) and western trailhead (39.824772 N, 75.557185 W) are situated in New Castle County, Delaware.



*Figure 62. Site 11 - Thompsons Bridge Road and Woodlawn Road Crossing*

## Observations

## Pictures

1. Trail crossing maneuvers are located on 3-way intersection. Woodlawn Rd is stop-controlled and DE-92, Thompson's Bridge Road, is uncontrolled. NPS stated that this intersection has a high incidence of left-turning movement crashes.



**Figure 63. Site 11 - Facing Northwest Trail Head**

2. During recreational activities, the roadside along Woodlawn Road is used for parking.



**Figure 64. Site 11 - Facing Northeast and Southeast Trail Heads**



**Figure 65. Site 11 – Facing Northeast 200 Feet from Trail Head**



**Figure 66. Site 11 – Facing Southwest Along DE-92 (200 Feet from Trail Heads)**

3. Existing warning sign with flashing beacon going eastbound along DE-92 shown in Figure 67. Otherwise, there is no other advanced warning signals for trail or pedestrian crossings at the intersection.



**Figure 67. Approaching Site 11 from Eastbound DE-92**

4. Existing sight distance challenges due to horizontal and vertical curves and roadside vegetation.



**Figure 68. Site 11 Intersection Westbound DE-92**

#### 4.11 Site 12: Thompsons Bridge Road Crossing

The trailheads, northern (39.824005 N, 75.559357W) and southern (39.823816 N, 75.559443W) are located in site 12, near a park access road and agriculture lands as depicted in Figure 69.



*Figure 69. Site 12 - Thompsons Bridge Road*

**Observations**

**Pictures**

1. The north trail runs along DE-92, Thompson Bridge Road between the pavement and boulders, Figure 69. The trailhead ends at a driveway to a farm as shown in Figure 70.



**Figure 70. Site 12 - Facing North Trailhead**

2. The south trailhead is located at the bottom of a slope and experiences sight distance difficulties due to high vegetation on either side making it difficult for drivers to see trail users, especially for drivers headed uphill northbound.



**Figure 71. Site 12 - Facing South Trailhead**

3. The access road, that enters the road at an acute angle and is located further south on DE-92 also has sight distance issues as shown in Figure 72.



**Figure 72. Site 12 - Facing NE 200 Feet from Trailheads**

4. The trail crosses a 22 foot 1 inch wide uncontrolled, unsigned, and unmarked active route. In the video study, pedestrians were observed walking down the trail, then turning to walk along the street.



*Figure 73. Site 12 – Facing SW 200 Feet from Trail Heads*

5. Video footage also showed cyclists riding along the unpaved shoulder, off the road, and then crossing the roadway onto the trail.



*Figure 74. Road User Mix Along DE-92*

6. Farm equipment was observed on the roadway. The north trail runs along a farm driveway.



*Figure 75. Site 12 - North Trail Shares Farm Driveway*

#### 4.12 Site 13: Woodlawn Road Crossing

Site 13 contains three trailheads that cross Woodlawn Road as shown in Figure 76. The northwest trailhead (39.823384 N, 75.556101 W) and southwest trailhead (39.823030 N, 75.555881 W) is an active trail, and the northeast trailhead (39.823129 N, 75.555777 W) leads to a dead-end trail. This site is located in New Castle County, Delaware.



*Figure 76. Site 13 - Woodlawn Road Crossing*

*Observations*

*Pictures*

1. East and South trailhead crossings experience sight distance obstructions by vegetation and the horizontal and vertical curve. Drivers are going up a steep grade when heading north on Woodlawn Road (Figure 77).



**Figure 77. Site 13 – Facing NW 200 Feet from North Trailhead**



**Figure 78. Site 13 – Facing SE 200 Feet from South Trailhead**

2. The eastern trail crossing is part of a recreational facility (same as shown in Site 11) and is maintained by New Castle County. There is currently no trail from this location.



**Figure 79. Site 13 - Facing Eastern Trailhead  
(maintained by New Castle County)**

3. *The northern trailhead leads to trails along Woodlawn Road and meets the trail from Site 12.*



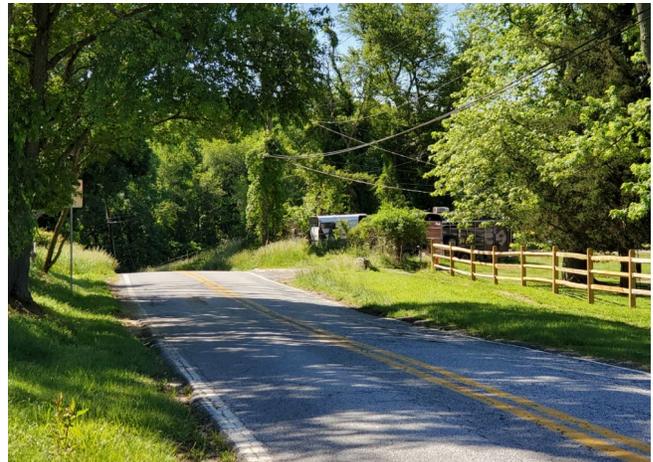
**Figure 80. Site 13 - Facing Northern Trailhead**

4. *The southern trailhead is adjacent to a driveway to a local business for kayak and other recreational rentals.*



**Figure 81. Site 13 – Facing Southern Trailhead**

3. *The trail crossings are across a 17 foot 8-inch-wide uncontrolled, active route. NPS reports many accidents at this location.*



**Figure 82. Driveway at Southern Trailhead**

### 4.13 Roadside – Multiple Locations

Several areas within the park, especially those that have been used as roadside parking, have roadside rutting and drainage issues. The following are some locations documented during the field visit.

*Observations*

*Pictures*

1. The sides of the roadway along Ramsey Road are used for parking when the closest parking lot is full leaving only one lane available for traffic. The video also shows many instances of pedestrians and cyclists using the road or “shoulder area” instead of the trail. This area has previously been stabilized using a plastic geo-grid system that is failing in some locations. The grids shift or come out, and some spots experience ponding. See Figure 83 through Figure 85.



*Figure 83. Site 7 – Facing West 200 Feet from Trail Head Crossing*



*Figure 84 - Roadside Facing East on Ramsey Road*



*Figure 85. Existing Geogrid System*



***Figure 86 - Brandywine Creek Roadside (Site 6)***

*2. Along the roadside near Sites 5 and 6 on Brandywine Creek Road, there are sections with geogrid material.*



***Figure 87 - Brandywine Creek Roadside (Site 5)***

## 5. Recommendations and Preliminary Cost Estimates

This section presents the site-specific recommendations for the various sites audited during the field visit. The suggested improvements were identified by the team and preliminarily discussed during the kick off and closeout meetings. These improvements were broken down into short-term and long-term measures. Preliminary Cost estimates are provided along with a list of the recommended improvements.

Several factors were taken into consideration when deciding on safety improvements. For the placement of trail crossing warning signage and crosswalk pavement markings, the posted speed limit, the road grade, the appropriate stopping sight distance for that speed, and road user mix were taken into account. The speed limits were recorded from the site visit and complimented using google maps. A perception-reaction time of 2.5 seconds and a deceleration rate of 11.2 feet per second were assumed as recommended by AASHTO, to account for the time needed for the majority of drivers to perceive and react to signage, crossings, etc. The following table provides the guidelines for advance placement of warning signs taken from the 2009 MUTCD, Table 2C-4. For the speed limits posted in the 13 FRST park trail crossing locations, a minimum of 100 feet between the advanced warning sign and the crosswalk is suggested.

Posted or 85th-Percentile Speed	Advance Placement Distance <sup>1</sup>								
	Condition A: Speed reduction and lane changing in heavy traffic <sup>2</sup>	Condition B: Deceleration to the listed advisory speed (mph) for the condition							
		0 <sup>3</sup>	10 <sup>4</sup>	20 <sup>4</sup>	30 <sup>4</sup>	40 <sup>4</sup>	50 <sup>4</sup>	60 <sup>4</sup>	70 <sup>4</sup>
20 mph	225 ft	100 ft <sup>6</sup>	N/A <sup>5</sup>	—	—	—	—	—	—
25 mph	325 ft	100 ft <sup>6</sup>	N/A <sup>5</sup>	N/A <sup>5</sup>	—	—	—	—	—
30 mph	460 ft	100 ft <sup>6</sup>	N/A <sup>5</sup>	N/A <sup>5</sup>	—	—	—	—	—
35 mph	565 ft	100 ft <sup>6</sup>	N/A <sup>5</sup>	N/A <sup>5</sup>	N/A <sup>5</sup>	—	—	—	—
40 mph	670 ft	125 ft	100 ft <sup>6</sup>	100 ft <sup>6</sup>	N/A <sup>5</sup>	—	—	—	—
45 mph	775 ft	175 ft	125 ft	100 ft <sup>6</sup>	100 ft <sup>6</sup>	N/A <sup>5</sup>	—	—	—
50 mph	885 ft	250 ft	200 ft	175 ft	125 ft	100 ft <sup>6</sup>	—	—	—
55 mph	990 ft	325 ft	275 ft	225 ft	200 ft	125 ft	N/A <sup>5</sup>	—	—
60 mph	1,100 ft	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft <sup>6</sup>	—	—
65 mph	1,200 ft	475 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft <sup>6</sup>	—
70 mph	1,250 ft	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	—
75 mph	1,350 ft	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft <sup>6</sup>

<sup>1</sup> The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 feet, which is appropriate for an alignment warning symbol sign. For Conditions A and B, warning signs with less than 6-inch legend or more than four words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning sign.

<sup>2</sup> Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2005 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet for the appropriate sign.

<sup>3</sup> Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2005 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second<sup>2</sup>, minus the sign legibility distance of 180 feet.

<sup>4</sup> Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second<sup>2</sup>, minus the sign legibility distance of 250 feet.

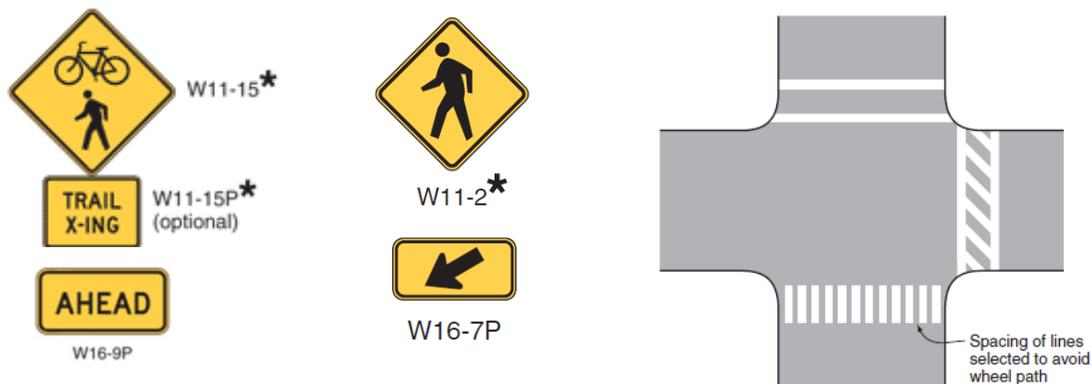
<sup>5</sup> No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing. An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.

<sup>6</sup> The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.

Another factor that can affect the distance traveled during perception-reaction time is the driver’s familiarity to the location. There is a mix of regular commuters or local traffic and park visitors, who are less familiar to the routes and road geometry. The park roads and trails are used by drivers, pedestrians, bicyclists, and equestrians. For that reason, some of the safety recommendations include wayfinding signage and trimming vegetation away from existing signs. The short-term and long-term safety recommendations below are accompanied with a graphical representation of each site. A summary of these recommendations is provided in Table 2. A preliminary cost estimate for the suggested improvements are provided in Appendix A.

### 5.1 Short-Term Safety Recommendations

The following are safety recommendations that can be implemented in the short-term. Most consist of pavement markings, trail head stabilization, and signage. The most common signs and markings are shown in Figure 88. The safety recommendations are listed below and listed by site number. Please note, where Pedestrian (W11-2) signs are proposed, Trail Crossing (W11-15a) or the combined Bicycle and Pedestrian (W11-15) sign can be used instead. Also, where “PED XING” pavement markings are proposed, “TRAIL XING” can be used instead. These improvements will allow trail users to easily locate the trails (trailhead improvements) and road users will be able to anticipate and see the trail crossing (advance warning signs and pavement markings).



**Figure 88. Advance Warning Signage and Crosswalks**

Source: MUTCD Figures 2C-10, 2C-11, 2C-12, and 3B-19

### Site 1-Beaver Valley Road

Recommendations: Alignment and rehabilitation of trailheads, crosswalk pavement markings, advance trail crossing signs, trail crossing signs, and wayfinding signage for visitors to know the location of the trail parking lot. The estimated costs for these improvements are \$13,000. Please see the detailed estimate in Appendix A for a cost breakdown.



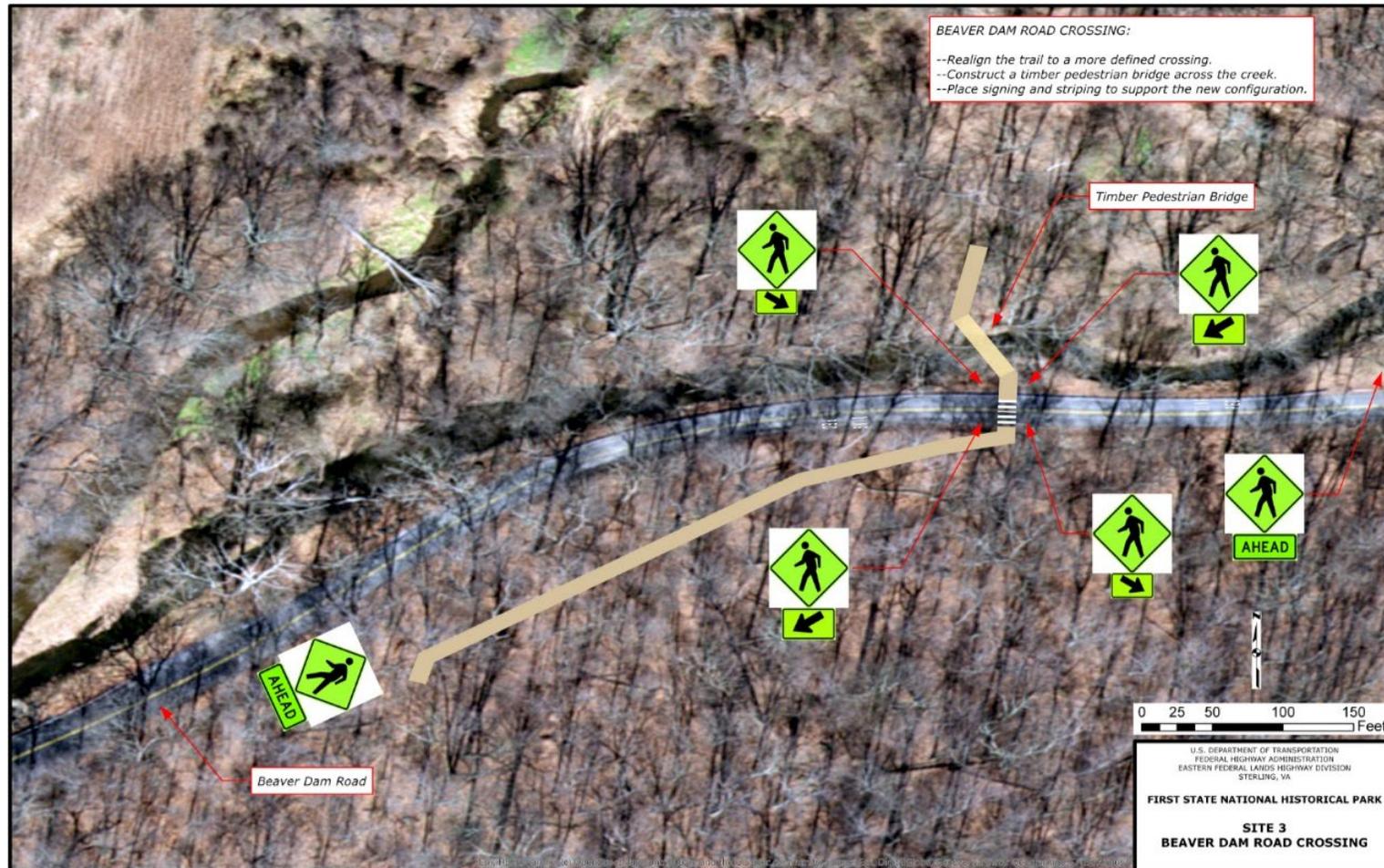
**Site 2 – Beaver Valley Road/ Beaver Dam Road Intersection**

Recommendations: Realign trails to create one aligned crossing, crosswalk pavement markings, flexible pylons with reflectors, delineate trail from driveway, stop bars, and install advance warning signs. To make stop signs more visible, LED stop signs or adding a flashing beacons can be installed. The LED stop signs are available with solar panels and have a vehicle detection option where it only blinks when it detects an oncoming vehicle. The estimated costs for these improvements are \$33,000. Please see the detailed estimate in Appendix A for a cost breakdown.



**Site 3 – Beaver Dam Road Crossing**

Recommendations: Realigning trail to provide one aligned pedestrian crossing, place advance warning signage, and trim vegetation back that is obstructing view of stop sign SW Beaver Valley Road and oncoming traffic. The estimated costs for these improvements are \$18,000. Please see the detailed estimate in Appendix A for a cost breakdown.



### Site 4 – Beaver Valley Road Crossing

Recommendations: Stabilize trailheads, add crosswalk pavement markings, “Ped Xing” pavement markings, and advance warning signage. The estimated costs for these improvements are \$9,000. Please see the detailed estimate in Appendix A for a cost breakdown.



### Site 5 – Trail Along Brandywine Creek Roadside Trail Alternative

Recommendations: Delineation of trail that travels alongside an active route with pylons until the Site 6 crossing. The estimated costs for these improvements are \$1,900. Please see the detailed estimate in Appendix A for a cost breakdown.



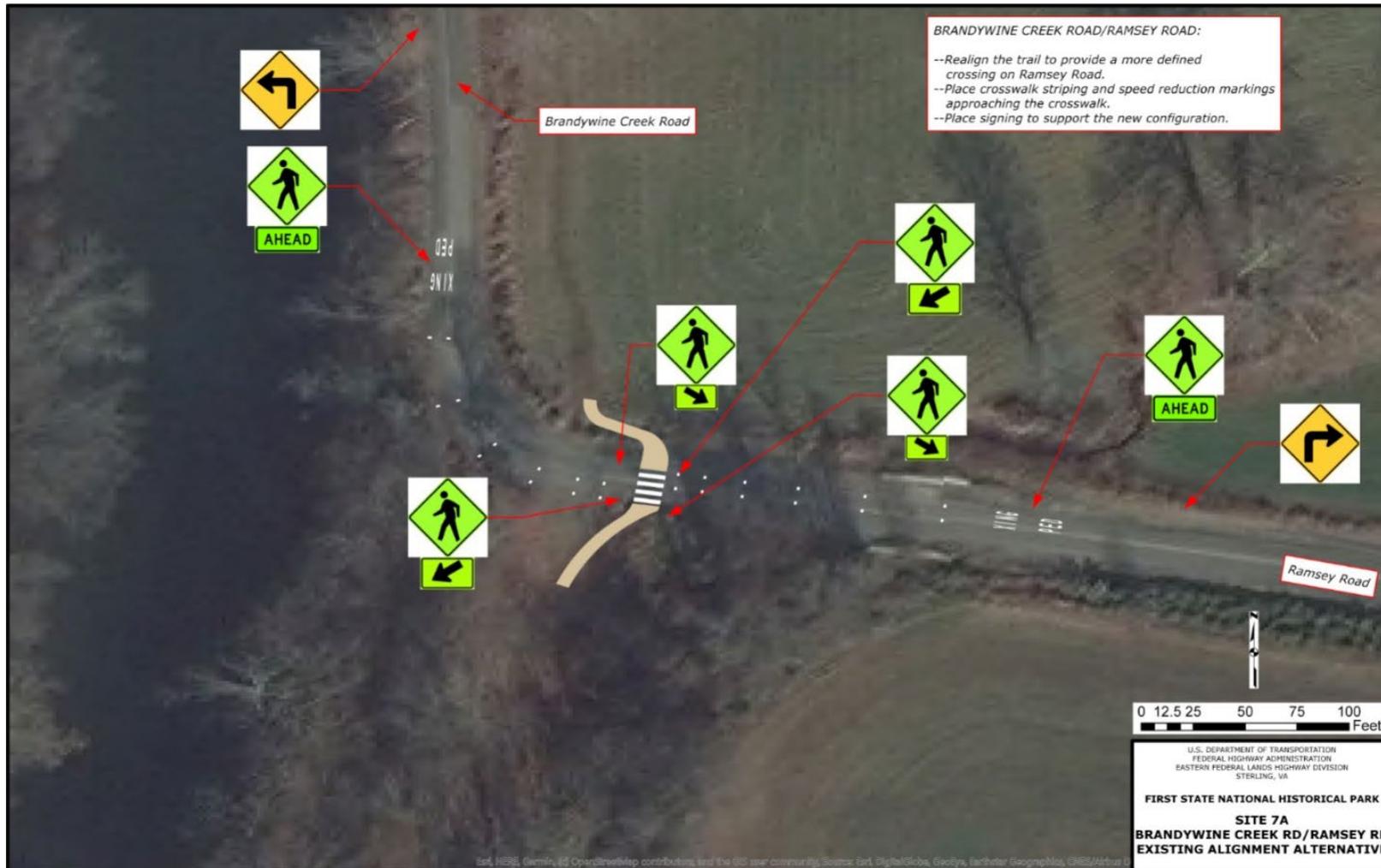
*Site 6 – Trail Along Brandywine Creek Southwest Improvements*

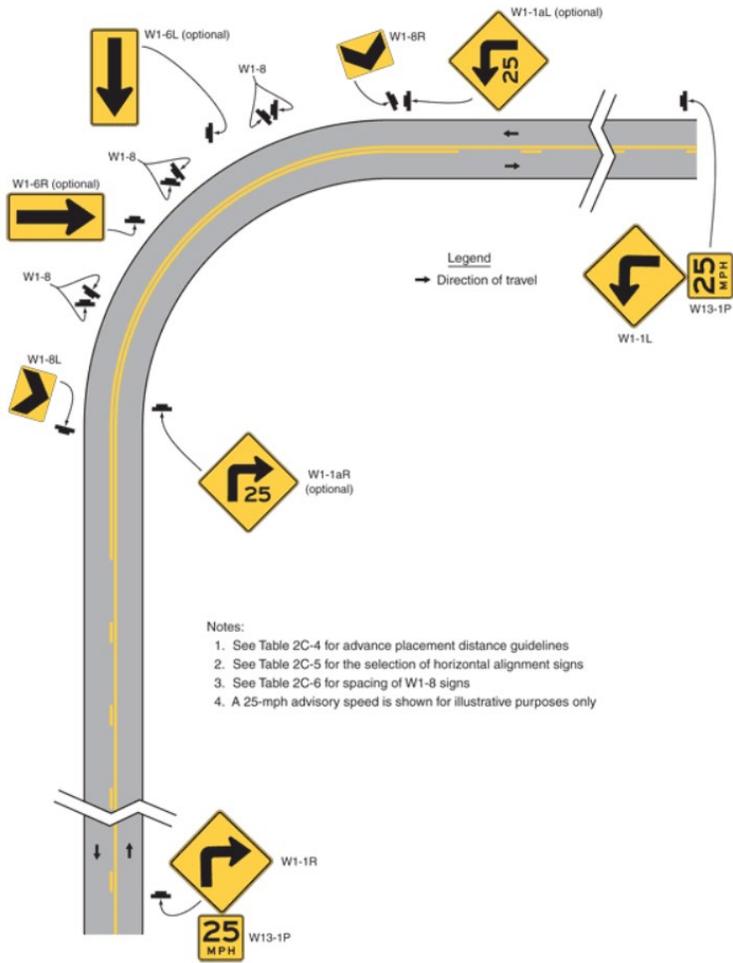
Recommendations: Add crosswalk pavement marking, advance warning signs – trail crossing ahead and trail crossing at crosswalk, trailhead/ road edge stabilization, and vegetation maintenance. The estimated costs for these improvements are \$15,000. Please see the detailed estimate in Appendix A for a cost breakdown.



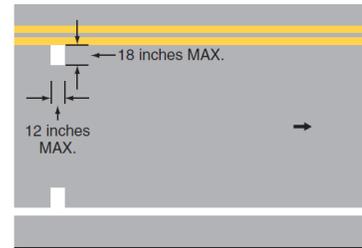
**Site 7 – Brandywine Creek Road/ Ramsey Road**

Recommendations: Advance warning signs, “Ped Xing” pavement markings, speed reduction pavement markings for vehicles to reduce speeds when approaching/ negotiating turn and trail crossing, realignment of trailheads, trailhead stabilization, and crosswalk pavement marking. The estimated costs for these improvements are \$11,000. Please see the detailed estimate in Appendix A for a cost breakdown.

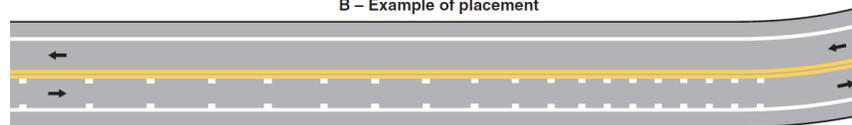




**A – Recommended dimensions**



**B – Example of placement**



Source: MUTCD Figure 2C-2 Example of Warning Signs for a Turn and Figure 3B-28 Example of the Application of Speed Reduction Pavement Markings



### Site 9 – Ramsey Road Crossing

Recommendations: Abandon south trail due to high risk concerns, post signage communicating the closed trail. Close north trailhead and post signage to discourage (prohibit) pedestrian crossing. The estimated costs for these improvements are \$21,000. Please see the detailed estimate in Appendix A for a cost breakdown.



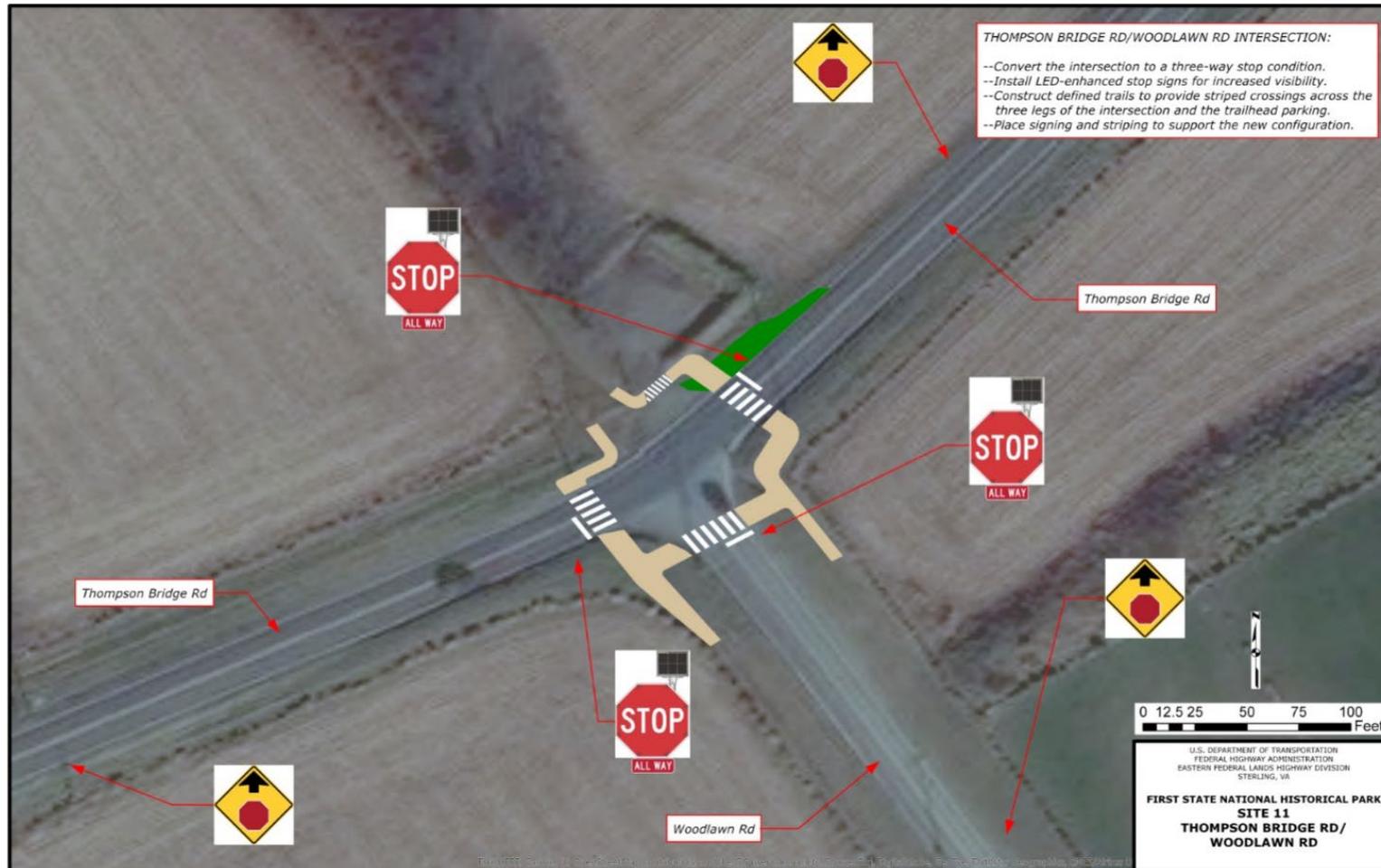
**Site 10 – Ramsey Road Crossing**

Recommendations: Realign trails/ trailheads, crosswalk pavement marking, “Ped Xing” pavement markings, and advance warning signs – trail crossing ahead and trail crossing at crosswalk. Since this is an active equestrian crossing, it is recommended that the trailheads and crosswalk pavement marking be wide enough to accommodate a horse and a walker. The estimated costs for these improvements are \$18,000. Please see the detailed estimate in Appendix A for a cost breakdown.



**Site 11 – Thompson Bridge Road and Woodlawn Road**

Improvement: Delineate/ realign trails, eliminate pull-off area at road edge in front of parking area, convert intersection to a three-way stop (see MUTCD 2B.07 guidance), add advance warning signage, add crosswalk pavement markings, and vegetation maintenance. Similar to Site 2, the LED Stop sign is also recommended for this location to catch the attention of drivers going up and down the vertical curves. The estimated costs for these improvements are \$39,000. Please see the detailed estimate in Appendix A for a cost breakdown.



**Site 12 – Thompson Bridge Road Crossing**

Recommendations: Delineate and realign trails, add crosswalk pavement marking, “Ped Xing” pavement markings, advance warning signs – trail crossing ahead and trail crossing at crosswalk, and vegetation maintenance. The estimated costs for these improvements are \$11,000. Please see the detailed estimate in Appendix A for a cost breakdown.



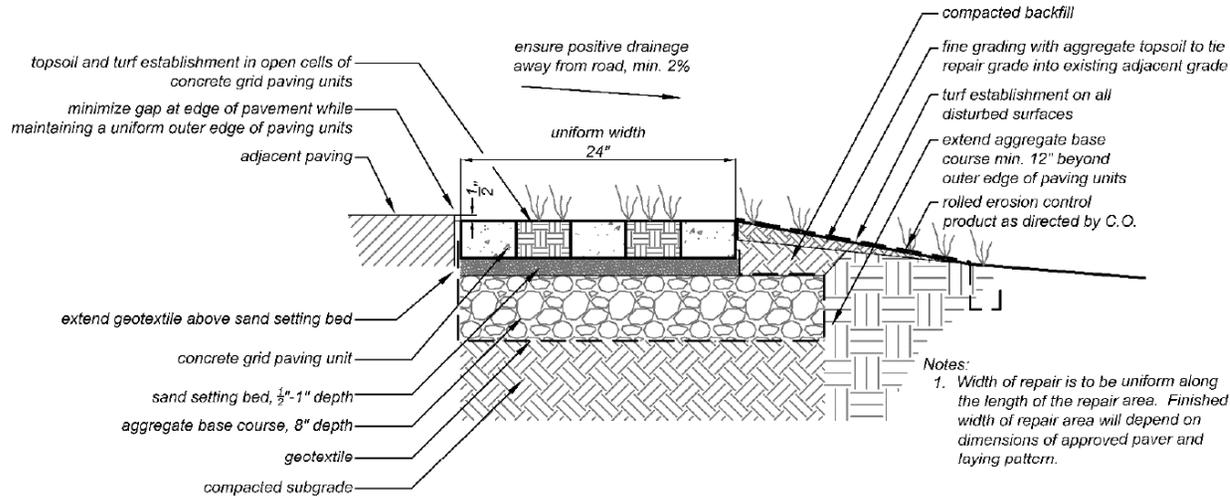
### Site 13 – Woodlawn Road Crossing

Recommendations: Delineate/ Realign trails Discontinuity between southern trails along Woodlawn Road. Trimming Vegetation (Facing NW 200 feet from trailheads). The estimated costs for these improvements are \$17,000. Please see the detailed estimate in Appendix A for a cost breakdown.



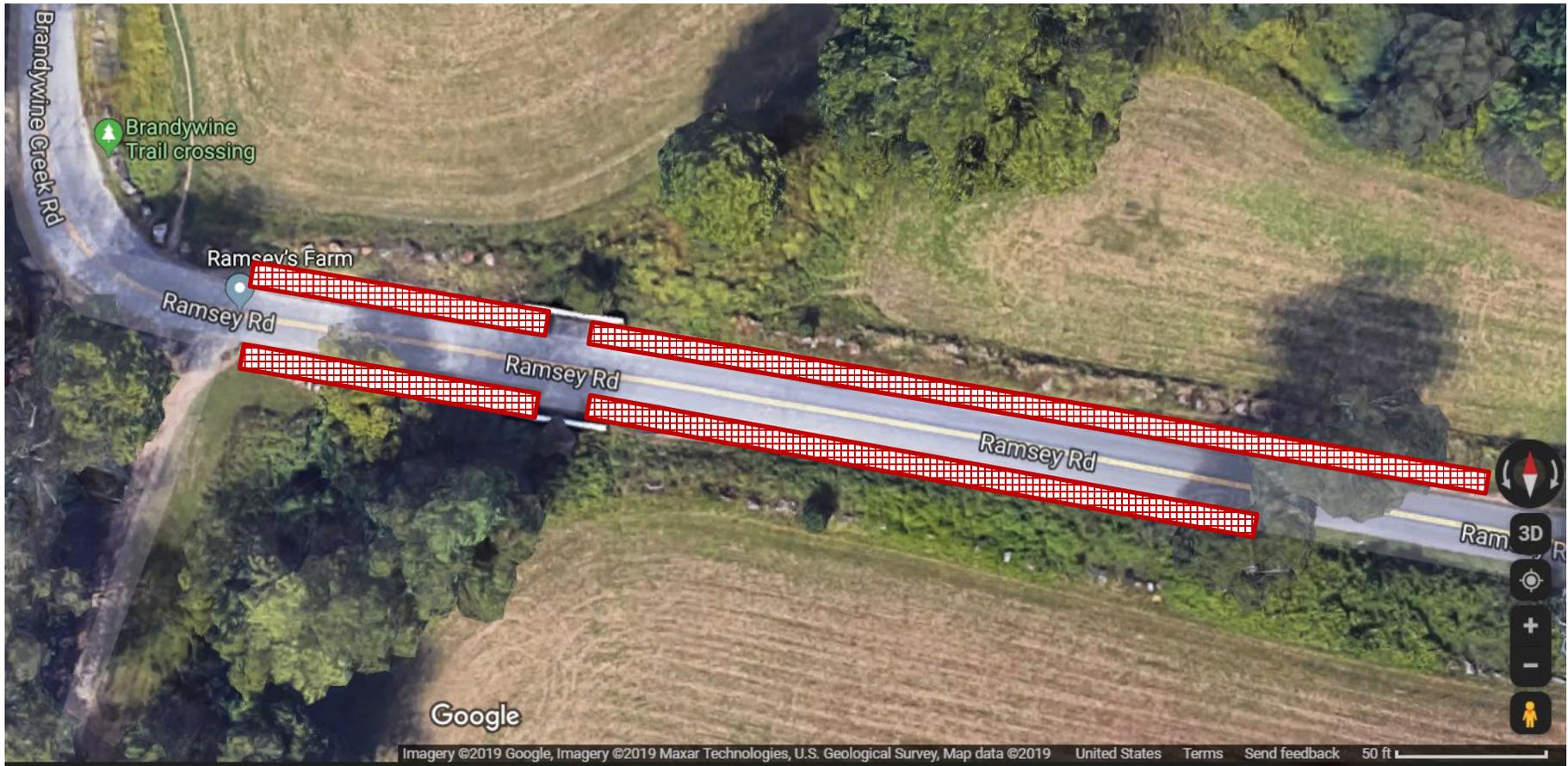
**Roadside – Multiple Locations**

Recommendations: Stabilize the roadside with concrete grid pavers. These pavers provide both safety and aesthetic benefits by providing a stable roadside with a natural look once the turf is established. The image shows a typical detail used in an application in a Coordinated Technology Implementation Program (CTIP) preliminary project on Blue Ridge Parkway. The estimated costs for these improvements are \$72,000. Please see the detailed estimate in Appendix A for a cost breakdown.



**DETAIL - TYPE A RUT REPAIR, CONCRETE GRID PAVING UNIT**  
 NOT TO SCALE

*Figure 89 - Concrete Grid Detail from Blue Ridge Parkway CTIP Project*





## 5.2 Long-Term Safety Recommendations

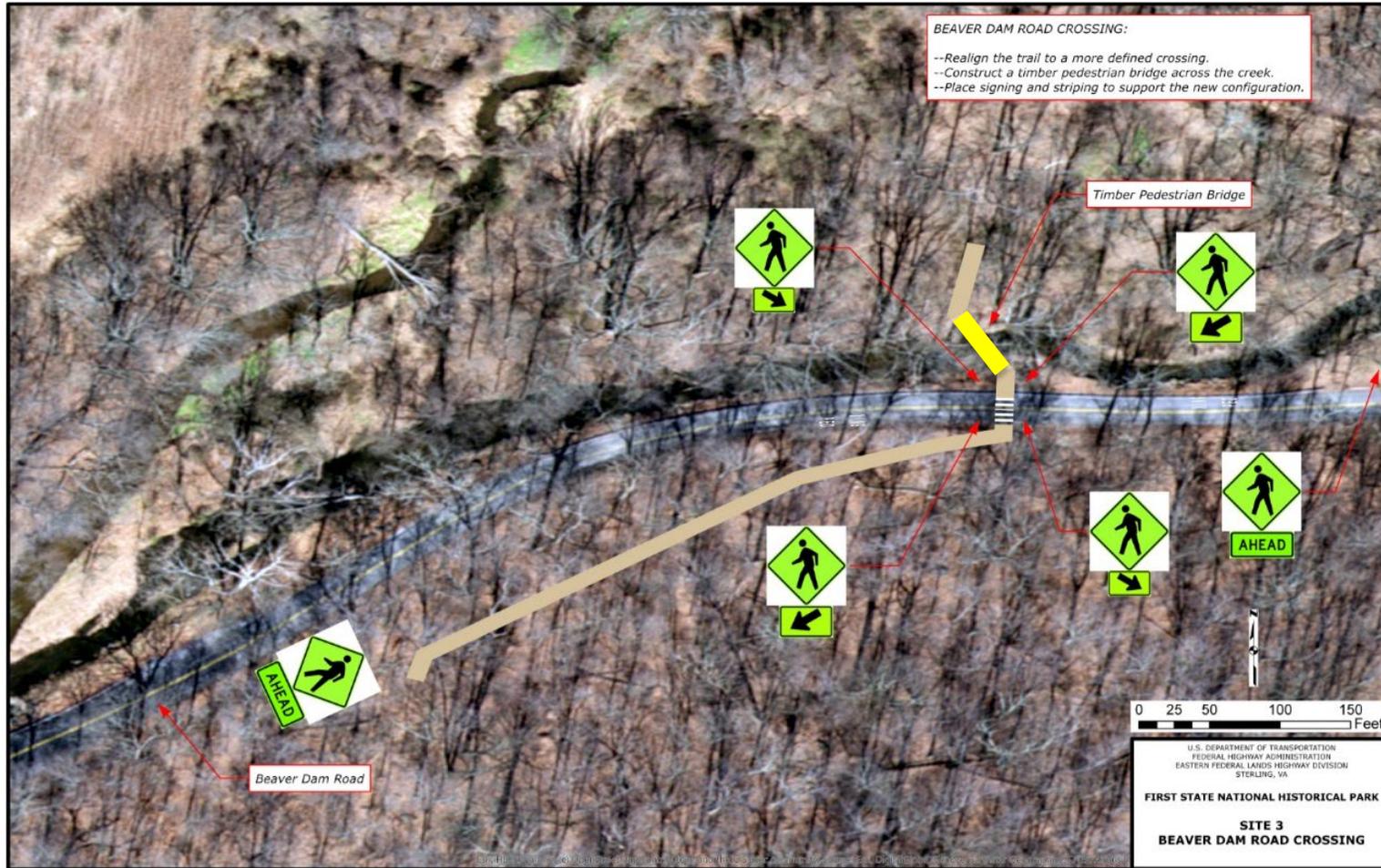
### *Site 2 – Beaver Valley Road/ Beaver Dam Road Intersection*

Recommendations: In addition to the short-term improvements described in the previous section, long-term recommendations include a timber pedestrian bridge to allow trail users access to the southern trailhead with less time inside the roadway. The estimated costs for these improvements are \$390,000. Please see the detailed estimate in Appendix A for a cost breakdown.



### Site 3 – Beaver Dam Road Crossing

Recommendations: In addition to the short-term recommendations, in the long-term the park may wish to construct a timber pedestrian bridge across the creek. The estimated costs for these improvements are \$218,000. Please see the detailed estimate in Appendix A for a cost breakdown.



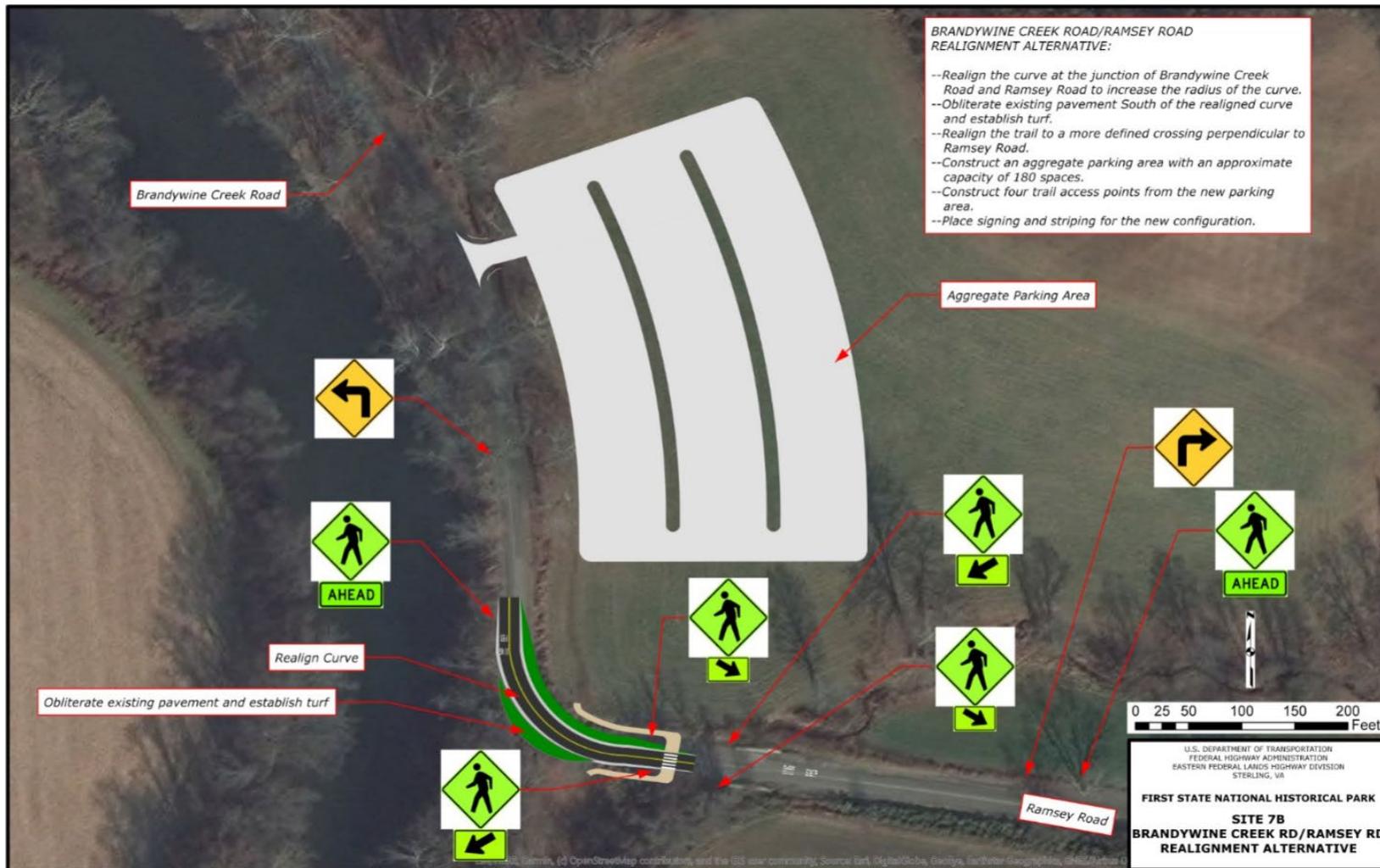
*Site 6 – Trail Along Brandywine Creek Southwest Improvements*

Recommendations: Add crosswalk pavement marking, advance warning signs – trail crossing ahead and trail crossing at crosswalk, trailhead/ road edge stabilization, timber pedestrian bridge, and vegetation maintenance. The estimated costs for these improvements are \$290,000. Please see the detailed estimate in Appendix A for a cost breakdown.



**Site 7 – Brandywine Creek Road/ Ramsey Road**

Recommendations: In addition to the short-term recommendations, the road would be realigned so that the radius of curve is increased, and an aggregate parking area would be provided to accommodate the park visitors. The new parking area would provide trail access points and wayfinding signage. The estimated costs for these improvements are \$250,000. Please see the detailed estimate in Appendix A for a cost breakdown.



In summary, the recommendations listed will increase safety for all park visitors. For example, a crash reduction of up to 41% has been shown with flashing LED Stop sign installations and crash reductions up to 25% have been shown for installations of advance warning markings and signage. A summary of the sites and their safety recommendations are provided in Table 2. A preliminary cost estimate for the suggested improvements are provided in Appendix A.

**Table 3. Safety Recommendation Summary Table**

Safety Recommendation	Recommendation is Applicable to Site:													Short or Long Term	
	1	2	3	4	5	6	7	8	9	10	11	12	13	Short	Long
AWS - Trail Crossing Ahead	X		X	X	X	X	X	X		X		X		X	
AWS - Trail Crossing	X		X	X	X	X	X	X		X		X		X	
Crosswalk Pavement Marking	X	X	X	X	X	X	X	X		X	X	X		X	
AWS - Turn/ Advisory Speed							X							X	
AWS - Stop Ahead		X									X			X	
LED Stop Sign		X									X			X	
Stop Bars		X									X			X	
Trail/ Trail Head Realignment	X	X	X			X	X	X			X	X		X	X
Wayfinding Signs	X		X				X	X		X				X	X
Flexible Pylons w/ Reflectors		X												X	
Reconfigure Roadway							X								X
Discourage Roadside Parking					X	X	X	X						X	
Eliminate Trail/ Trail Head			X						X				X	X	
Trail Head Stabilization	X		X	X	X	X	X	X		X	X	X		X	
Vegetation Maintenance	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Other Pavement Markings*							X	X						X	X
Timber Pedestrian Bridge		X	X		X										X
Concrete Grid Pavers					X	X	X							X	X

*\*Other Pavement Markings such as XING AHEAD, Speed Reduction Markings, and NO PARKING*

## **Appendix A – Cost Estimate Detail**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 1 Beaver Valley Rd

10/1/2019

**Description:** --Realign the trail to provide a more defined crosswalk across Beaver Valley Road.  
--Place signing and striping to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	105	\$ 30	\$ 3,150
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	575	\$ 2	\$ 1,150

Subtotal: \$ 9,550

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 3,343

**Total Construction Estimate (Rounded): \$ 13,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 2S Beaver Dam Rd Intersection - Short Term

10/1/2019

**Description:** --Place white reflective delineators on the vehicle bridge to separate vehicle traffic from pedestrians.  
 --Place signing and striping to configure the intersection for a 3-way stop and provide a crosswalk for trail users.  
 --Install LED-enhanced Stop sign lights for increased visibility.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	55	\$ 75	\$ 4,125
DELINEATOR, TYPE FLEXIBLE	EACH	17	\$ 60	\$ 1,020
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	625	\$ 2	\$ 1,250
SYSTEM INSTALLATION, TRAFFIC SIGNAL (LED ENHANCED STOP SIGN)	EACH	3	\$ 6,000	\$ 18,000

Subtotal: \$ 24,395

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 8,538

**Total Construction Estimate (Rounded): \$ 33,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 2L Beaver Dam Rd Intersection - Long Term

10/1/2019

**Description:** --Realign the trail and construct a timber pedestrian bridge to separate trail users from vehicular traffic.  
--Place signs and striping to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	23	\$ 30	\$ 690
NEGOTIATED PAY ITEM (CONSTRUCT TIMBER PEDESTRIAN BRIDGE)	SQYD	105	\$ 2,700	\$ 283,500

Subtotal: \$ 284,190

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 99,467

**Total Construction Estimate (Rounded): \$ 390,000**

Delaware FLAP Pedestrian Safety Analysis  
 Preliminary Estimate  
 Site 3S Beaver Dam Rd - Short Term  
 10/1/2019

**Description:** --Realign the trail to a more defined crossing.  
 --Place signing and striping to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	230	\$ 30	\$ 6,900
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	550	\$ 2	\$ 1,100

---

Subtotal: \$ 13,250

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 4,638

**Total Construction Estimate (Rounded): \$ 18,000**

**Delaware FLAP Pedestrian Safety**

**Analysis Preliminary Estimate**

Site 3L Beaver Dam Rd - Long Term

10/1/2019

- Description:**
- Realign the trail to a more defined crossing.
  - Construct a timber pedestrian bridge across the creek.
  - Place signing and striping to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	230	\$ 30	\$ 6,900
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	550	\$ 2	\$ 1,100
NEGOTIATED PAY ITEM (CONSTRUCT TIMBER PEDESTRIAN BRIDGE)	SQYD	55	\$ 2,700	\$ 148,500

Subtotal: \$ 161,750

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 56,613

**Total Construction Estimate (Rounded): \$ 218,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

Site 4 Beaver Valley Rd Crossing  
10/1/2019

*Description:* --Place signing and striping to define a crosswalk across Beaver Valley Road.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	525	\$ 2	\$ 1,050

Subtotal: \$ 6,300

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 2,205

**Total Construction Estimate (Rounded): \$ 9,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

Site 5A Brandywine Creek Rd East Trail  
10/1/2019

**Description:** --Construct white reflective tubular delineators along the trail crossing on the Brandywine Creek Road vehicle bridge.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
DELINEATOR, TYPE FLEXIBLE	EACH	23	\$ 60	\$ 1,380

Subtotal: \$ 1,380

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 483

**Total Construction Estimate (Rounded): \$ 1,900**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 5B      Brandywine Creek Rd East Trail

10/1/2019

**Description:** --Realign the trail away from the vehicle bridge and construct a timber pedestrian bridge parallel to the vehicle bridge.  
 --Provide trail connections to the existing trail as well as the Site 6 trail.  
 --Place boulders to direct trail users away from the vehicle bridge to the new pedestrian bridge.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
BOULDER	EACH	7	\$ 700	\$ 4,900
AGGREGATE SURFACE COURSE	TON	70	\$ 30	\$ 2,100
NEGOTIATED PAY ITEM (CONSTRUCT TIMBER PEDESTRIAN BRIDGE)	SQYD	75	\$ 2,700	\$ 202,500

Subtotal: \$ 209,500

Mobilization, Survey/Staking, Testing, Additional Contingency:      35%      \$ 73,325

**Total Construction Estimate (Rounded): \$ 290,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 6            Brandywine Creek Rd West Trail

10/1/2019

**Description:**    --Place striping to define a more perpendicular crosswalk across Brandywine Creek Road.  
                          --Place boulders to direct trail users away from the old crosswalk and to the new one.  
                          --Place signing to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
BOULDER	EACH	7	\$ 700	\$ 4,900
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	290	\$ 2	\$ 580

Subtotal: \$ 10,730

Mobilization, Survey/Staking, Testing, Additional Contingency:    35%    \$ 3,756

**Total Construction Estimate (Rounded):    \$ 15,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

Site 7A Brandywine Creek Rd  
10/1/2019

**Description:** --Realign the trail to provide a more defined crossing on Ramsey Road.  
--Place crosswalk striping and speed reduction markings approaching the crosswalk.  
--Place signing to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	29	\$ 30	\$ 870
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	75	\$ 75	\$ 5,625
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	625	\$ 2	\$ 1,250

Subtotal: \$ 7,745

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 2,711

**Total Construction Estimate (Rounded): \$ 11,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

**Site 7B      Brandywine Creek Rd  
10/1/2019**

- Description:**
- Realign the curve at the junction of Brandywine Creek Road and Ramsey Road to increase the radius of the curve.
  - Obliterate existing pavement South of the realigned curve and establish turf.
  - Realign the trail to a more defined crossing perpendicular to Ramsey Road.
  - Construct an aggregate parking area with an approximate capacity of 180 spaces.
  - Construct four trail access points from the new parking area.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
REMOVAL OF PAVEMENT, ASPHALT	SQYD	280	\$ 7	\$ 1,960
ROADWAY EXCAVATION	CUYD	60	\$ 15	\$ 900
UNCLASSIFIED BORROW	CUYD	160	\$ 15	\$ 2,400
AGGREGATE SURFACE COURSE	TON	4,000	\$ 30	\$ 120,000
ASPHALT CONCRETE PAVEMENT, GYRATORY MIX, 3/8-INCH NOMINAL MAXIMUM SIZE AGGREGATE, 0.3 TO <3 MILLION ESAL	TON	65	\$ 200	\$ 13,000
ASPHALT CONCRETE PAVEMENT, GYRATORY MIX, 3/4-INCH NOMINAL MAXIMUM SIZE AGGREGATE, 0.3 TO <3 MILLION ESAL	TON	95	\$ 200	\$ 19,000
ASPHALT PAVEMENT MILLING, 2-INCH DEPTH	SQYD	470	\$ 30	\$ 14,100
TURF ESTABLISHMENT	SQYD	110	\$ 10	\$ 1,100
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	75	\$ 75	\$ 5,625
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	1,500	\$ 2	\$ 3,000

Subtotal: \$ 181,085

Mobilization, Survey/Staking, Testing, Additional Contingency:      35%      \$ 63,380

**Total Construction Estimate (Rounded): \$ 250,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

**Site 8            Woodlawn Parking Crossing  
10/1/2019**

**Description:**    --Realign the trail to a more defined crosswalk.  
                          --Place signing and striping for the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	95	\$ 30	\$ 2,850
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	525	\$ 2	\$ 1,050

Subtotal: \$ 9,150

Mobilization, Survey/Staking, Testing, Additional Contingency:    35%    \$ 3,203

**Total Construction Estimate (Rounded):    \$ 13,000**

**Delaware FLAP Pedestrian Safety Analysis**  
**Preliminary Estimate**  
**Site 9 Ramsey Rd**  
**10/1/2019**

**Description:** --Abandon the existing North and South trailheads by placing boulders to close the trailheads.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
BOULDER	EACH	22	\$ 700	\$ 15,400

Subtotal: \$ 15,400

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 5,390

**Total Construction Estimate (Rounded): \$ 21,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

Site 10 Ramsey Rd

10/1/2019

- Description:**
- Construct a more defined roadway crossing.
  - Obliterate the existing crossing, establish turf and place boulders to direct trail users to the new crossing.
  - Place signing and striping for the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
BOULDER	EACH	7	\$ 700	\$ 4,900
AGGREGATE SURFACE COURSE	TON	39	\$ 30	\$ 1,170
TURF ESTABLISHMENT	SQYD	31	\$ 10	\$ 310
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	725	\$ 2	\$ 1,450

Subtotal: \$ 13,080

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 4,578

**Total Construction Estimate (Rounded): \$ 18,000**

**Delaware FLAP Pedestrian Safety Analysis  
Preliminary Estimate**

**Site 11 Thompson Bridge Rd  
10/1/2019**

**Description:** --Construct defined trails to provide striped crossings across the three legs of the intersection and the trailhead parking.  
--Place signing and striping to support the new configuration.

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
AGGREGATE SURFACE COURSE	TON	100	\$ 30	\$ 3,000
TURF ESTABLISHMENT	SQYD	60	\$ 10	\$ 600
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	55	\$ 75	\$ 4,125
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	1,400	\$ 2	\$ 2,800
SYSTEM INSTALLATION, TRAFFIC SIGNAL (LED ENHANCED STOP SIGN)	EACH	3	\$ 6,000	\$ 18,000

Subtotal: \$ 28,525

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 9,984

**Total Construction Estimate (Rounded): \$ 39,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

**Site 12 Thompson Bridge Rd**

**10/1/2019**

**Description:** --Realign the trail and construct a striped crosswalk to direct trail users to a single perpendicular roadway crossing.  
--Place signs and striping to support the new configuration.

**Quantities:**

<b>Description</b>	<b>Unit</b>	<b>Quantity</b>	<b>Unit Price</b>	<b>Total</b>
AGGREGATE SURFACE COURSE	TON	39	\$ 30	\$ 1,170
SIGNS, ALUMINUM PANELS, TYPE 3 SHEETING	SQFT	70	\$ 75	\$ 5,250
PAVEMENT MARKINGS, TYPE B, SOLID	LNFT	575	\$ 2	\$ 1,150

Subtotal: \$ 7,570

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 2,650

**Total Construction Estimate (Rounded): \$ 11,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

**Site 13 Woodlawn Rd Crossing**

**10/1/2019**

**Description:** --Abandon the North trailhead by establishing turf and installing boulders.

**Quantities:**

<b>Description</b>	<b>Unit</b>	<b>Quantity</b>	<b>Unit Price</b>	<b>Total</b>
BOULDER	EACH	17	\$ 700	\$ 11,900
TURF ESTABLISHMENT	SQYD	18	\$ 10	\$ 180

Subtotal: \$ 12,080

Mobilization, Survey/Staking, Testing, Additional Contingency: 35% \$ 4,228

**Total Construction Estimate (Rounded): \$ 17,000**

**Delaware FLAP Pedestrian Safety Analysis**

**Preliminary Estimate**

**Roadway – Various Locations**

**10/7/19**

**Description:** -- Remove existing plastic geogrid and replace with concrete geogrid pavers  
-- Install concrete geogrid pavers where existing road edge rutting is present

**Quantities:**

Description	Unit	Quantity	Unit Price	Total
Ramsey Road	LF	642	\$ 56	\$ 35,952
Brandywine Creek Road	LF	300	\$ 56	\$ 16,800

Subtotal: \$52,752

Contingency: 35% \$18,463

Total Construction Estimate: \$72,000