



Memorandum

To: Jimmy Terry, PE
 TGS Engineers
 804-C N. Lafayette Street
 Shelby, NC 28150

Date: October 23, 2020

Project #: 38536.39

From: Andrew Topp, PE, PTOE

Re: STIP Project No. A-0009C - Passing and Climbing Lane Justification
 Graham County, NC

The above referenced project proposes to implement a 2+1 (alternating passing lanes) cross-section design along NC 143 and NC 28 in Graham County, NC. The construction of a 2+1 design will improve mobility along both corridors by allowing vehicles to efficiently pass slow moving vehicles and trucks while maintaining their direction of travel and minimizing crossings into the opposing lane of traffic. Table 1 identifies the proposed locations of the 2+1 design (locations based on Figures 1-4 in the Appendix) along with climbing lanes located on steep grades and characterizes elements that support the implementation of that design.

As reported in the traffic analysis for this study, the improvements result in a corridor-wide average speed benefit of several miles per hour and improved reliability. Each direction and peak period experiences reliability benefits, however the largest improvement occurs the mountainous section between Cheoah and Stecoah. In this area, travel time variability reduces from 15 minutes in the No-Build condition to less than 8 minutes in the Build condition in the PM peak westbound direction due to the passing and climbing lanes installed.

Table 1: Passing and Climbing Lane Justification

Proposed Passing/ Climbing Lane Location	Associated Figure # (Hydraulic Site No.)	Reasons for Implementation	Standards
NC 143 SB Passing Lane (1,684 ft)	Figure 1 (Site 3, 4)	<ul style="list-style-type: none"> Rolling terrain¹ Located in curve that diminishes sight distance² Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 NB Climbing Lane (2,569 ft)	Figure 1	<ul style="list-style-type: none"> Steep grade (approx. 4%)⁴ Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.3) – Climbing Lanes Highway Capacity Manual (Chapter 15)
NC 143 SB Climbing Lane (5,144 ft)	Figure 1 (Site 5, 6)	<ul style="list-style-type: none"> Steep grade (approx. 3% and higher)⁴ Located in multiple curves² Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.3) – Climbing Lanes AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)



Memorandum

Proposed Passing/ Climbing Lane Location	Associated Figure # (Hydraulic Site No.)	Reasons for Implementation	Standards
NC 143 NB Climbing Lane (2,601 ft)	Figure 2 (Site 7)	<ul style="list-style-type: none"> Rolling terrain and an opportunity to pass trucks before a series of curves^{4 5} Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.3) – Climbing Lanes AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 SB Passing Lane (3,095 ft)	Figure 2 (Site 8)	<ul style="list-style-type: none"> Sight distance is impaired due to curve² Steep grade (approx. 3% and higher into curve)¹ Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 NB Passing Lane (2,802 ft)	Figure 2	<ul style="list-style-type: none"> Slight grade and rolling terrain¹ Located in curve that diminishes sight distance² Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 SB Passing Lane (2,133 ft)	Figure 3 (Site 9)	<ul style="list-style-type: none"> Opportunity to pass vehicles before a series of curves⁵ Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 NB Climbing Lane (11,299 ft)	Figure 3 (Site 10)	<ul style="list-style-type: none"> Steep grade (8%) and located in a series of tight curves that diminish sight distance⁴ Climbing lane gives the opportunity to pass trucks and slow-moving vehicles⁵ Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.3) – Climbing Lanes AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)
NC 143 SB Climbing Lane (10,075 ft)	Figure 3	<ul style="list-style-type: none"> Steep grade (8%) and located in a series of tight curves that diminish sight distance⁴ Climbing lane gives the opportunity to pass trucks and slow-moving vehicles⁵ Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> AASHTO Green Book (Section 3.4.3) – Climbing Lanes AASHTO Green Book (Section 3.4.4) – Passing Lanes Highway Capacity Manual (Chapter 15)



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Proposed Passing/ Climbing Lane Location	Associated Figure # (Hydraulic Site No.)	Reasons for Implementation	Standards
NC 28 WB Climbing Lane (6,724 ft)	Figure 3 (Site 21, 22)	<ul style="list-style-type: none"> • Steep grade (7%) and located in a series of tight curves that diminish sight distance⁴ • Climbing lane gives the opportunity to pass trucks and slow-moving vehicles⁵ • Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> • AASHTO Green Book (Section 3.4.3) – Climbing Lanes • AASHTO Green Book (Section 3.4.4) – Passing Lanes • Highway Capacity Manual (Chapter 15)
NC 28 WB Passing Lane (1,487 ft)	Figure 4	<ul style="list-style-type: none"> • Steep grade (7%) and located before a major curve¹ • Passing lane gives the opportunity to pass slow-moving vehicles and vehicles turning off the mainline onto the smaller y-line roadways⁵ • Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> • AASHTO Green Book (Section 3.4.4) – Passing Lanes • Highway Capacity Manual (Chapter 15)
NC 28 EB Passing Lane (5,162 ft)	Figure 4 (Site 24-26)	<ul style="list-style-type: none"> • Grade (approx. 5%) and located before a series of curves¹ • Passing lane gives the opportunity to pass slow-moving vehicles and vehicles turning off the mainline onto the smaller y-line roadways⁵ • Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> • AASHTO Green Book (Section 3.4.4) – Passing Lanes • Highway Capacity Manual (Chapter 15)
NC 28 EB Climbing Lane (2,221 ft)	Figure 4	<ul style="list-style-type: none"> • Steep grade (approx. 7%) and located in a curve⁴ • Climbing lane gives the opportunity to pass slow-moving trucks and vehicles turning off the mainline onto the smaller y-line roadways and other destinations⁵ • Increased travel speed and reduced percentage time spent following³ 	<ul style="list-style-type: none"> • AASHTO Green Book (Section 3.4.3) – Climbing Lanes • AASHTO Green Book (Section 3.4.4) – Passing Lanes • Highway Capacity Manual (Chapter 15)

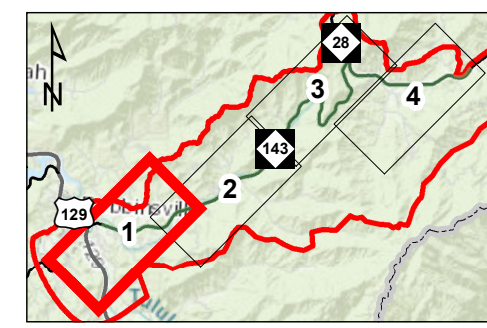
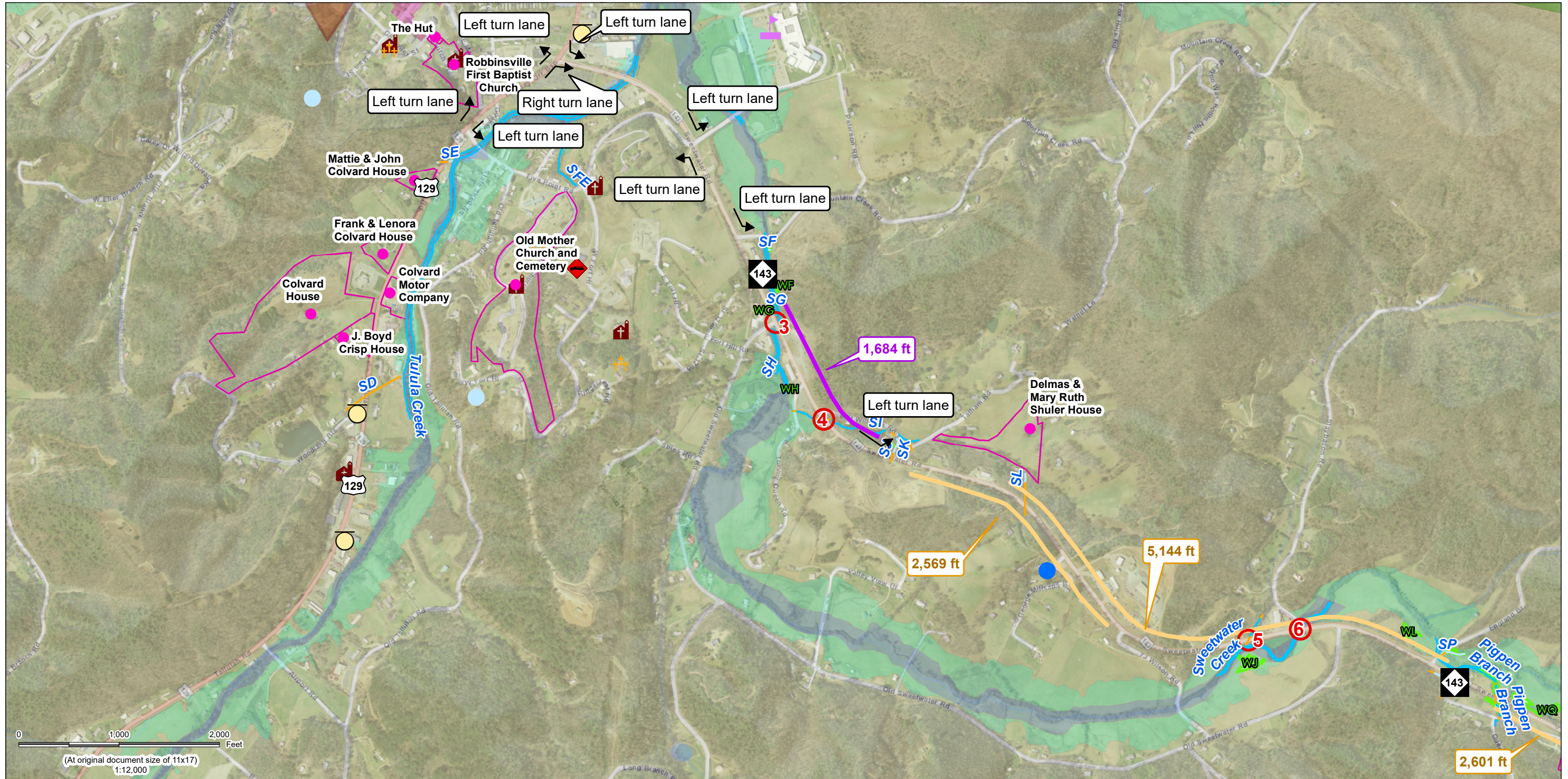
¹ Where a sufficient number and length of passing sections cannot be obtained in the design of horizontal and vertical alignment alone, an occasional added lane in one or both directions of travel may be introduced to provide more passing opportunities. Such sections are particularly advantageous in rolling terrain, especially where alignment is winding, or the profile includes critical lengths of grade. (AASHTO Green Book – 3.4.4)

From: Andrew Topp, PE, PTOE
Ref: 38536.39
October 23, 2020
Page 4




Memorandum

- ² The value of a passing lane is more obvious at locations where passing sight distance is restricted. (AASHTO Green Book – 3.4.4)
- ³ Within the passing lane, the average travel speed is generally between 8% and 11% higher than its upstream value and the percent time spent following is generally 58% to 62% of its upstream value. Within the climbing lane, there is a 7% improvement in ATS and 80% improvement in PTSF. (Highway Capacity Manual – Chapter 15, Part 4)
- ⁴ Adding a climbing lane for an upgrade on a two-lane highway can offset the decline in traffic operations caused by the combined effects of the grade, traffic volume, and heavy vehicles. (AASHTO Green Book – 3.4.3)
- ⁵ Passing lanes can also be provided to improve overall traffic operations on two-lane highways by reducing delays caused by inadequate passing opportunities over significant lengths of highways. (AASHTO Green Book – 3.4.4)



Legend

- Passing Lanes
- Climbing Lanes
- Hydraulic Site
- + Cemetery
- ♦ Graham County Fire Dept
- ⛪ Religious Facility
- ⚡ Daycare/School
- Water Supply Intakes
- Water Tanks
- Regional Underground Storage Tanks
- Recommended Eligible District
- NRHP Boundaries
- ~ Potential Jurisdictional Perennial Stream
- ~ Potential Jurisdictional Intermittent Stream
- Select Culverts/Pipes/Bridges
- Potential Jurisdictional Wetland
- Floodplain
- Floodway
- Geologic Map Unit Zwe
- Tribal Land

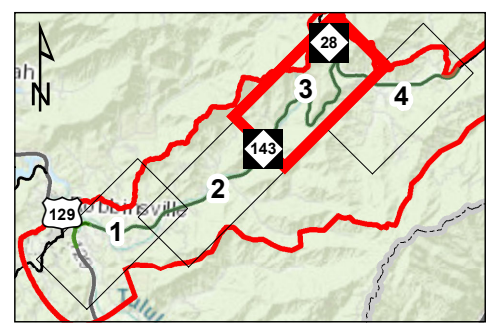
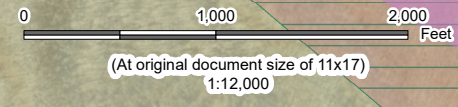
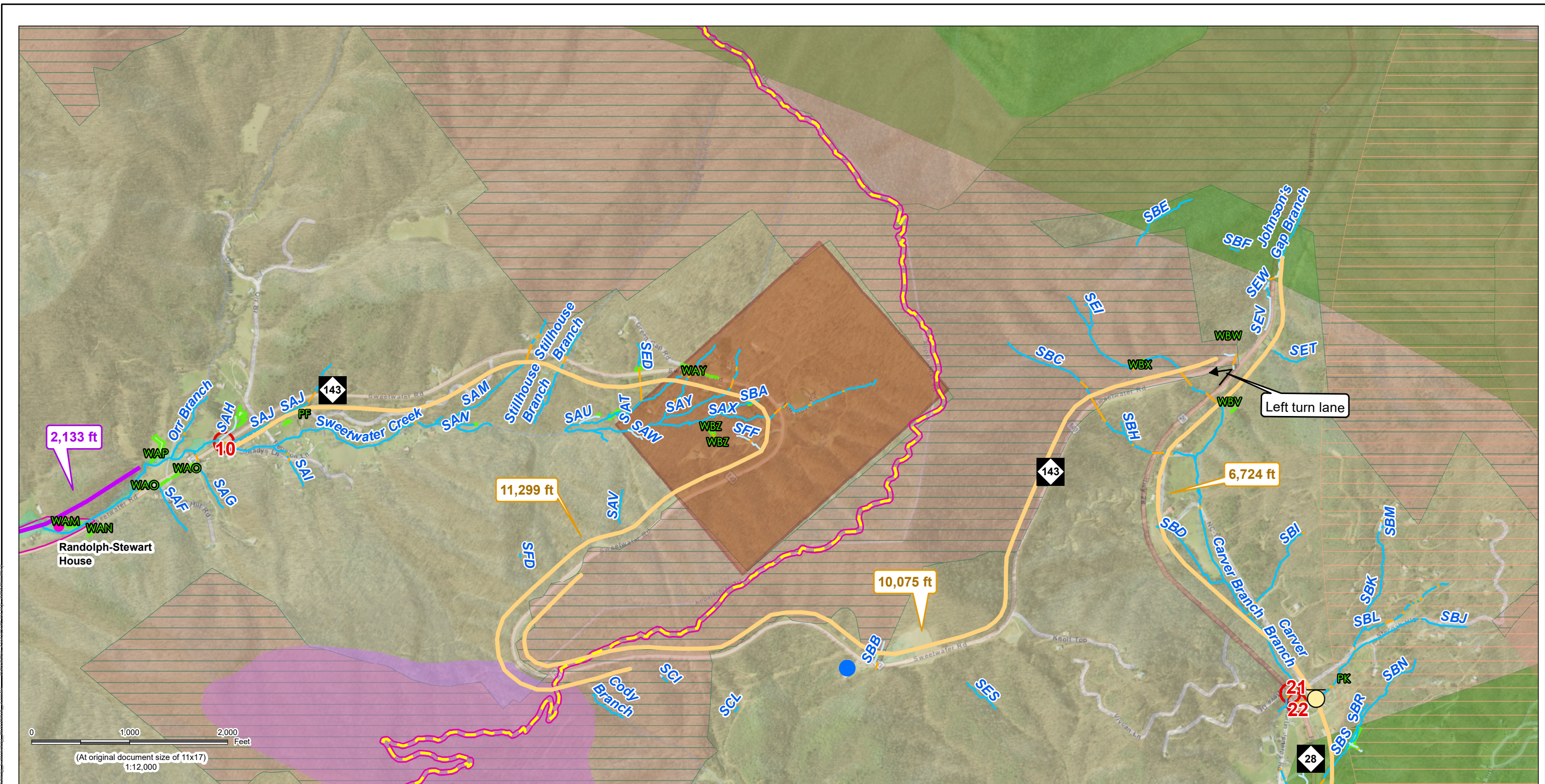

NC DEPARTMENT OF TRANSPORTATION
 DIVISION OF HIGHWAYS
 DIVISION 14

Project Location: Graham County, NC
 Client/Project: NCDOT - Division 14
 Corridor K Improvements
 STIP Project No. A-0009C

Prepared by ECL on 2020-01-13
 Revised by ALK on 2020-03-31


Figure No. **1**
 Title **Passing & Climbing Sections**

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- Legend**
- Passing Lanes
 - Climbing Lanes
 - Hydraulic Site
 - Water Supply Intakes
 - Regional Underground Storage Tanks
 - Historic Architecture**
 - Recommended Eligible
 - NRHP Boundaries
 - Appalachian Trail
 - Potential Jurisdictional Perennial Stream
 - Potential Jurisdictional Intermittent Stream
 - Select Culverts/Pipes/Bridges
 - Potential Jurisdictional Wetland
 - Floodplain
 - Indiana Bat Potential Habitat
 - National Forest System Lands
 - Geologic Map Unit Zwe
 - Tribal Land
 - Natural Heritage Program Areas
 - Game Lands



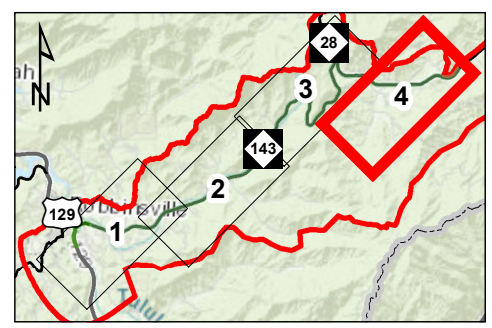
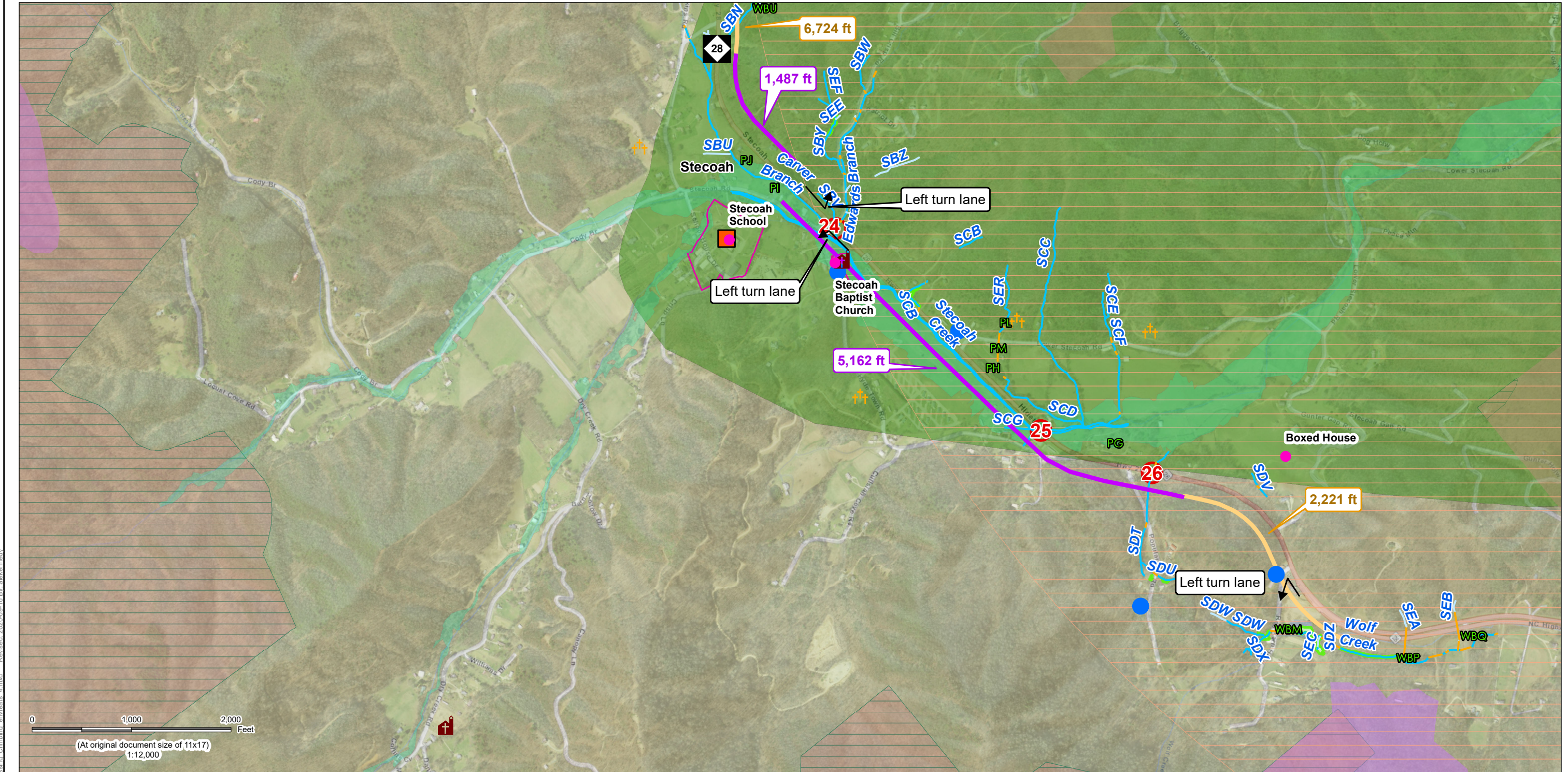

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 DIVISION OF HIGHWAYS
 DIVISION 14

Project Location: Graham County, NC
 Client/Project: NCDOT - Division 14
 Corridor K Improvements
 STIP Project No. A-0009C

Figure No. **3**
 Title **Passing & Climbing Sections**

Prepared by ECL on 2020-01-21
 Revised by ALK on 2020-03-31

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- Legend**
- Passing Lanes
 - Climbing Lanes
 - Hydraulic Site
 - Cemetery
 - Stecoah Valley Center
 - Religious Facility
 - Water Supply Intakes

- Historic Architecture**
- Recommended Eligible
 - NRHP Boundaries
 - Potential Jurisdictional Perennial Stream
 - Potential Jurisdictional Intermittent Stream
 - Select Culverts/Pipes/Bridges
 - Potential Jurisdictional Wetland
 - Floodplain

- Indiana Bat Potential Habitat
- National Forest System Lands
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Figure No. 4
Title: **Passing & Climbing Sections**

