



DESIGN STUDY REPORT

CORRIDOR K, APPALACHIAN HIGHWAY DEVELOPMENT SYSTEM
STIP PROJECT No. A-0009

The findings of this report are preliminary in nature and may change as a result of stakeholder engagement, project team coordination, and upcoming public meetings on February 12 and February 14, 2019.



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Toolbar >> View >> Page Display >> Two Page View

The screenshot shows the Adobe Acrobat Pro interface with the 'Page Display' menu open, highlighting the 'Two Page View' option. The main workspace displays a map of the Stecoah Valley corridor, showing the proposed alignment in pink and various geographical features and landmarks. To the right, a document titled 'Scenario S-1' is displayed in a two-page view, detailing the corridor's impact on various resources and listing design factors and construction costs.

Map Legend:

- Quantum Points
- Locally Identified Hot Spots
- Quantum Hot Spots
- Grade Exceptions
- Appalachian Trail Waypoints
- Appalachian Trail
- Existing Road
- Streams
- NFS Lands
- EBCI Tribal Land Holdings
- Scenario S-1
- Tunnel
- Bridge

Design Factors¹ (Level 1 Screening)

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)	Design Factors ¹ (Level 1 Screening)	Construction Cost ⁴	
AG	7.6	4,190	1,207	16	32	0.40 (5%)	\$134 M
Total	7.6	4,190	1,207	16	32	0.40 (5%)	\$134 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
3. Grade exceptions include grades exceeding desired grade of 6%.
4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

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STIP PROJECT No. A-0009



Prepared for
FEDERAL HIGHWAY ADMINISTRATION
NCDOT HIGHWAY DIVISION 14

Prepared by
STANTEC CONSULTING SERVICES INC.
TGS ENGINEERS

ACKNOWLEDGEMENTS

Thank you to the entire A-0009 project team and other individuals and organizations that committed their time, energy, and resources to this effort.

This design study would not have been possible without the support of many throughout the process.

Special thanks to:

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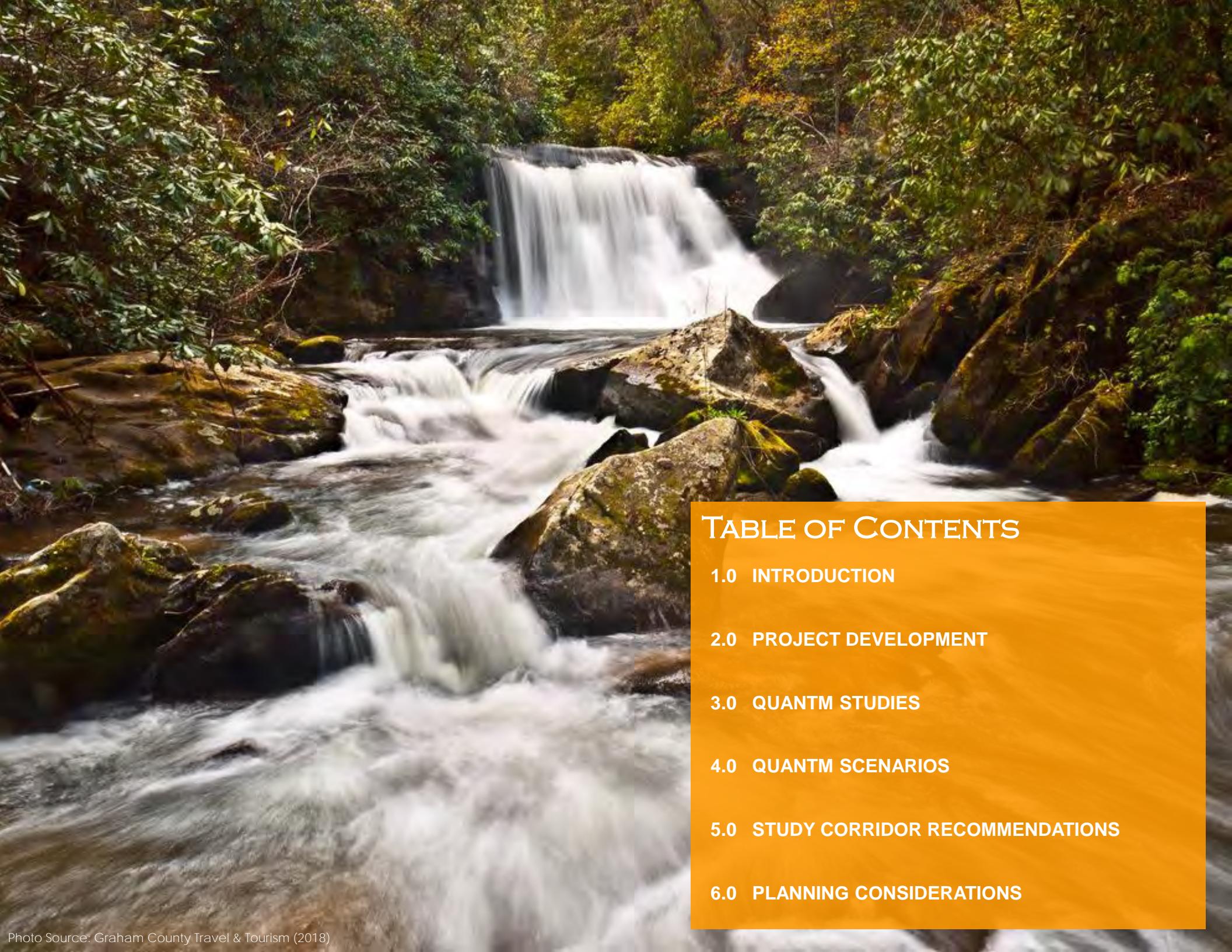


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INTRODUCTION

New studies for A-0009 were officially kicked off in July 2015 with a transportation and resource agency leadership meeting where themes were identified for a new project approach.

During the early stages of the restart, it was noted that the new approach should consider the role of ADHS funding on project development. In other words, the project has limited ADHS funding which will ultimately shape what is constructed. As such, before initiating environmental studies, the team needed to better define the project scope past the general descriptions contained in county transportation plans and the STIP.

The A-0009 process was developed to bridge the gap between Cherokee and Graham Counties' Transportation Plans and what specifically will be studied under the National Environmental Policy Act (NEPA).

Although specific elements of the project are still being explored, a "fresh look" approach with a focus on early and ongoing collaboration was developed to help avoid schedule delays by addressing impasses as they developed.

The A-0009 process was developed in recognition of the recommendations contained in the 2011 U.S. Institute for Environmental Conflict Resolution's report, notably: "An atmosphere of exploration will need to be created in the interagency meetings so that preliminary ideas can be expressed freely..." The proposed approach incorporates this recommendation by including an iterative process that allows for the exploration and subsequent refinement of the project scope within the bounds of this "pre-NEPA" process.

The project team is currently at the point of evaluating design options as documented in this Design Study Report.

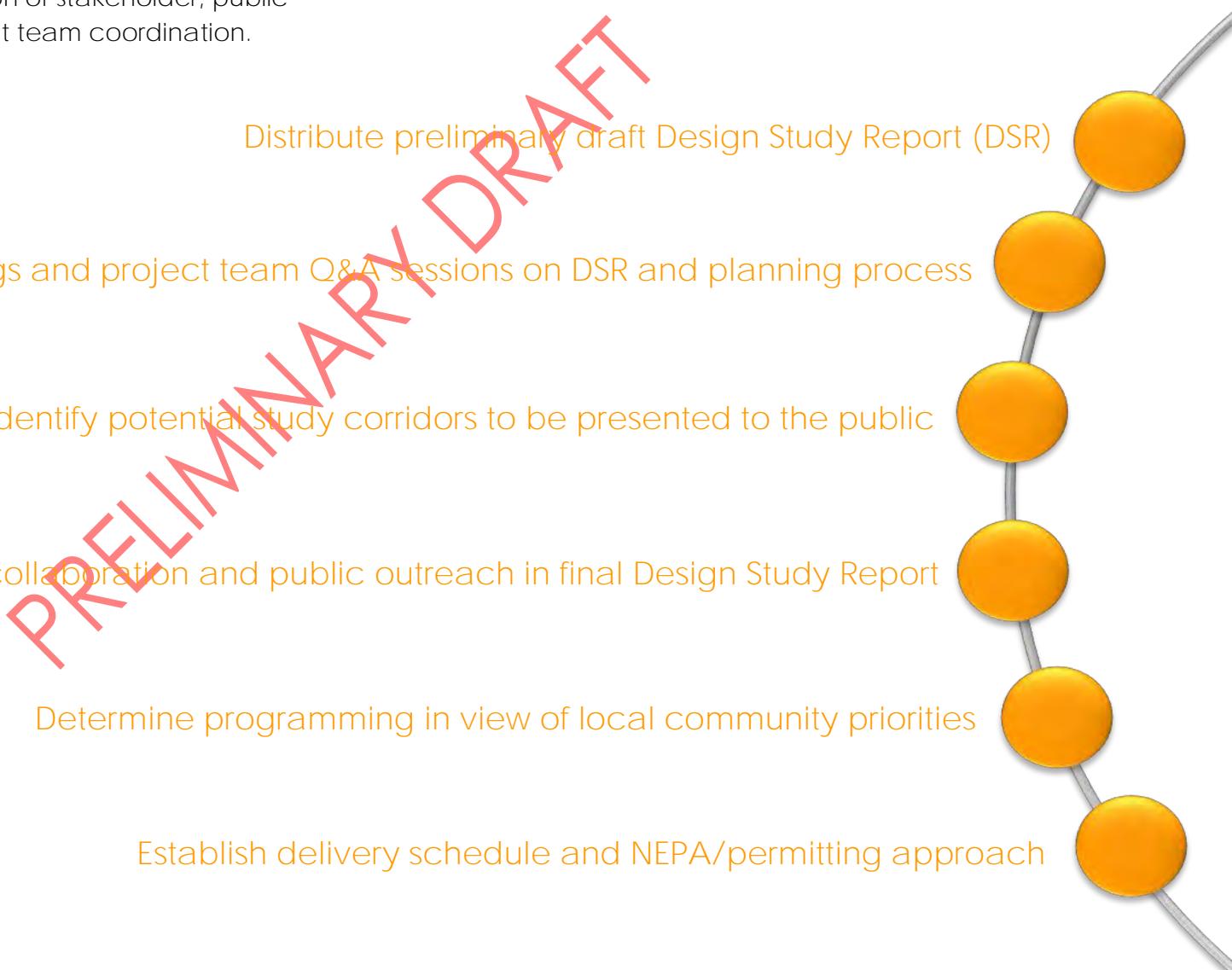
The A-0009 planning process represents a paradigm shift toward an integrated framework for project development.



Prior to initiating the NEPA environmental review phase, public outreach will be conducted to present potential study corridors. The desired outcome for this preliminary draft Design Study Report is to provide a tool that can be used by the project team to identify study corridors that will be presented to the public for input. The final Design Study Report will include documentation of stakeholder, public outreach and subsequent project team coordination.

Next Steps

The final Design Study Report will note which items the project team agrees should be incorporated into the NEPA planning process as well as project team notes regarding specific items to consider in the NEPA phase. These items may include early mitigation strategies and other project elements.





PROJECT DEVELOPMENT

This project is being developed using a “pre-NEPA” approach that bridges the gap between long-range planning and NEPA environmental review. By design, it is an iterative process that allows for exploration prior to finalizing the project’s scope and corridors to be studied under NEPA.

Since May 2015, FHWA and NCDOT have coordinated a number of project team meetings, stakeholder group meetings, and local officials meetings. Early meetings focused on developing and reaching consensus on the planning approach for A-0009; subsequent meetings focused on subjects related to implementing the process.

In early 2016, the project team established the preliminary study area, the preliminary project needs and purpose; and, then assessed the team’s readiness to move forward into design workshops.

2.1 Preliminary Study Area

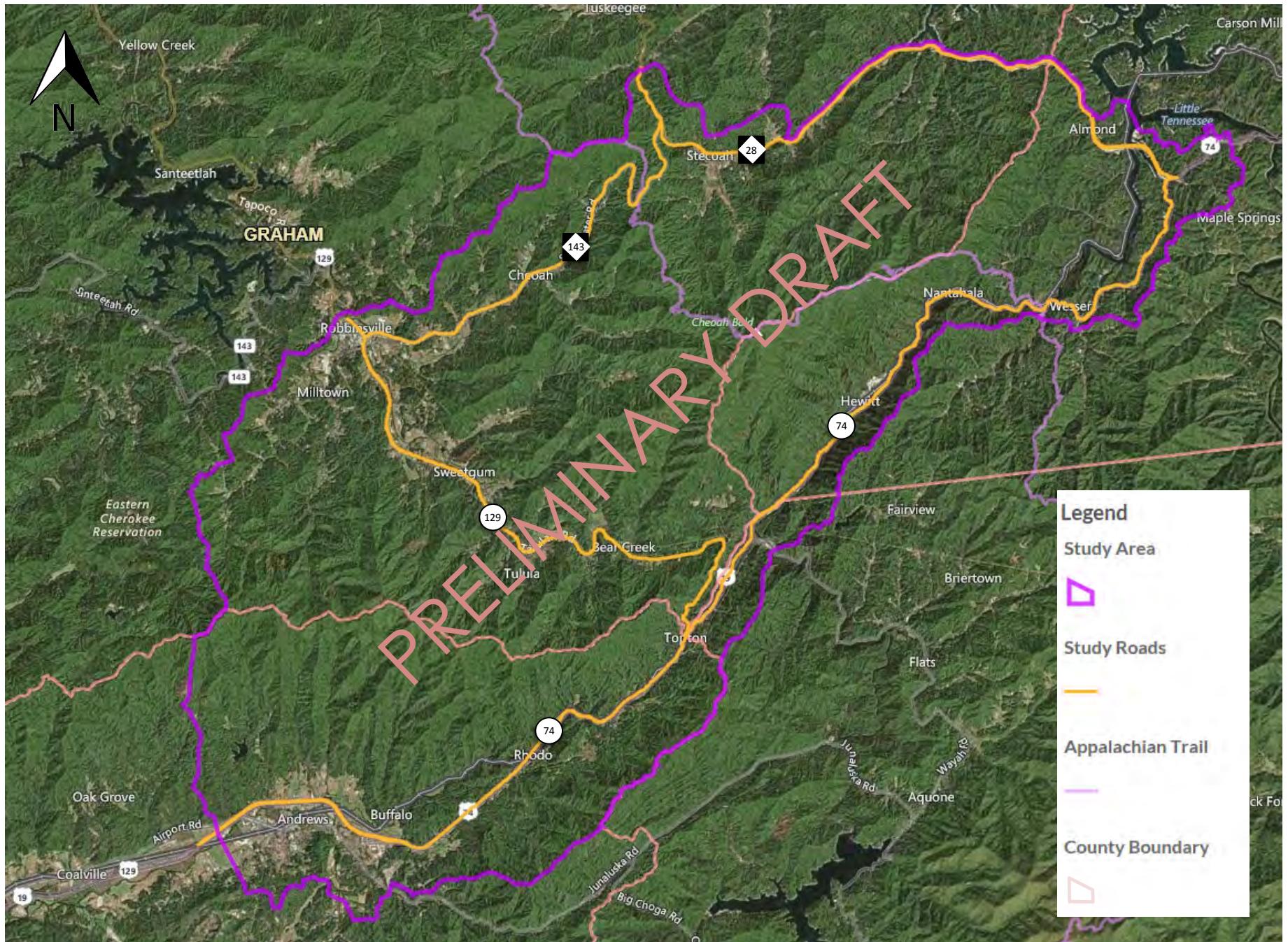
The preliminary study area was drawn to include portions of Graham County between the proposed termini of Andrews in Cherokee County and Stecoah in Graham County. The boundary follows hydrological boundaries and major roadways where possible.

Although the project purpose does not include improving US 74 through the Nantahala Gorge, the project team agreed to enter the design workshops using the preliminary study area that includes the Gorge so as not to constrain creativity and idea generation. Including the Gorge area provides a full transportation context.

PRELIMINARY DRAFT



PRELIMINARY STUDY AREA





2.2 Project Needs

Local Input

As part of taking a fresh look at the project, early meetings were geared toward ensuring all team members were informed of residents' needs, including improved access to employment, medical facilities, commercial centers, and educational facilities. The first project team meeting was held in Graham County in September 2015 to provide team members with the opportunity to see how winter weather, fog, washouts/landslides, slow-moving vehicles and accidents – in combination with steep roadway grades, narrow lanes and sharp curves – affect mobility and travel time reliability.

Existing Roadway Characteristics

Roadways within the study area typically have steep grades and sharp curves. Roadways may have paved or unpaved shoulders of varying widths or no shoulders at all. The roadway network in the study area is limited with only four two-lane roads; NC 28, NC 143, US 129, and US 19-74.

Grades often exceed 6% in mountainous areas, most notably in the Stecoah Gap on NC 28 and along US 19-74.

Speed limits within the study area generally range from 25 miles per hour (mph) in tight curve sections to 55 mph in straighter sections with better sight distance.

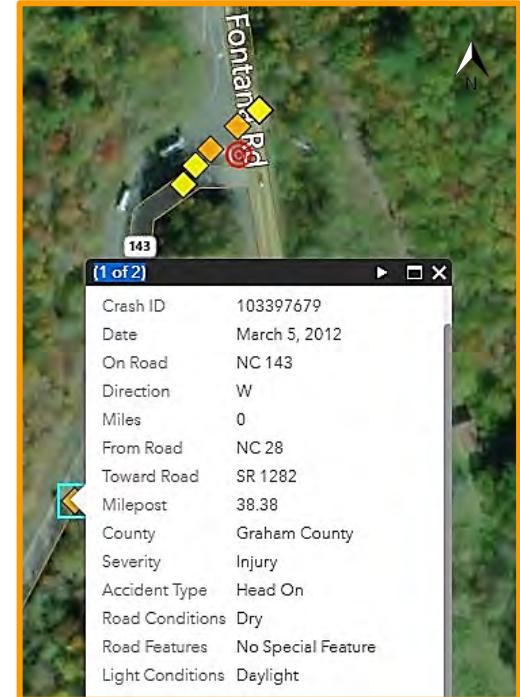
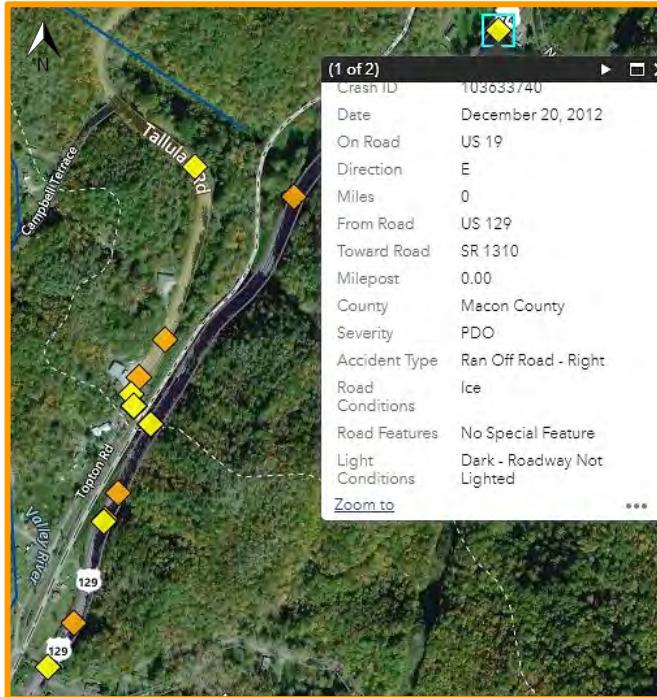
As shown in the image below, GIS analysis was performed to identify curves that do not meet a 50 mph design speed.

Project team members can access the online GIS viewer to view detailed information on existing conditions for specific locations in the study area.





LOCALLY IDENTIFIED HOT SPOTS – ONLINE GIS VIEWER AND FIELD PHOTOGRAPH





Narrow lanes and varying shoulder widths combined with sharp and/or irregular curves contribute to the frequency of crashes in the study area.

The image below shows a heat map of crash locations in the Stecoah area. Crash data shows that crashes are generally clustered around specific locations. High crash locations are among areas of concern termed "hot spots" in this report.



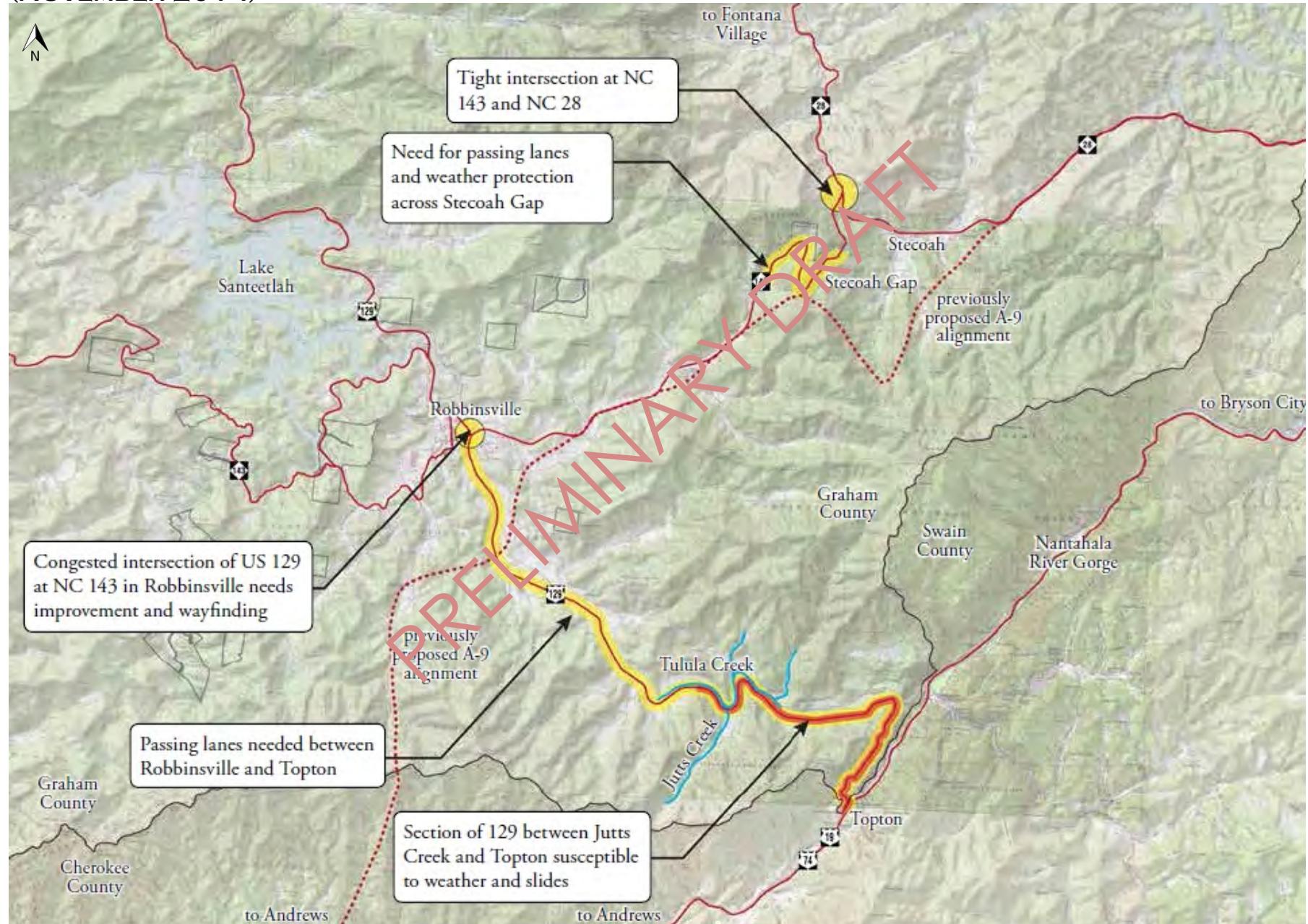
PRELIMINARY DRAFT

An informational presentation on crash data for the study area was presented to the project team by NCDOT Traffic Safety in May 2016. The project team reviewed a high-level crash analysis, examples of design elements that can help reduce crash potential, and an overview of how a safety analysis is performed.





HOT SPOTS IDENTIFIED BY CORRIDOR K FOCUS GROUP IN REGIONAL "OPT-IN" STUDY (NOVEMBER 2014)





Physical Needs

Limited roadway options: Reliability of these two-lane roadways is impaired by any type of blockage or disruption due to winter weather, fog, washouts, landslides, fallen trees, traffic incidents, vehicle breakdowns, or slow moving vehicles. Such situations adversely affect travel time as travelers must wait or back track.

Steep grades, narrow lane widths, and sharp curves on US 129, NC 143, and NC 28 affect travel speed and opportunities to pass slower vehicles.

Over-capacity roadway segments (2040)
– US 129 between NC 143 and SR 1155; US 129 between SR 1204 and SR 1105; NC 143 between 3-lane section at SR 1275 and SR 1277 {Graham County CTP}.

Mobility Needs

Improved access to employment, medical facilities, commercial centers, and educational facilities. 67% of Graham County residents that are employed **commute to jobs outside of the county**. Additionally, 1,000 jobs in Graham County are filled by workers that commute in from other counties, most commuting in from Cherokee County {Graham County CTP}.

All paved roads into and out of Graham County are primarily two-lane and there is an **inability to pass slower vehicles over substantial distances** ("up to 19 miles") {Graham County CTP}.

Impaired mobility and constrained freight movement due to combination of steep grades, tight curves, and heavy vehicles {Graham County CTP}.

Emergency medical service response times are frequently affected by roadway conditions and the volume/type of traffic encountered while responding to emergencies. This factor has resulted in the loss of life.



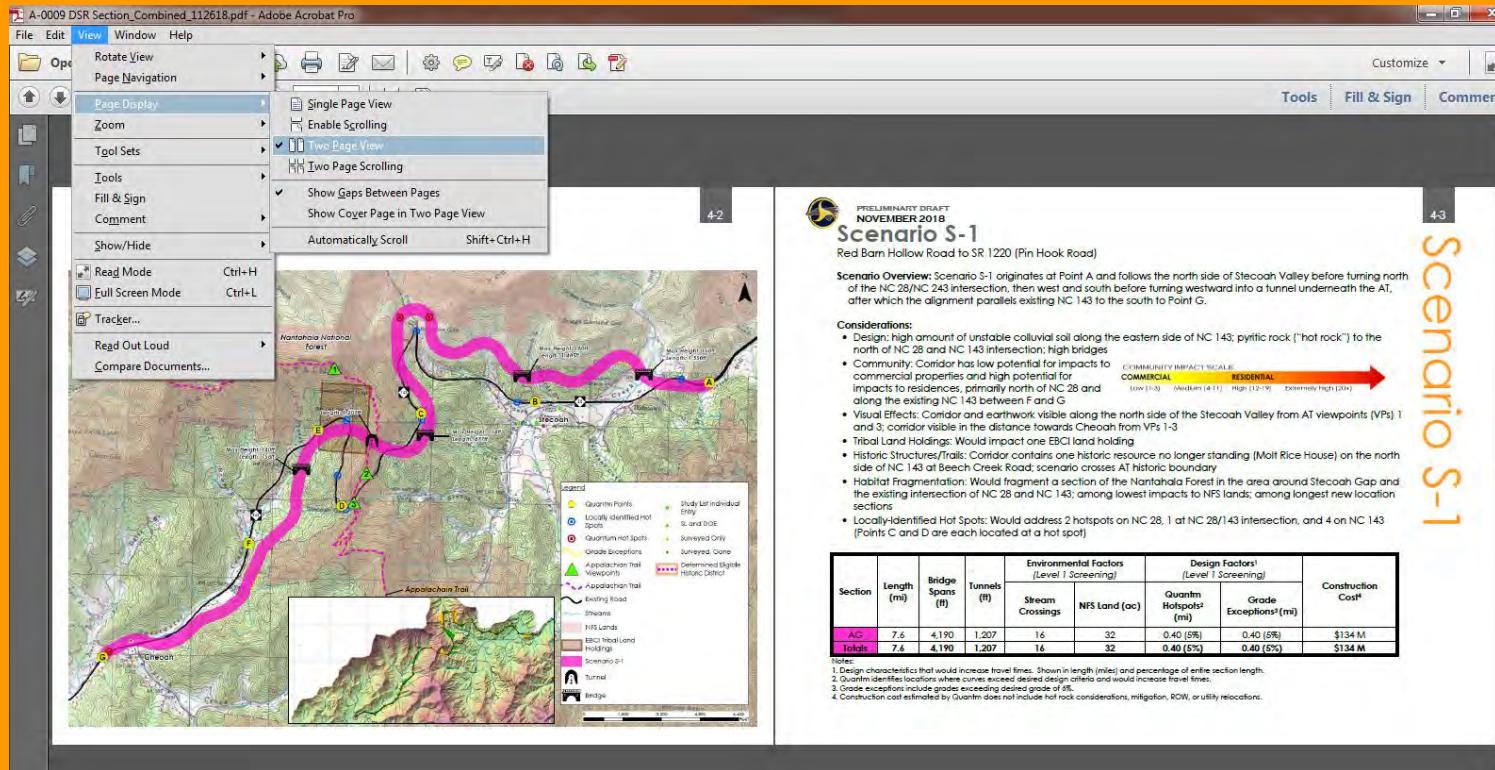
Preliminary Project Purpose

Based on the identified needs and with input from local officials, the Team crafted the following preliminary high-level purpose statement:

The proposed project purpose is to provide the transportation infrastructure necessary for the well-being of local residents and regional traffic by improving vehicular travel time, reliability, and safety between the existing four-lane section on N.C. 28 at Stecoah and the existing four-lane section on U.S. 74 east of Andrews; providing an average travel speed of 50 mph, consistent with the Appalachian Development Highway System criteria, and in a manner that is sensitive to the natural environment.

Sections 3 and 4 are best viewed onscreen using two-page display.

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QUANTM STUDIES

3.1 Introduction to Quantm™

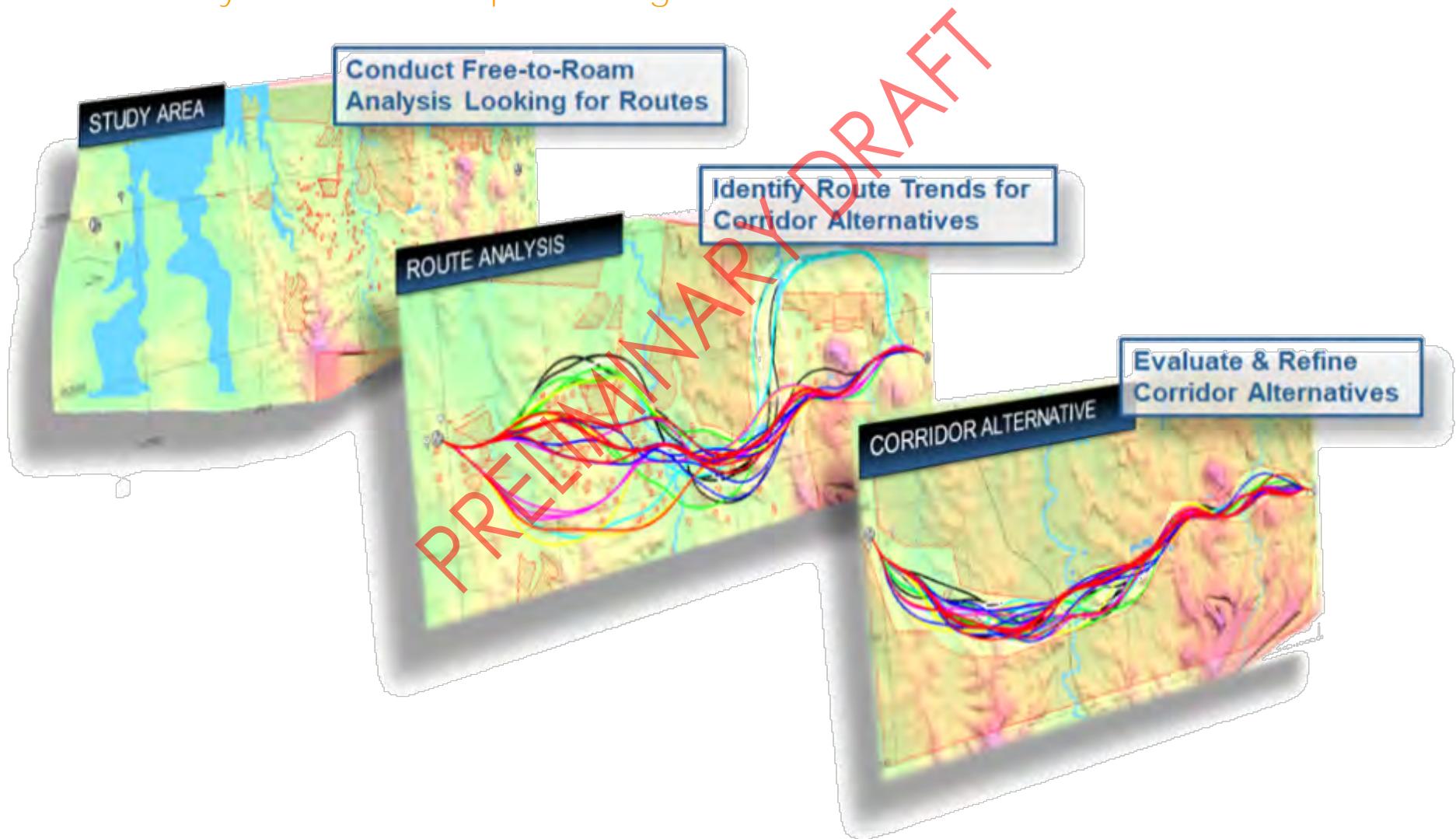
Prior to entering the design exploration stage, FHWA and NCDOT team members researched an innovative planning tool called Quantm. Quantm is an alignment optimization program that develops optimized routes in consideration of design criteria inputs, construction costs, and environmental features.

The software is used to obtain a representational cost range of potential study alignments and can be used to refine an existing alignment within an established roadway corridor. Information on Quantm was provided at the Spring 2016 meetings to familiarize the project team with the software.

PRELIMINARY DRAFT



Quantm is an optimization program that identifies route trends to help refine study corridors and optimize alignments within the refined corridors.



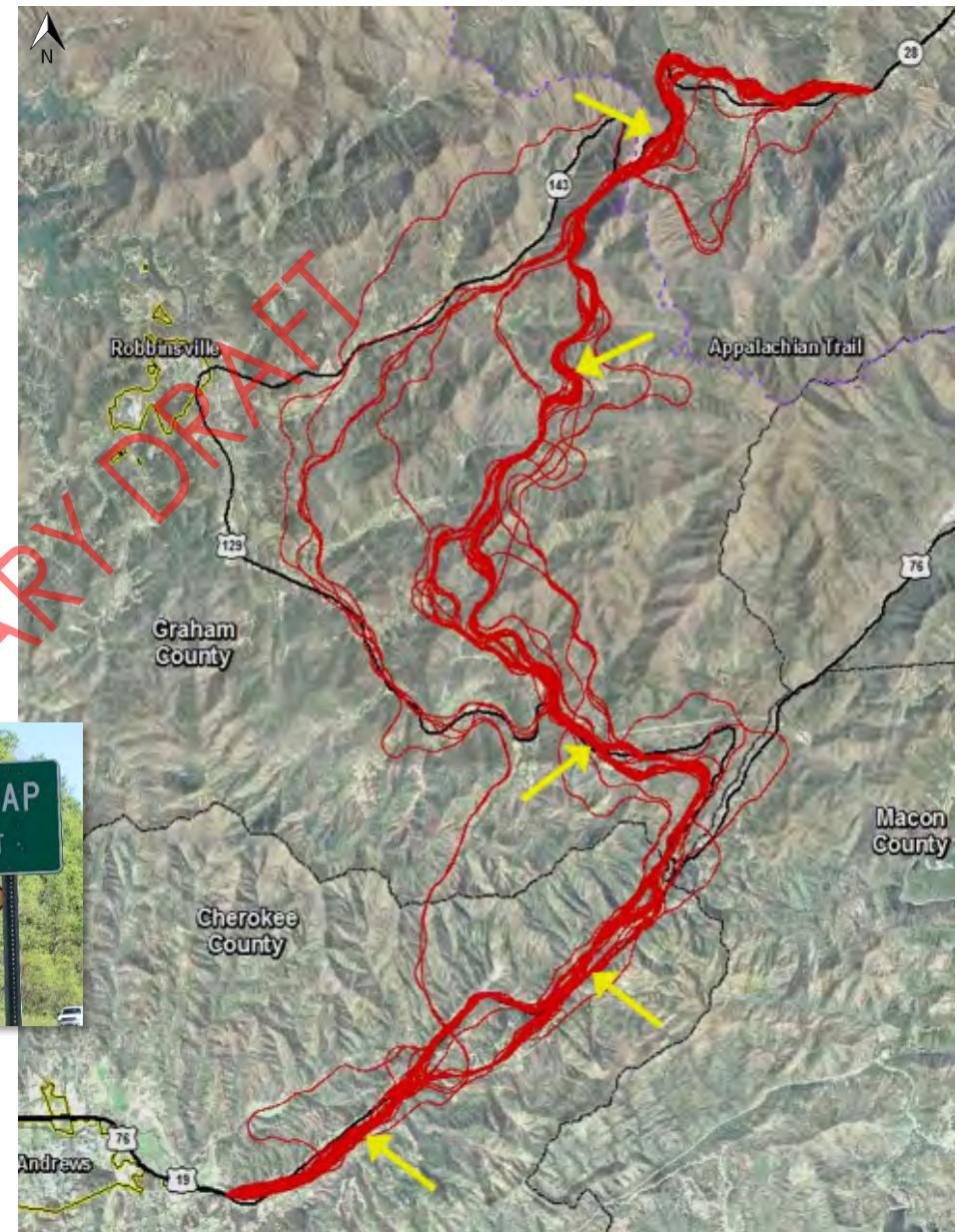


FHWA and NCDOT conducted a review of technical studies that used Quantm and coordinated with Trimble, the software developer, to conduct a trial Quantm demonstration. The trial demonstration resulted in the creation of a range of new location alignments connecting Andrews and Stecoah (shown to the right). The alignments were shown for reference on mapping used during the August 2016 design workshop.

The map to the right illustrates the effect the study area's extreme topography has on route trends as evidenced by the thick bands where multiple alignments run concurrently or within very close proximity (shown with yellow arrows). Simply stated, Quantm is finding the same corridors over and over because there are no other places to go while still maintaining the desired design criteria.



The study area's extreme topography is the primary factor for Quantm route trends.



Trial Quantm Demonstration, August 2016.



3.2 Design Workshop: Identify Concepts, August 2016

The design workshop included mapping exercises that facilitated the exploration of potential design options. Its purpose was to move the project team closer to determining “the project” by collectively agreeing upon what concepts would be studied. Team members were encouraged to provide input on features such as scenic overlooks, recreational areas, animal passages, and local historic landmarks. It was agreed that evaluation and impact assessment would follow once the project team agreed to a methodology to screen potential study corridors.

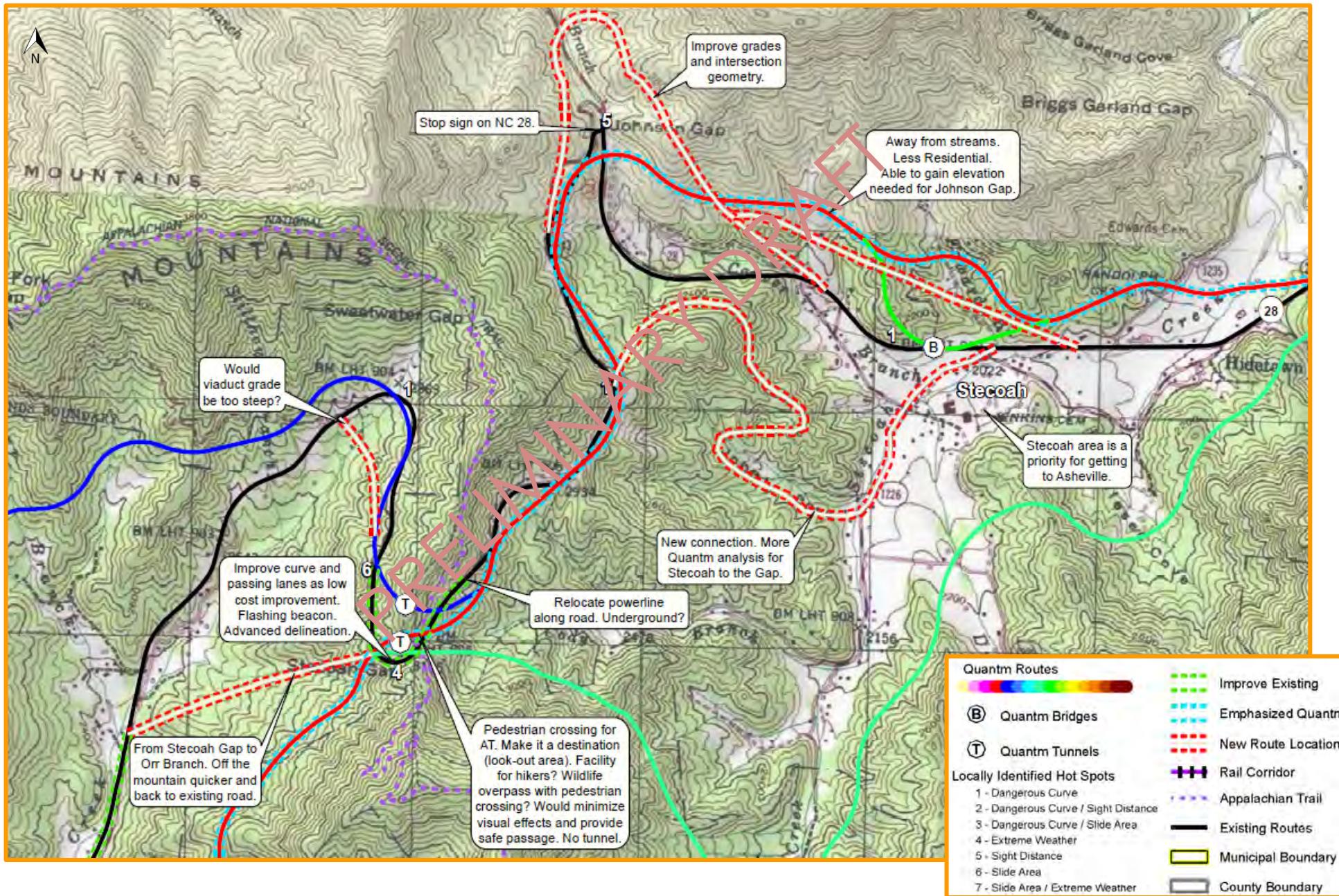
The aggregate map resulting from the design workshop shows options identified by the project team for further investigation. These options included areas where the existing roadways could be improved and areas where new location options could be explored.

In addition to mapping exercises, the project team discussed the approach to screen or evaluate the design concepts that evolved from the workshop and identified draft evaluation criteria. It was noted that at this point the design studies would be comparable to a typical feasibility study, not a detailed evaluation that would be conducted later as part of NEPA studies.

The purpose of the design workshop was to build on the Graham County CTP and “Opt-in” Regional Vision to ultimately define the project scope.



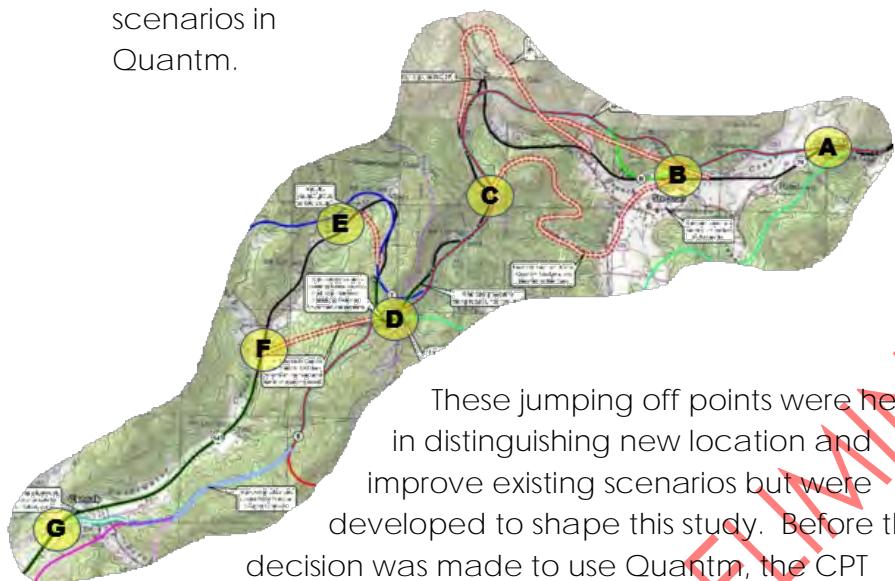
EXCERPT FROM DESIGN WORKSHOP AGGREGATE RESULTS MAP (AUGUST 2016)





3.3 Post Workshop: First Round of Quantm™

The Core Planning Team (CPT) reviewed the aggregate map, created during the Workshop, to identify break points where new location and improve existing options met each other. These jumping off points ("Quantm points") were used as breakpoints for new location and improve existing scenarios in Quantm.



These jumping off points were helpful in distinguishing new location and improve existing scenarios but were developed to shape this study. Before the decision was made to use Quantm, the CPT coordinated with Tennessee DOT (TDOT) Corridor K team members on their use of Quantm. As a result of discussions with TDOT, the CPT decided to use the jumping off points along the existing roadways to evaluate short sections that could all be combined with other short sections. This methodology would ensure a robust analysis where both new location and improve existing sections could be evaluated and feasible options joined to create a single study corridor stretching between Stecoah and Andrews.

The resulting Quantm scenarios can be combined to create continuous study corridors between Andrews and Stecoah. From a programming standpoint, this approach is helpful because it provides break-outs of construction costs for specific areas.

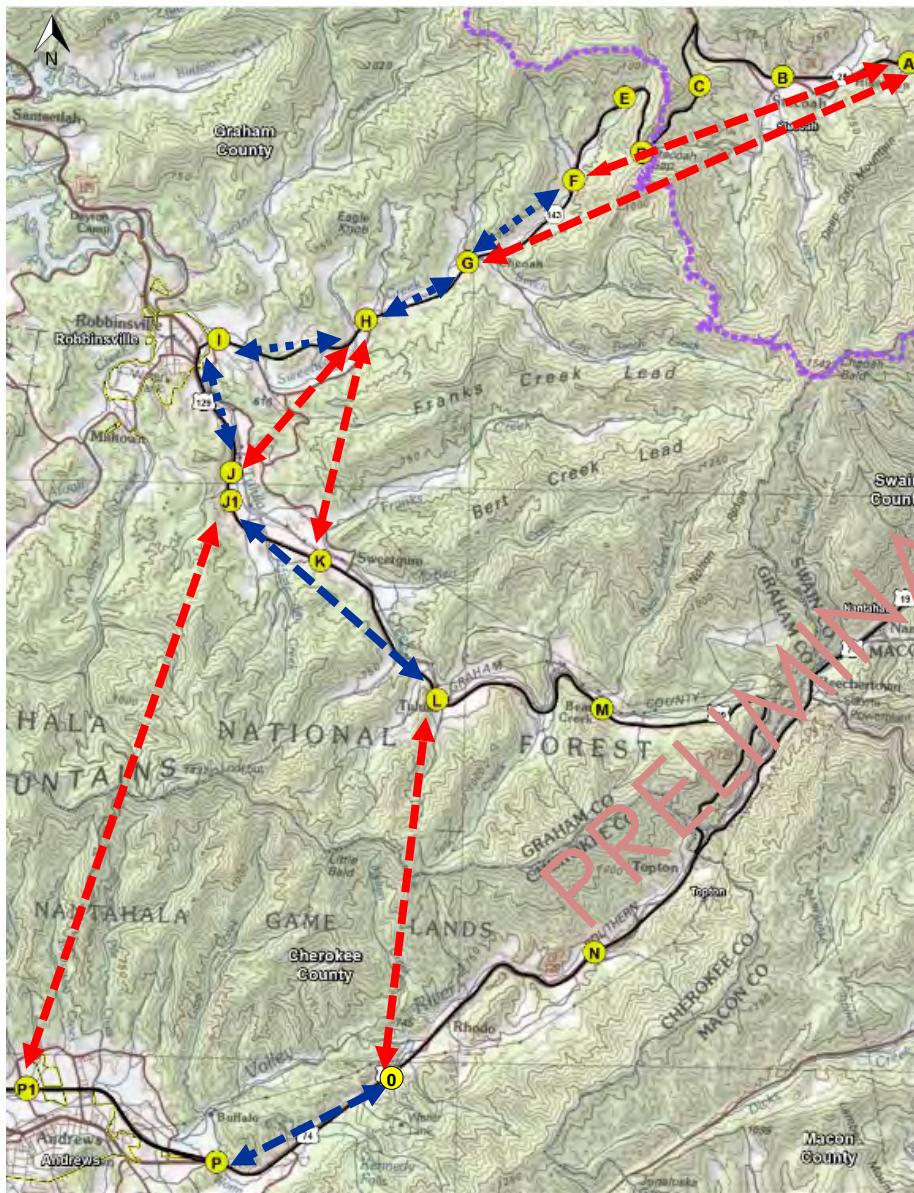
Each Quantm iteration (or Quantm "run") evaluates hundreds of potential alignments then produces a scenario that shows a representational set of 13 optimized alignments that meet the model's design parameters. These alignments are not always the lowest cost, lowest earthwork, or shortest length, but rather, illustrate a representational range of design options.

The CPT participated in Quantm work sessions held in July 2017 and November 2017. During the work sessions, team members built and refined the model using design parameters including:

- Road template – median, pavement, shoulder, cut, and fill inputs
- Geometric parameters – horizontal/vertical radii, maximum grade, maximum sustained grade, superelevation, and design speed
- Earthwork/geology costs – fill, cut in rock, cut in soil, side slope, and borrow
- Structure costs – tunnel, bridge, retaining wall, and culvert



QUANTM POINTS



Quantm scenarios were developed to:

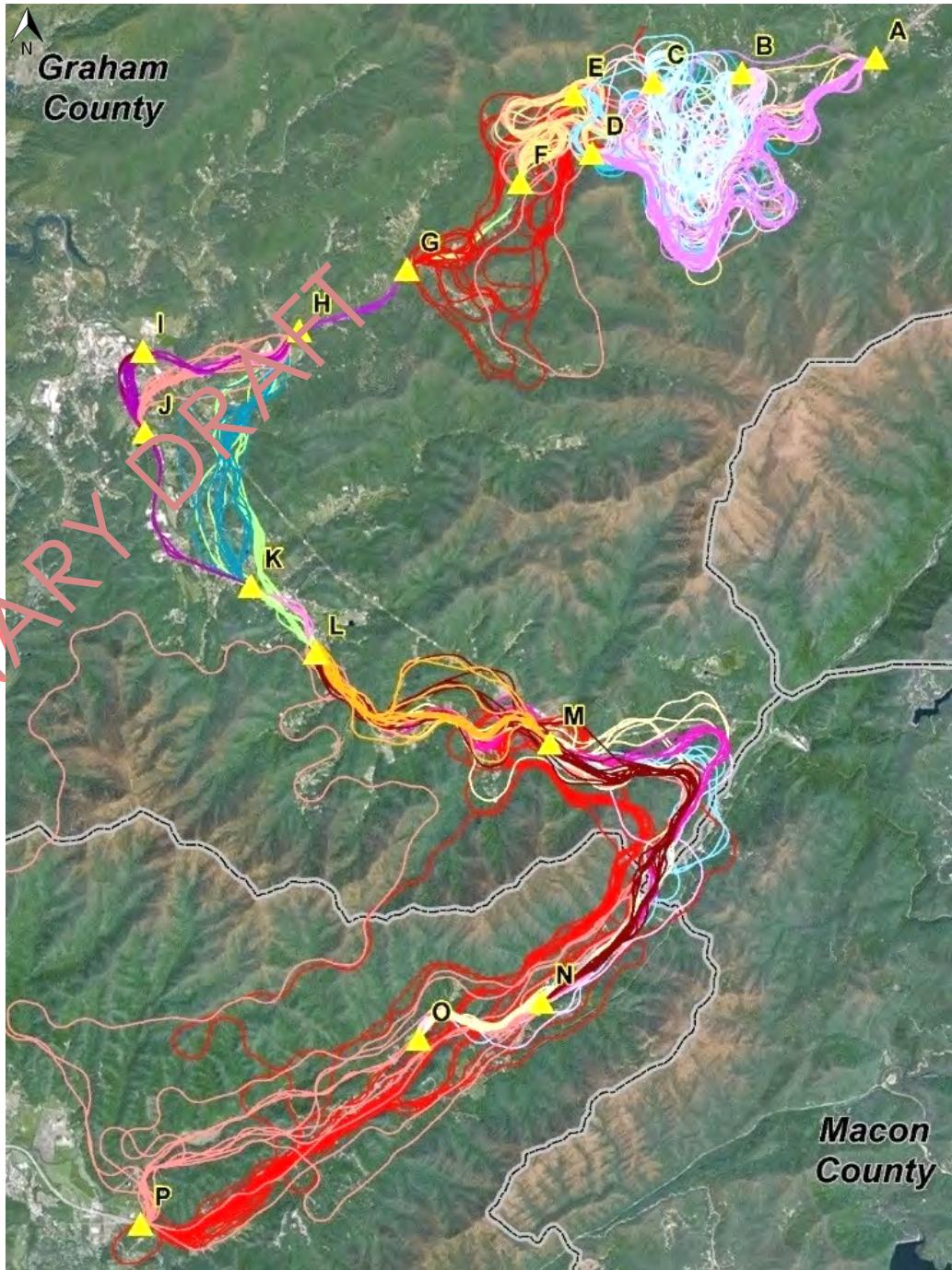
- Connect spatially-separated points (e.g., AG, J1P1, LO) to evaluate new location options; or,
- Connect adjacent Quantm points in some areas (e.g., GH, HJ, JL, OP) to refine existing roadway alignments



QUANTM MODEL INPUTS:

- Scenarios are based on a two-lane cross-section with an eight-foot paved shoulder and four-foot grass shoulder. Scenarios in the Snowbird Mountains include a 15-foot ditch for rock catchment
- Scenarios use a maximum tunnel length of 6,000 feet
- Design speed: 55 mph with design exception areas allowing 35 mph at Stecoah Gap and along the Snowbird Mountains
- Maximum grade: Although 6% is the desired maximum grade, given the setting's extreme terrain factors, the model was developed to allow a maximum 7% grade with design exception areas allowing up to 8% at Stecoah Gap and along the Snowbird Mountains
- Maximum super-elevation (e.g., roadway cross-slope): 6%
- Passing lanes, climbing lanes, and slow vehicle pull-offs to be evaluated in subsequent traffic and design studies
- Design elements to minimize impacts will be evaluated in subsequent design studies
- Per project team discussions, no environmental or cultural resource avoidance areas were set

The first round of Quantm involved an iterative process that created scenarios between a wide range of points. Because Quantm identifies route trends, the CPT wanted to explore this feature to see how changing end points and bearings (the angle of departure for each scenario) would affect model results. This exercise resulted in a large number of scenarios that either shared an end point or were traversed by other scenarios (e.g., MN is traversed by LM, LN, LO, LP, MO, and MP). As shown in the map to the right, first-round results indicate that many scenarios have the same route trends, regardless of origin. These results illustrate how the topography of the study area has a major influence on where roads can feasibly be built.





In the Stecoah area, scenarios were developed for AC, AD, AE, AF, BC, BD, BE, and BF. Whereas route trends are easily discernable for scenarios to the south. The scenarios in the Stecoah area resulted in alignments that zigzagged between end points in order to gain elevation without exceeding a maximum grade of 6%. A sample of scenarios in this area are shown below; all scenarios are shown in the map on Page 3-8. This area was referred to as the "spaghetti bowl" during team discussions.



September 2017 Project Team Webinar

The results of the first round of Quantm were presented to the project team in September 2017 in preparation for a project team meeting in October. The purpose of this webinar was to ensure that all team members had the same knowledge base and understanding of the Quantm design studies going into the October 2017 meeting. It was also held to make sure that all project team member questions and concerns were identified and addressed prior to the October 2017 meeting. The project team participated in a webinar where an overview of Quantm was provided and the expectations for the upcoming meeting were discussed.

October 2017 Project Team Meeting: First Round of Quantm Discussions

The first round of Quantm results were presented at the October 2017 project team meeting. The purpose of this meeting was to evaluate the first-round results of Quantm and collaborate on the approach for additional Quantm evaluations. The scenarios were presented at this early stage to 'check in' with project team members to make sure the team understood and agreed with:

- how the outcomes of the Design Workshop were being incorporated into the Quantm scenarios;
- how the scenarios were being developed/evaluated; and,
- how the iterative capabilities of Quantm fit into the next steps.

The CPT noted that there were no environmental or cultural avoidance areas in the first round of analysis. The team agreed that no specific environmental avoidance areas would be created for the next round of Quantm but noted that the Appalachian Trail (AT) and tribal resources will be influencing factors on the project. [Later studies would show that the extreme topography of the study area precluded the complete avoidance of the Trail of Tears in Scenario T-4. As such, it is reasonable to infer that avoidance of certain locations may be beyond what is physically able to be built.]



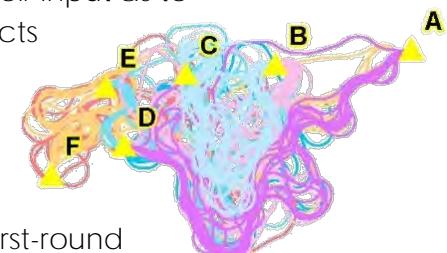
Because these scenarios were not developed to avoid or minimize impacts to GIS features, the bridges shown in the alignments are structures required by design, not for hydraulic conveyance. It was agreed that the next round of analysis will reference a stream layer to generate culverts.

In addition to tall bridges, it was noted that most scenarios in the Stecoah area included tunnels and that the cost data generated for each alignment is an estimated construction cost and does not include right-of-way or utilities.

The presentation emphasized the significance of the route trends from the first round of analysis and how the results can be used moving forward. Alignments within banded areas can be given a higher level of credibility because these corridors consistently meet design parameters. Alignments outside the banded areas can be explored or otherwise referenced to provide insight into "trade-offs" between different alignments.

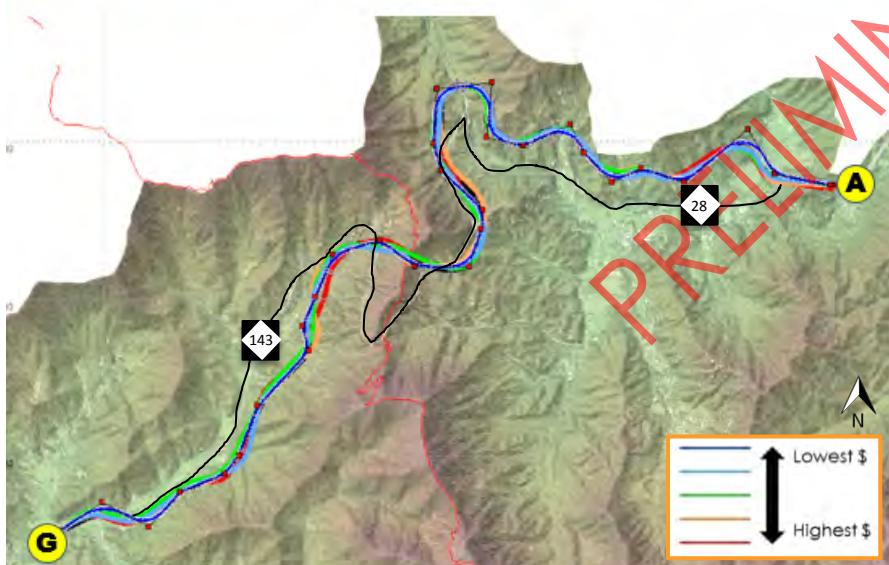
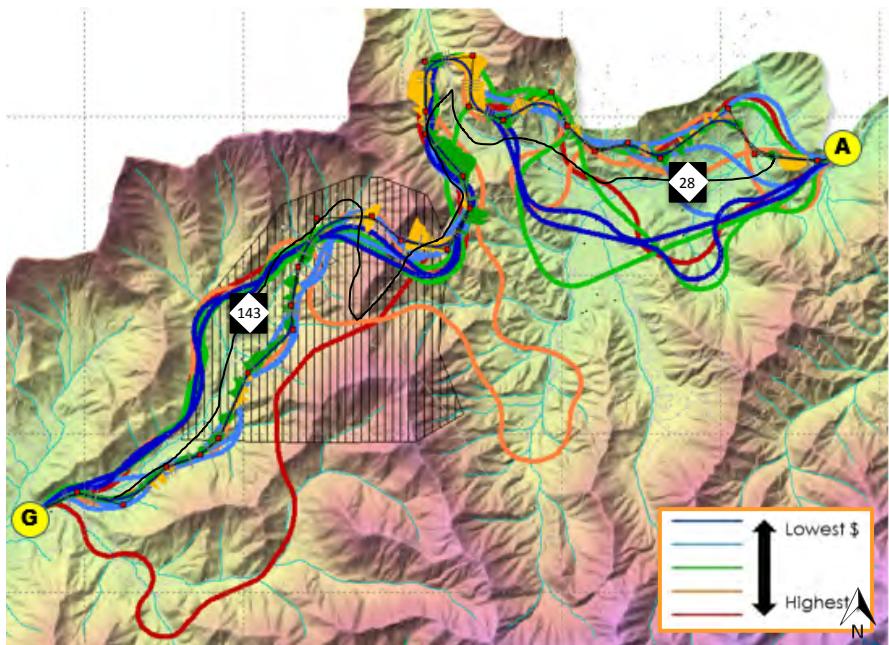
The project team reviewed available GIS data and discussed its inclusion in the model. It was recommended that the CPT coordinate with NCDOT staff working on the statewide GIS-based modeling program: Project ATLAS (Advancing Transportation through Linkages Automation and Screening). GIS data and Project ATLAS are discussed further in subsequent sections of this report.

As frequently noted in project team meetings, part of taking a fresh look at this project is creating an "atmosphere of exploration... so that preliminary ideas can be expressed freely...". With that overarching goal in mind, the project team was asked for their input as to whether there are any other aspects to the Quantm investigations that should be discussed further by the project team. The project team agreed that the CPT would move forward with reducing the first-round Quantm results, most notably, "the spaghetti bowl," into a smaller set of scenarios. It was noted that the next round of Quantm results would be compiled into this Design Study Report to show a representational range of costs and potential impacts for this smaller set of scenarios.



Second Round of Quantm:T From Unseeded to Seeded

As noted previously, each Quantm "run" produces a scenario that is a set of representational alignments between two end points. These first-round "runs" are termed "unseeded" scenarios in Quantm, meaning that the software is free to roam and is not constrained to a specific corridor. For the second round of studies, "seeded" runs were performed on select alignments from unseeded runs. In seeded runs, Quantm seeks to optimize the selected alignment within a corridor. This seeded run finds a range of optimized alignments within the unseeded alignment's corridor and generates a representational range of construction costs for alignments within that corridor.

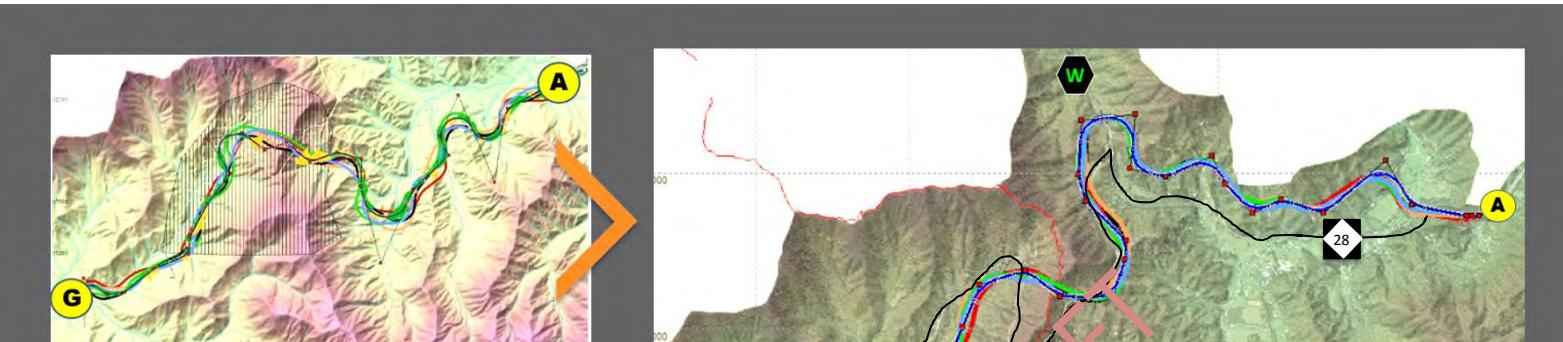


Quantm produces "unseeded", or free to roam, scenarios (top) that are not confined to a specific area. Viable alignments from unseeded scenarios are then selected for "seeded" runs that optimizes an alignment within its corridor (bottom).

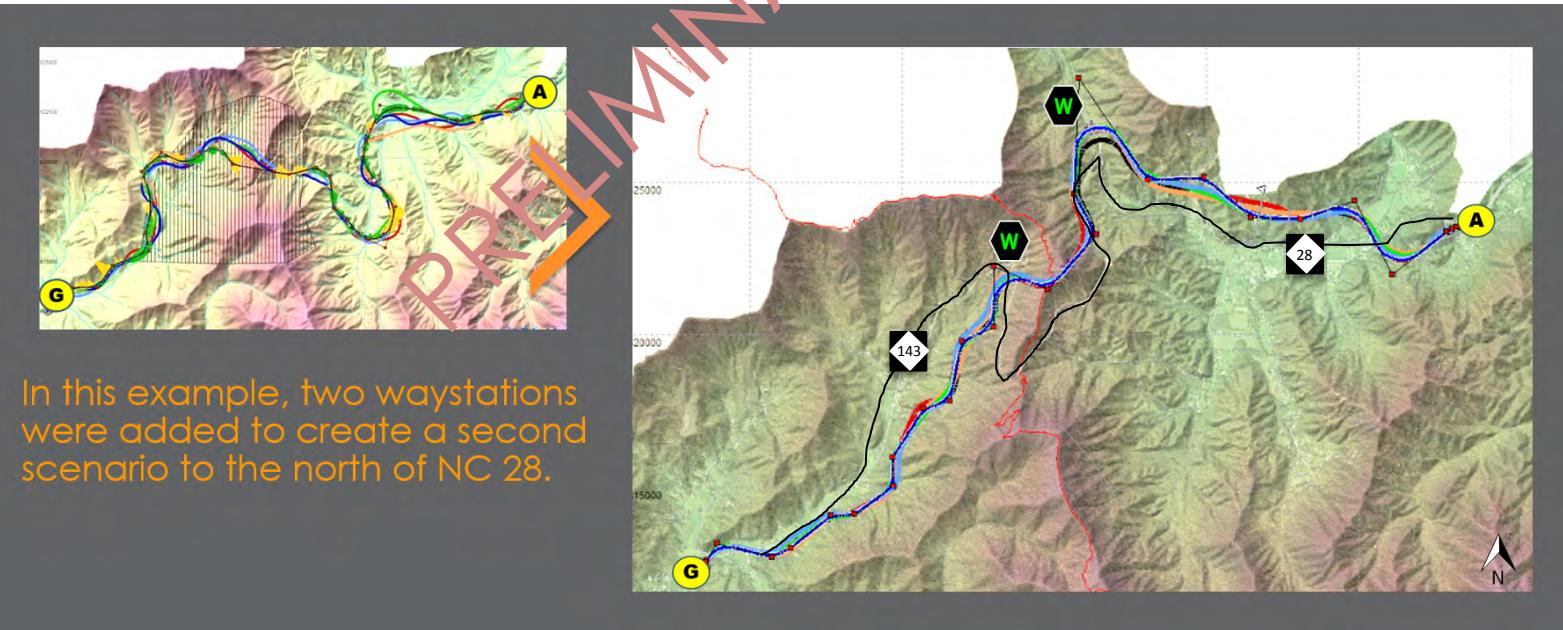
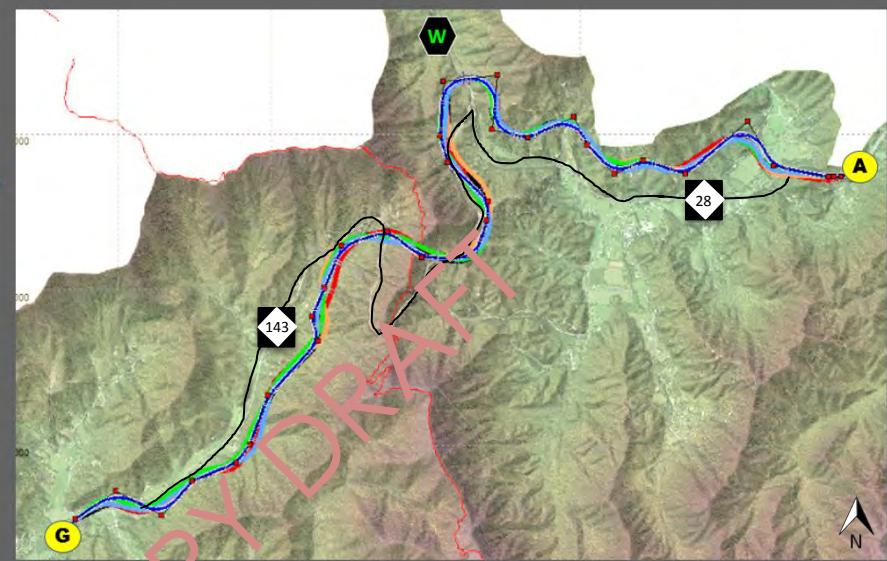
Alignments from unseeded runs were selected for seeded runs primarily based on alignment and construction costs. As shown in the top left image, unseeded scenarios can traverse a large area to generate a representational range of alignments. Construction costs can widely vary; as shown in the table to the right, construction costs for this unseeded scenario range from \$135 million to \$298 million. Generally, the most-costly alignments are the longest, although there are circumstances where the earthwork, bridges, and tunnels for shorter alignments contribute to a higher construction cost. For some unseeded scenarios, multiple alignments were identified for seeded runs. In the scenario to the top left, only one alignment was found to be viable based on construction costs and alignment length/location. The results of the seeded run are shown in bottom left image.

The AG scenario on the top left is a good example of an unseeded scenario that does not result in an easily discernable route trend. This scenario was created in response to input received at the first local officials stakeholder meeting because there were no initial Quantm scenarios that went north of NC 28. As such, "waystations" were added to the Quantm model to pull the alignments to the north rather than follow the route trend to the south around Stecoah Valley. Although route trends can be seen in the western portion of the unseeded scenario (top left), this characteristic is somewhat absent in the eastern portion.

TOTAL COST AG1 UNSEEDED
\$135,000,000
\$144,000,000
\$150,000,000
\$163,000,000
\$167,000,000
\$171,000,000
\$183,000,000
\$187,000,000
\$189,000,000
\$194,000,000
\$215,000,000
\$250,000,000
\$298,000,000



"Waystations" can be added to Quantum models to draw scenarios toward a specific area. In this example, a waystation was added to create a scenario to the north of NC 28.



In this example, two waystations were added to create a second scenario to the north of NC 28.



Local Officials Stakeholder Meetings (November 2017-October 2018)

The CPT conducted stakeholder coordination meetings concurrent with performing Quantm studies. Six meetings were held with local officials stakeholders between November 2017 and October 2018 to further examine the nature of the transportation problems in the study area, confirm understanding of the local priorities and perspectives, and continue to receive local input on the Quantm scenarios.

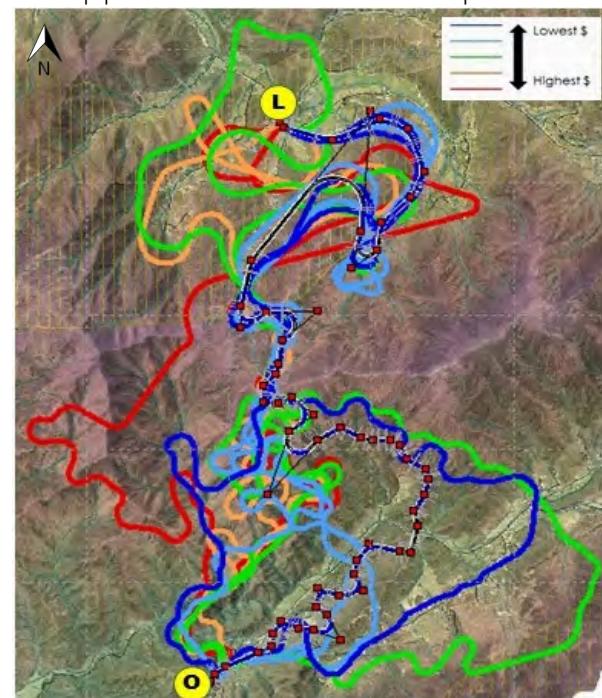
In the Stecoah area, local officials agreed the number of scenarios from the first round of Quantm was overwhelming and needed to be streamlined. They further suggested investigating scenarios north of NC 28 and the NC 28/NC 143 intersection. Local officials noted that the area known as Barber Shop Hill is particularly problematic due to the grade. Additionally, its location in the permanent shade of the mountain makes winter travel hazardous. This idea was ultimately incorporated into the AG scenarios (see Page 3-11).

In the Robbinsville area, it was agreed that scenarios for HK and HL would not be evaluated further because they would bypass Robbinsville. Graham County representatives emphasized the adverse economic effects of pulling traffic away from Robbinsville. Also, floodplains in this area (HJ) could make a new location option challenging. They suggested considering the alignment along Five Point Road identified in the 2015 CTP or a short new location section from NC 143 to the southern portion of Five Point Road.

In the US 129 and Topton area, the local officials asked the CPT to investigate new location options around the Campbell Creek area (LO, between Robbinsville and Andrews). The unseeded scenario (see image below) produced alignments that met desired design criteria but were not feasible due to their length and associated construction costs. The alignments shown had construction costs ranging from \$185 million to \$520 million and included long tunnels and high bridges. Local official stakeholders agreed that these alignments did not merit further refinement or investigation.

Local officials did not support scenarios south of Topton (NO) that would create community impacts along Reb Marble Road.

Local officials expressed general concern with options along existing roads in areas where there is geological instability.



This unseeded scenario in the Campbell Creek area did not produce any alignments that met planning-level criteria related to purpose & need and ADHS goals.



Local officials asked the CPT to re-consider an option going through Tatum Gap if geological concerns did not make it unfeasible. This option is described in Section 4.

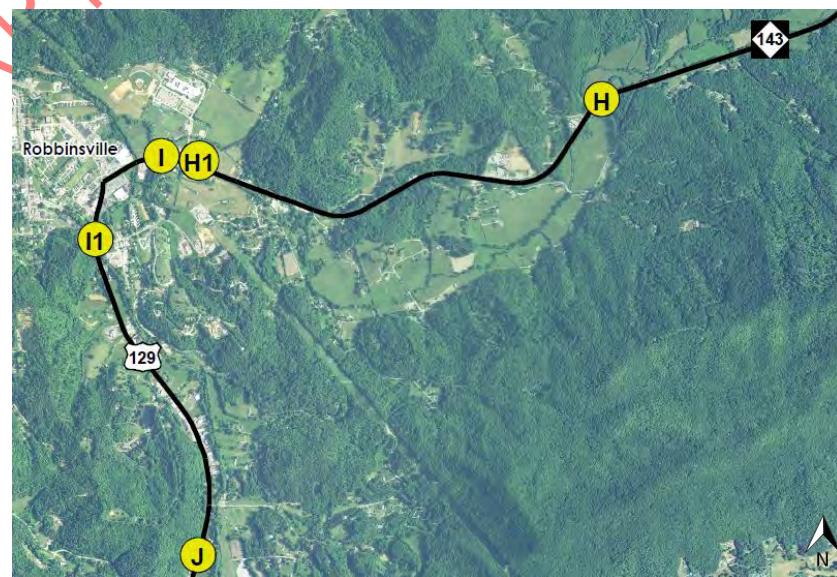
The CPT generated several options for HJ that pulled the alignments closer to Robbinsville and avoided the Old Mother Church and Cemetery as requested. While these modified scenarios would not bypass Robbinsville, local officials determined that the impacts to commercial and residential development in Robbinsville would be too great to warrant further consideration of those options. They asked the CPT to develop 'best fit' alignments with the following local goals in mind:

- Close to Robbinsville without major impacts to businesses, Old Mother Cemetery, or homes on Five Point Road
- Maintains connectivity to Town
- Promote mobility and do not create a traffic bottleneck
- May improve walkability
- Can still pursue ideas and plans for revitalizing Robbinsville

To develop best-fit options in the Robbinsville area, additional avoidance areas were created for community features and new jumping off points (H1 and I1) were evaluated along NC 143 and US 129. Potential best-fit options were presented to local officials in late October 2018. The Robbinsville scenario detailed in Section 4 was identified as the best-fit option for the Robbinsville area.

LOCAL OFFICIAL COORDINATION KEY OUTCOMES:

- ✓ Confirmed understanding of local perspectives
- ✓ Identified additional Quantm scenarios
- ✓ Reinforced importance of "local ownership"
- ✓ Built knowledge base for future discussions



New Points H1 and I1 were added and new Quantm scenarios generated in the Robbinsville area as a result of Local Officials Stakeholder coordination.



Tribal Coordination

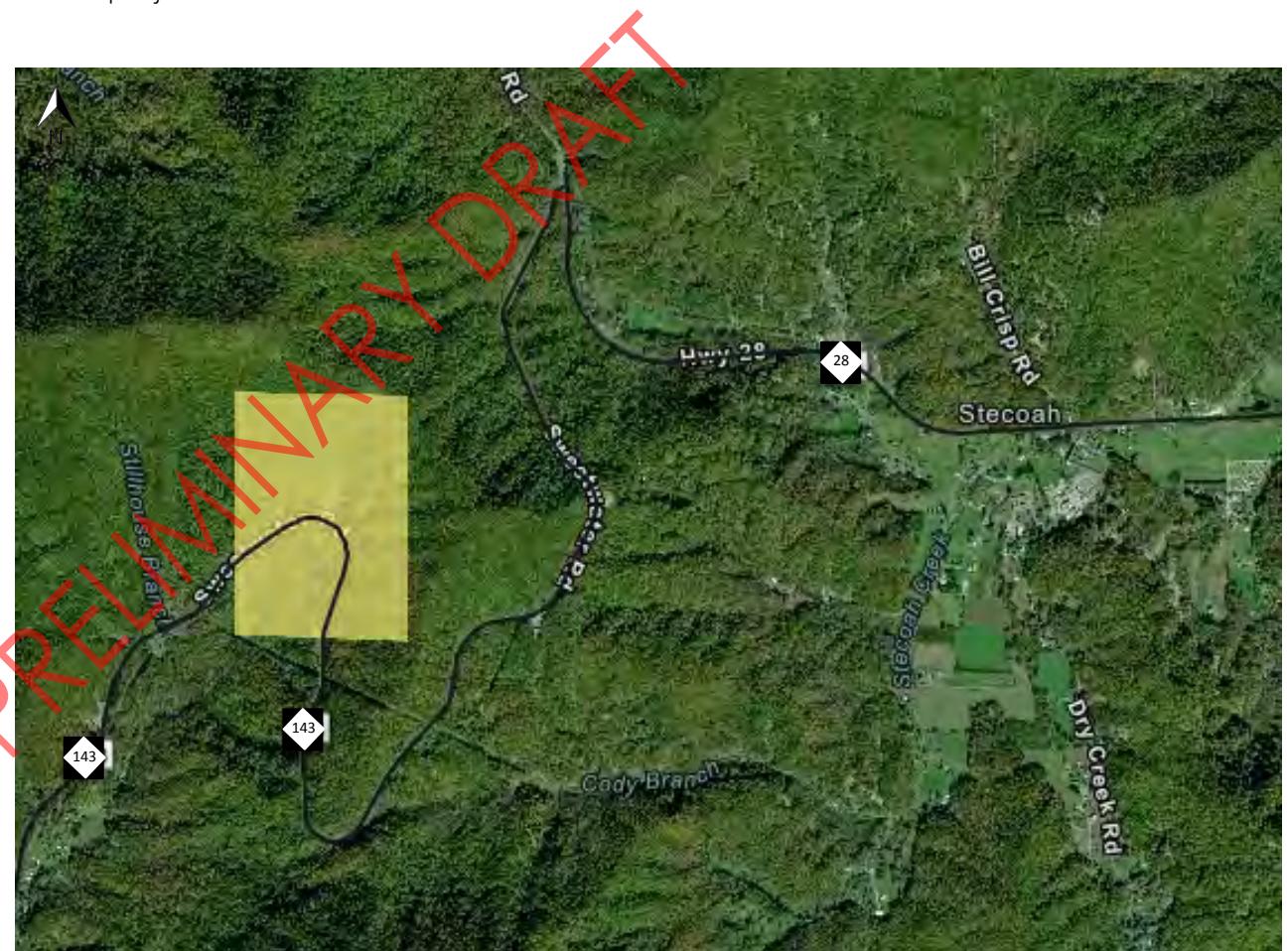
The project team includes representatives from the Eastern Band of Cherokee Indians (EBCI), Cherokee Nation, and the United Keetoowah Band of Cherokee Indians in Oklahoma (UKB). Tribal representatives have been included in project correspondence and coordination since the project's restart in 2015.

Representatives have generally conveyed that input would be provided as the project progressed into environmental review; however, the presence of EBCI-owned parcels along existing NC 143 necessitated early coordination with the EBCI and the Bureau of Indian Affairs to ensure the CPT understands timing and protocol should land transfer agreements be necessary in the future.

On August 27, 2018, FHWA team members met with EBCI Principal Chief Richard Sneed and Paxton Myers, EBCI Chief of Staff. The CPT also wanted to present the Quantum scenarios to tribal partners. An option through Tatham Gap was requested by local officials and as such, the CPT solicited comments from the EBCI during the

coordination meeting. No major issues were identified during the meeting.

In addition to meeting with the EBCI, coordination is ongoing with the UKB and Cherokee Nation.



Eastern Band of Cherokee Indians (EBCI) landholding along NC 143



Appalachian Trail Stakeholder Meetings (March 2018-June 2018)

Three meetings with the AT stakeholders were held between March 2018 and June 2018. The AT stakeholders are comprised of representatives from the National Park Service, US Forest Service, AT Conservancy, and State Historic Preservation Office.

These meetings confirmed that the AT stakeholders understand there are transportation needs in the area and they support efforts to improve transportation. Relative to the AT, they expressed the following key interests:

- The experience of hikers using the AT. The AT stakeholders tasked the CPT with minimizing visual and noise impacts, preserving picnic sites, and provide safe crossings where the road may intersect the Trail.
- Preserving access to USFS property and roads used for AT maintenance and timbering.
- Cultural resources, including archaeology and Cherokee resources.
- Direct impact to the AT (e.g. cuts, fill, tunnels) and any cumulative impacts that may occur associated with development activities

The Stecoah area and AT were the focus of these meetings, as all scenarios in this area must cross the AT. The group assessed the conceptual alignments in Stecoah in terms of the potential effect the options may have from specific viewsheds along the AT. In other words, the group considered what hikers may experience and see at different viewpoints along the AT. From this exercise, two ideas were offered.

Similar to feedback received at local officials meetings, AT stakeholders wanted to evaluate scenarios that would travel on the north side of NC 28 with the intent of crossing Stecoah Gap to the north of existing NC 143.

Refined scenarios were presented at the following AT stakeholder meeting. It was noted that the western portion of the AG scenarios traverses the south side of the Sweetwater Valley. This would create new visual impacts from the AT. It was suggested that the CPT evaluate scenarios that use the waystations and connect to existing NC 143 sooner. Therefore, the CPT developed waystations to pull alignments north of Sweetwater Gap, which can be seen in Section 4 of this document. Examples of these AG scenarios can be seen on Page 3-12.



Some stakeholders thought that using waystations and pulling the scenarios to the north of NC 28 would create alignments that would cross the AT Trail (shown in yellow in the image below) at Sweetwater Gap instead of further south at Stecoah Gap. Ideally, this would have helped minimize visual effects from the AT by shortening the length of the new roadway. It is noted that none of the new AG scenarios traversed Sweetwater Gap as an alignment through this area would have exceeded the desired design criteria.

AT STAKEHOLDER COORDINATION KEY OUTCOMES:

- ✓ Identified additional Quantum scenarios
- ✓ Developed and vetted new tools to be used in DSR
- ✓ Gained further understanding of stakeholder interests
- ✓ Facilitated ongoing effort to obtain all necessary guidance materials

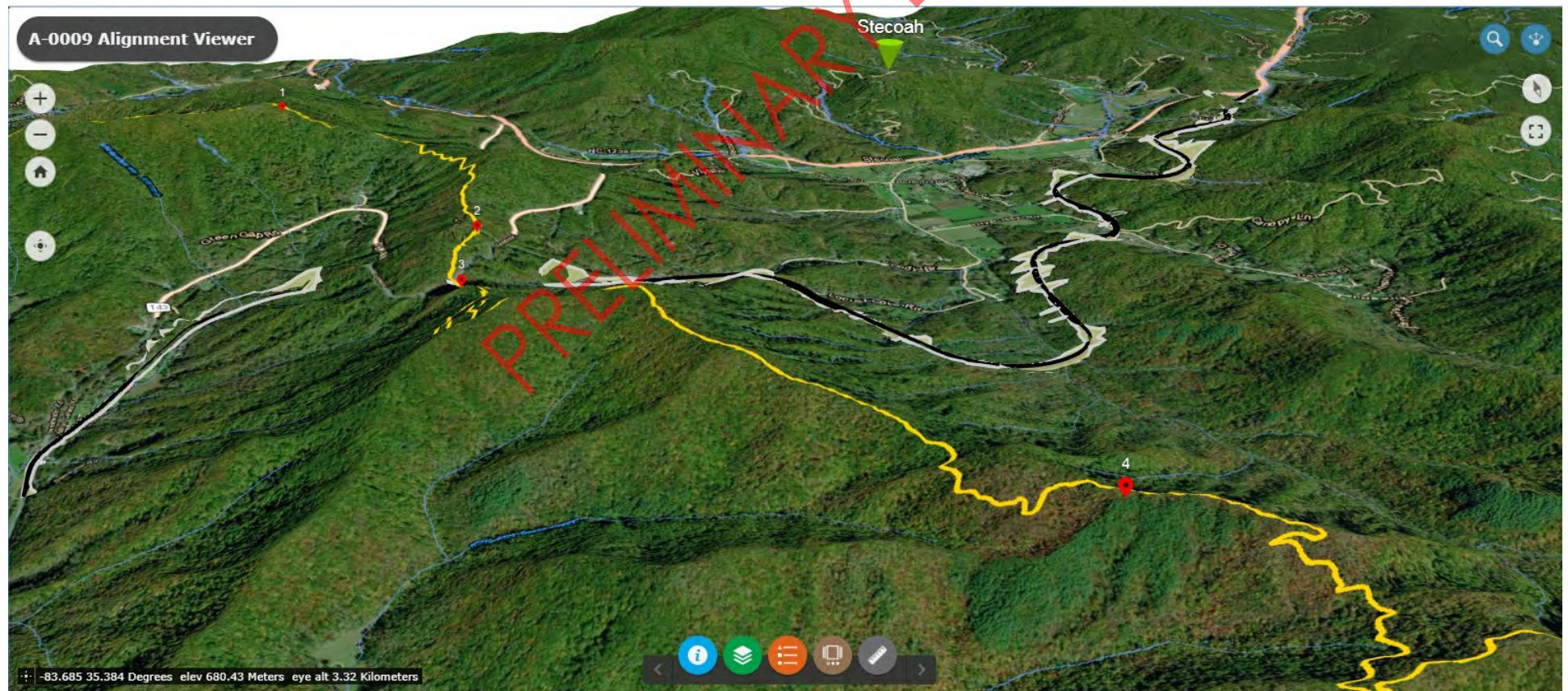


Waystation scenarios in the Stecoah area did not go through Sweetwater Gap as team members had predicted, but rather, most scenarios crossed the AT to the south of Sweetwater Gap, generally in the Stecoah Gap area, due to topography.



Another outcome of AT stakeholder coordination was the creation of a 3D visualizer for the AT area. The visualizer allowed AT stakeholders and others on the project team to review scenarios from vista points on the AT to get a sense of likely visual impacts.

Project team members have access to a 3D visualizer to view Quantum scenarios in the Appalachian Trail area.





The following data sets were considered for use in this DSR:

GIS DATA SET	USED IN DSR? YES/NO/WHY
USGS Streams	YES: Quantm uses stream data to place culverts (bridges shown in the Quantm scenarios are placed due to terrain not hydrology, although some bridges also happen to cross streams)
NFS lands	YES: all scenarios traverse
Natural Heritage Areas and Game Lands	YES: only to illustrate that NHAs and game lands occur within NFS land
HOWs/ORWs/WSWs	YES: scenarios from Robbinsville to Topton have potential to traverse
NWI Wetlands	NO: most occurrences in farm fields and within proximity of existing roadways; not a major factor in selecting study corridors; will have more weight in future studies
Tribal lands	NO: FHWA is coordinating with EBCI regarding the EBCI-owned parcels along NC 143 just west of Stecoah Gap; not a major factor in selecting study corridors; will have more weight in future studies
Floodplains	NO: located within valley areas; not a major factor in study corridor selection
State-owned Land	NO: small parcels in Andrews; not a major factor in corridor selection
Critical Habitat	NO: None within potential study corridors
Roadless Areas	NO: None within potential study corridors
Black Bear Sanctuary	NO: None within preliminary study area
Important Bird Areas	NO: None within preliminary study area
Spruce Fir Forest	NO: None within preliminary study area

At the time this DSR was developed, ATLAS data was still under development and was not referenced for this report. Rather, the CPT reviewed available data sets to determine the most prudent evaluation method given the amount of relevant high-level GIS data available for use. Moving forward, the CPT will continue to coordinate with Project ATLAS team members to identify data sets that can be used in future studies. The table to the left shows how environmental data was used in Quantm studies. The checklist on Page 3-20 shows the evaluation process that was utilized to identify scenarios for inclusion in this DSR.

The scenarios described in this DSR were identified based on planning-level criteria, impact potential, and design considerations.





DESIGN STUDY REPORT

SCENARIO CHECKLIST

Does the scenario:

✓ SUPPORT THE GOALS OF THE ADHS?

Long alignments with a high number of switch backs and curves would not support ADHS related to achieving "continuity and reasonable uniformity" and providing "an average travel speed of approximately 50 miles per hour between major termini" nor would their larger footprints contribute to preserving the "scenic beauty of the region."

✓ MEET REGIONAL AND COMMUNITY VISIONS?

Scenarios were evaluated for consistency with local priorities and plans, including *Reimagining Robbinsville* and *Corridor K Guiding Principles* contained in the *Regional Opt-In Study*. Scenarios that would bisect the Stecoah community or bypass Robbinsville were not further evaluated. Long alignments with large footprints would not minimize impacts to natural and cultural resources.

✓ ADDRESS THE PROJECT'S PRELIMINARY PURPOSE AND NEED?

While additional design work and detailed traffic analyses are required to ultimately determine which scenarios will best meet project goals, scenarios were evaluated based on their potential ability to meet identified needs and achieve the project purpose. Long alignments and/or alignments that generated a high number of new "Quantm hot spots" (discussed in Section 4) were not further evaluated as they would not provide increased reliability and safety.

✓ INDICATE A ROUTE TREND?

Individual alignments that were part of an unseeded route trend were given higher preference than comparable alignments outside the route trend. Route trends from previous Quantm runs were referenced when identifying trend locations.

✓ HAVE A REASONABLE CONSTRUCTION COST?

Scenarios with lower shorter lengths were typically found to cost less than long alignments or alignments with a high amount of earthwork or structures. Alignments from seeded runs generally reflect the alignment with the lowest construction costs, provided there were no apparent trade-offs with potential impacts, purpose and need elements, or ADHS criteria.

✓ MAINTAIN CONSISTENCY WITH RESOURCE AGENCY GOALS?

Scenarios were presented to the AT Stakeholder Group at this preliminary level to make sure that the scenarios do not immediately raise issues with respective agency goals and planning objectives.



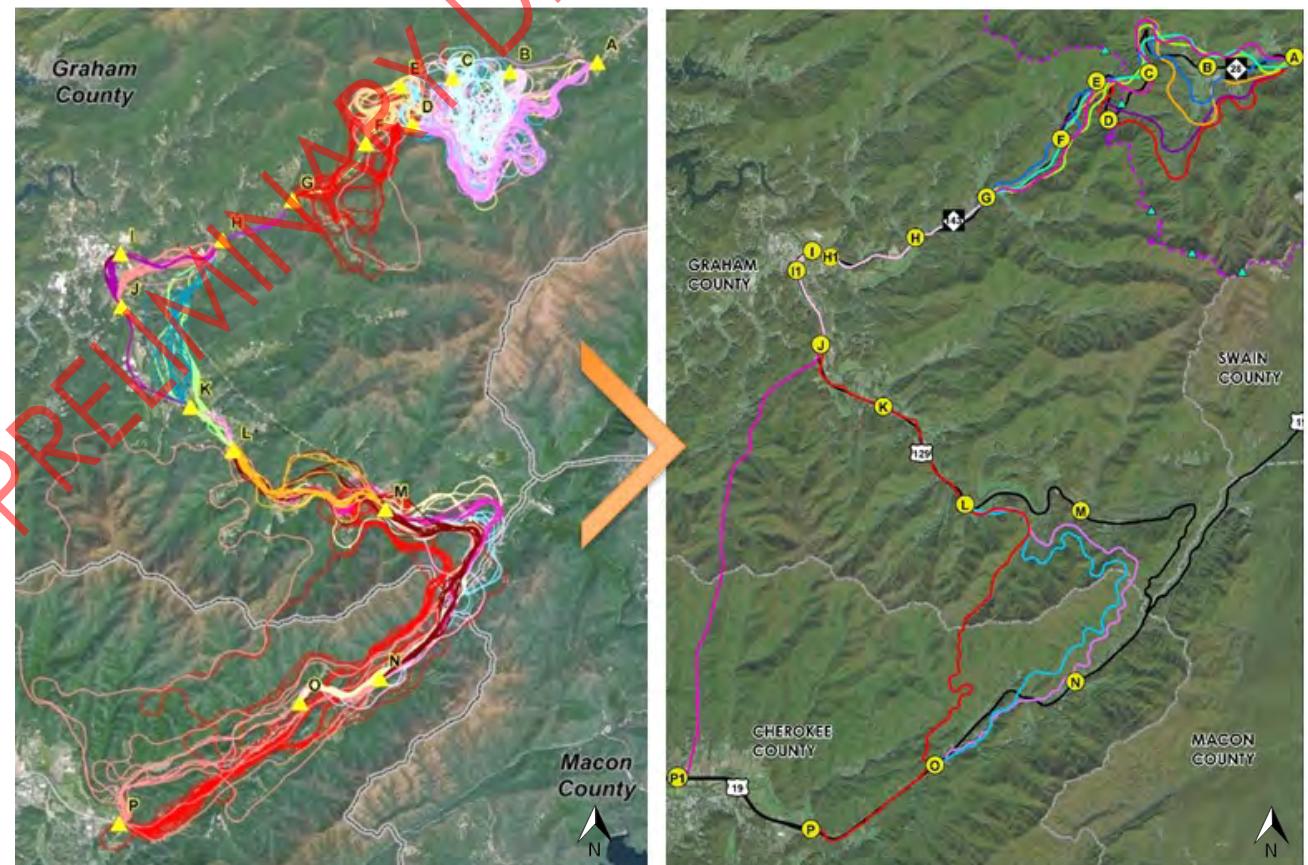
The scenarios included in Section 4 represent potential solutions for the identified transportation needs of Graham and Cherokee Counties. These scenarios were identified with the purpose of reducing the first-round "spaghetti bowl" of Quantm results and presenting a smaller set of scenarios for the project team's evaluation.

With this DSR, the project team has an opportunity to provide feedback and help identify study corridors that can be presented to the public for input prior to starting any formal studies under NEPA.

Similar to a conventional feasibility study, the Quantm analyses performed for this DSR can be used to identify potential study corridors for future NEPA studies.

This DSR can be used as a tool for resource agencies to make sure ecological planning goals and regional priorities are considered in the development of study corridors.

Resource agency team members can inform the project team of potential cumulative effects, early mitigation strategies, and environmental needs that require working together across jurisdictional boundaries in order for those needs to be met.



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Toolbar >> View >> Page Display >> Two Page View

Toolbar >> View >> Page Display >> Two Page View

The screenshot shows the Adobe Acrobat Pro interface with the 'Page Display' menu open, highlighting 'Two Page View'. The main workspace displays a map of the Stecoah Valley corridor, showing the proposed alignment in pink and various environmental features and landmarks. To the right, a document titled 'Scenario S-1' is displayed in a two-page view, detailing the corridor's impact on various resources and listing design factors and construction costs.

Map Legend:

- Quantum Points
- Locally Identified Hot Spots
- Quantum Hot Spots
- Grade Exceptions
- Appalachian Trail Waypoints
- Appalachian Trail
- Existing Road
- Streams
- NFS Lands
- EBCI Tribal Land Holdings
- Scenario S-1
- Tunnel
- Bridge

Design Factors¹ (Level 1 Screening)

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)	Design Factors ¹ (Level 1 Screening)	Construction Cost ⁴	
AG	7.6	4,190	1,207	16	32	0.40 (5%)	\$134 M
Total	7.6	4,190	1,207	16	32	0.40 (5%)	\$134 M

Notes:

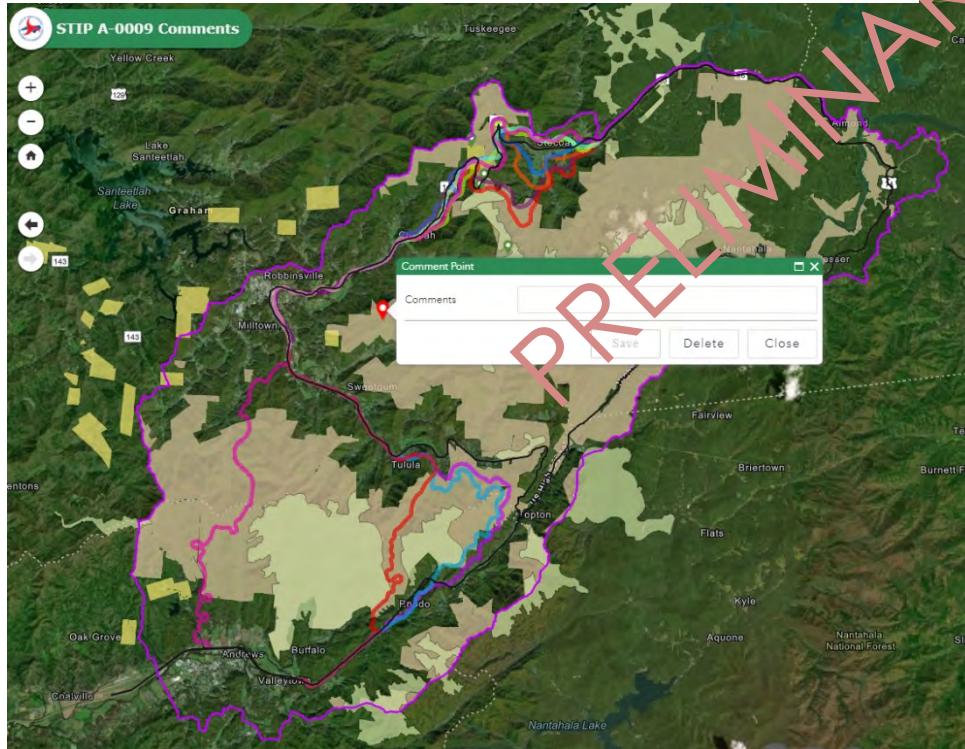
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
3. Grade exceptions include grades exceeding desired grade of 6%.
4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



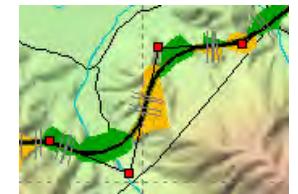
QUANTM SCENARIOS

These scenarios represent a range of potential solutions that were selected for project team review based on the methodology detailed in Section 3. Each scenario map shows a 500-foot corridor, notable GIS features, and an inset of the scenario as shown in Quantm. The Quantm inset provides insight into the earthwork associated with each scenario with cuts shown in yellow and fill shown in green.

This report is one of several tools available to the project team. In addition to the comparative data summarized in this report, project team members have access to online GIS viewers that show Quantm scenarios and 3D visualizations of the scenarios in the Appalachian Trail area.

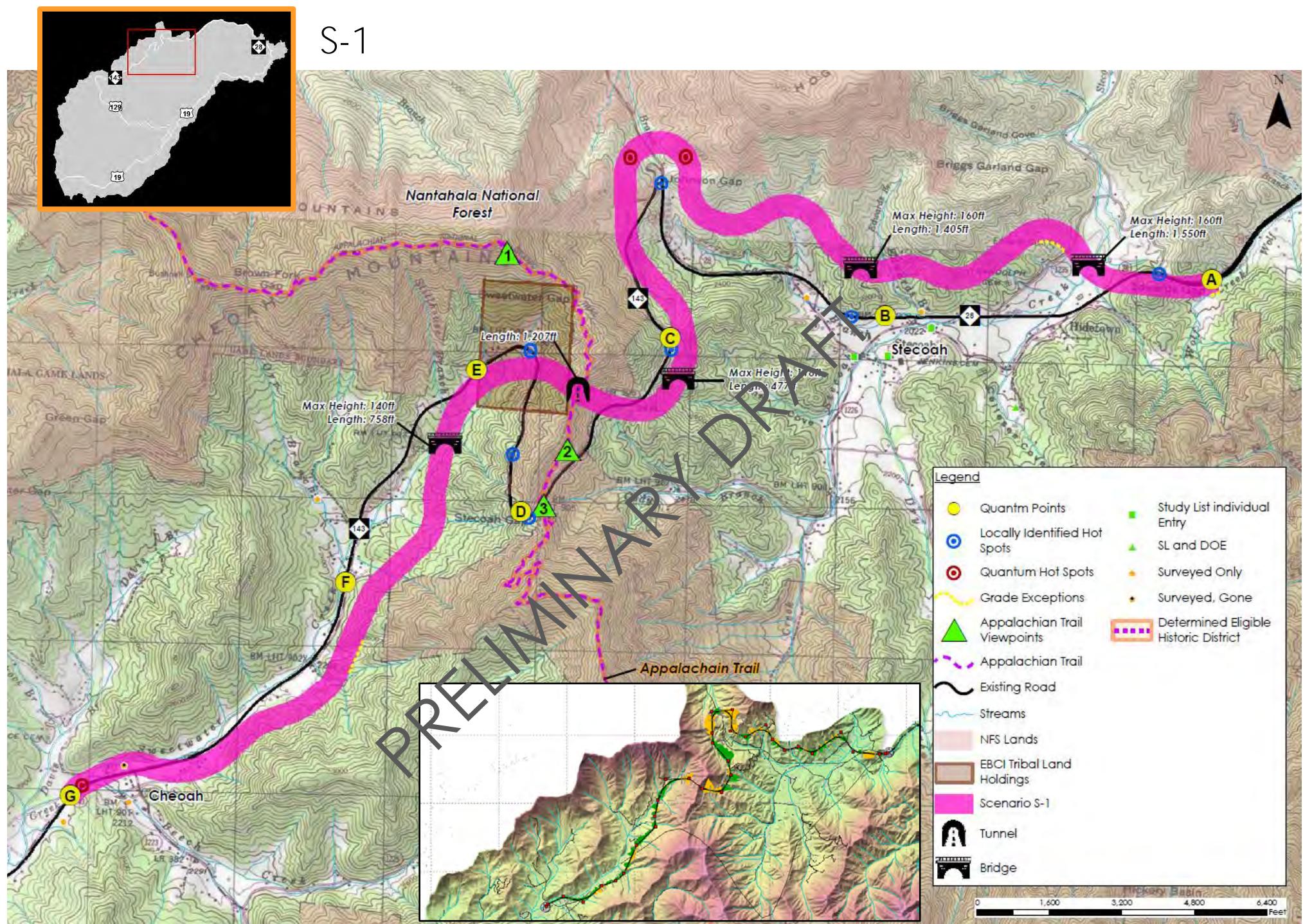


The GIS viewer has a “crowdsourcing” feature where project team members can add comments and/or questions for the CPT or as notes for group discussion at the next project team meeting.





S-1





Scenario S-1

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-1 originates at Point A and follows the north side of Stecoah Valley before turning north of the NC 28/NC 243 intersection, then west and south before turning westward into a tunnel underneath the AT, after which the alignment parallels existing NC 143 to the south to Point G.

Considerations:

- Design: high amount of unstable colluvial soil along the eastern side of NC 143; pyritic rock ("hot rock") to the north of NC 28 and NC 143 intersection; high bridges
 - Community: Corridor has low potential for impacts to commercial properties and high potential for impacts to residences, primarily north of NC 28 and along the existing NC 143 between F and G
 - Visual Effects: Corridor and earthwork visible along the north side of the Stecoah Valley from AT viewpoints (VPs) 1 and 3; corridor visible in the distance towards Cheoah from VPs 1-3
 - Tribal Land Holdings: Would impact one EBCI land holding
 - Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House) on the north side of NC 143 at Beech Creek Road; scenario crosses AT historic boundary
 - Habitat Fragmentation: Would fragment a section of the Nantahala Forest in the area around Stecoah Gap and the existing intersection of NC 28 and NC 143; among lowest impacts to NFS lands; among longest new location sections
 - Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)

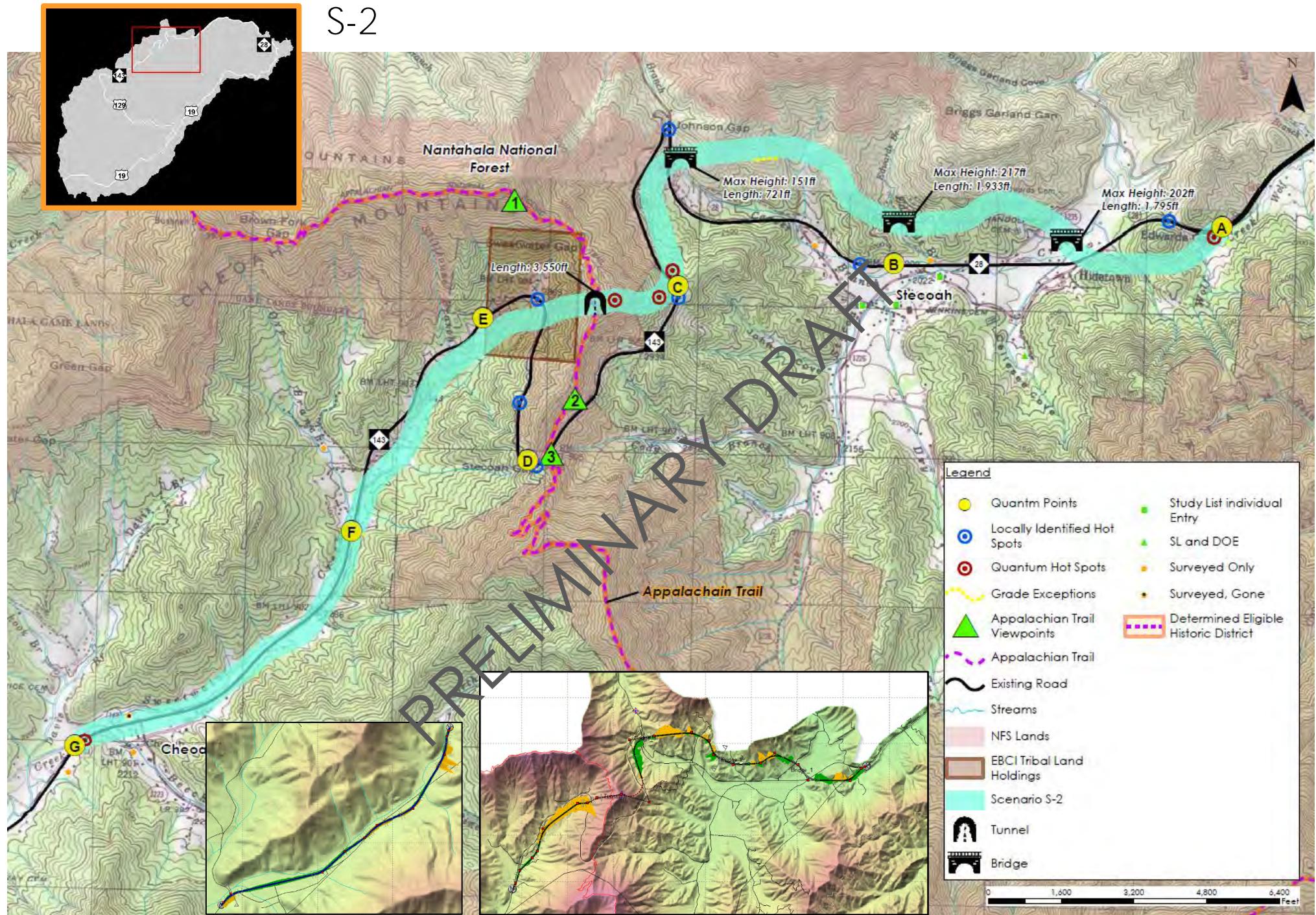


Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AG	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M
Totals	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
 2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
 3. Grade exceptions include grades exceeding desired grade of 6%.
 4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

S-2



Scenarios S-2

Scenario S-2

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-2 originates at Point A and follows the north side of the Stecoah Valley, then turning south crossing NC 28 and NC 143 south of the existing intersection, before climbing to a tunnel under the AT, after which the alignment turns south paralleling NC 143 to the east. From Point F to Point G, this scenario would follow the existing NC 143 corridor.

Considerations:

- Design: Shortest length; less bridges than S-3 on north side of NC 28; parallel route to NC 28 improves system reliability; low amount of design exception areas; potential for passing/climbing lanes on NC 143 west of Stecoah Gap; low amount of design exception areas
- Community: Corridor would have a low potential to impact commercial properties and extremely high impact on residences, primarily located north of NC 28 and along the existing NC 143 between F and G.
- Visual Effects: Parallels existing corridor for majority of corridor – cut/fill slopes north of Valley visible from AT VP's but minimal compared to other scenarios
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House) on the north side of NC 143 at Beech Creek Road; crosses AT historic boundary
- Habitat Fragmentation: Would fragment a section of the Nantahala Forest in the area around Stecoah Gap and the existing intersection of NC 28 and NC 143; lowest impacts to NFS lands.
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AF	5.0	4,449	3,550	12	14	0.30 (7%)	0.20 (3%)	\$152 M
FG	1.6	0	0	4	0	0.10 (4%)	0 (0%)	\$4.6 M
Totals	6.6	4,449	3,550	16	14	0.40 (6%)	0.20 (2%)	\$157 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

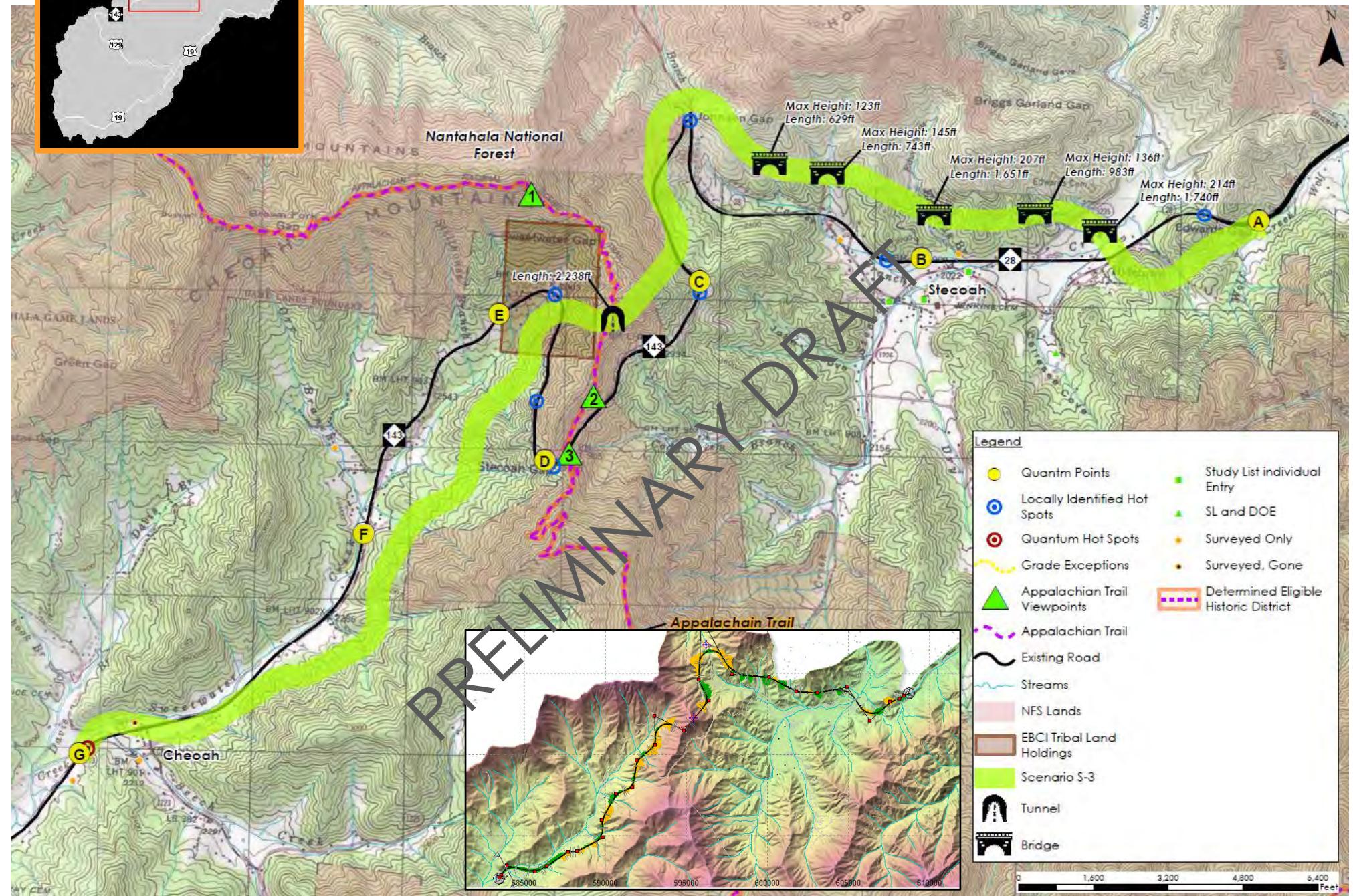
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



S-3



Scenario S-3

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-3 originates at Point A and follows the north side of the Stecoah Valley before crossing north of the NC 143/NC 28 intersection and then moving south to a tunnel under the AT, after which the alignment turns west and parallels the existing NC 143 corridor ending at Point G.

Considerations:

- Design: Avoids the most pyritic rock and colluvium of options in Stecoah, large cut on west side of Stecoah Gap is in unstable material with a history of large slides; high number of bridges
 - Community: Corridor would have low potential impacts on commercial properties and high potential impact on residences located north of NC 28
 - Visual Effects: Most of corridor on new location but parallels existing road - corridor north of the gap visible but notable concerns for visual effects from new location corridor on west side of Stecoah Gap from AT VPs north of the Gap looking westward
 - Tribal Land Holdings: Would impact one EBCI land holding
 - Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House, Gone) on the north side of NC 143 at Beech Creek Road; crosses AT historic boundary
 - Habitat Fragmentation: Would fragment a contiguous segment of the Nantahala Forest to the north and east of Stecoah Gap; among longest new location sections
 - Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)

COMMUNITY IMPACT SCALE
COMMERCIAL → RESIDENTIAL
Low (1-3) Medium (4-11) High (12-19) Extremely high (20+)

NOTARY



Environmental (Level)

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AG	6.9	5,746	2,238	12	42	0.07 (1%)	0.02 (0.3%)	\$152 M
Totals	6.9	5,746	2,238	12	42	0.07 (1%)	0.02 (0.3%)	\$152 M

Notes:

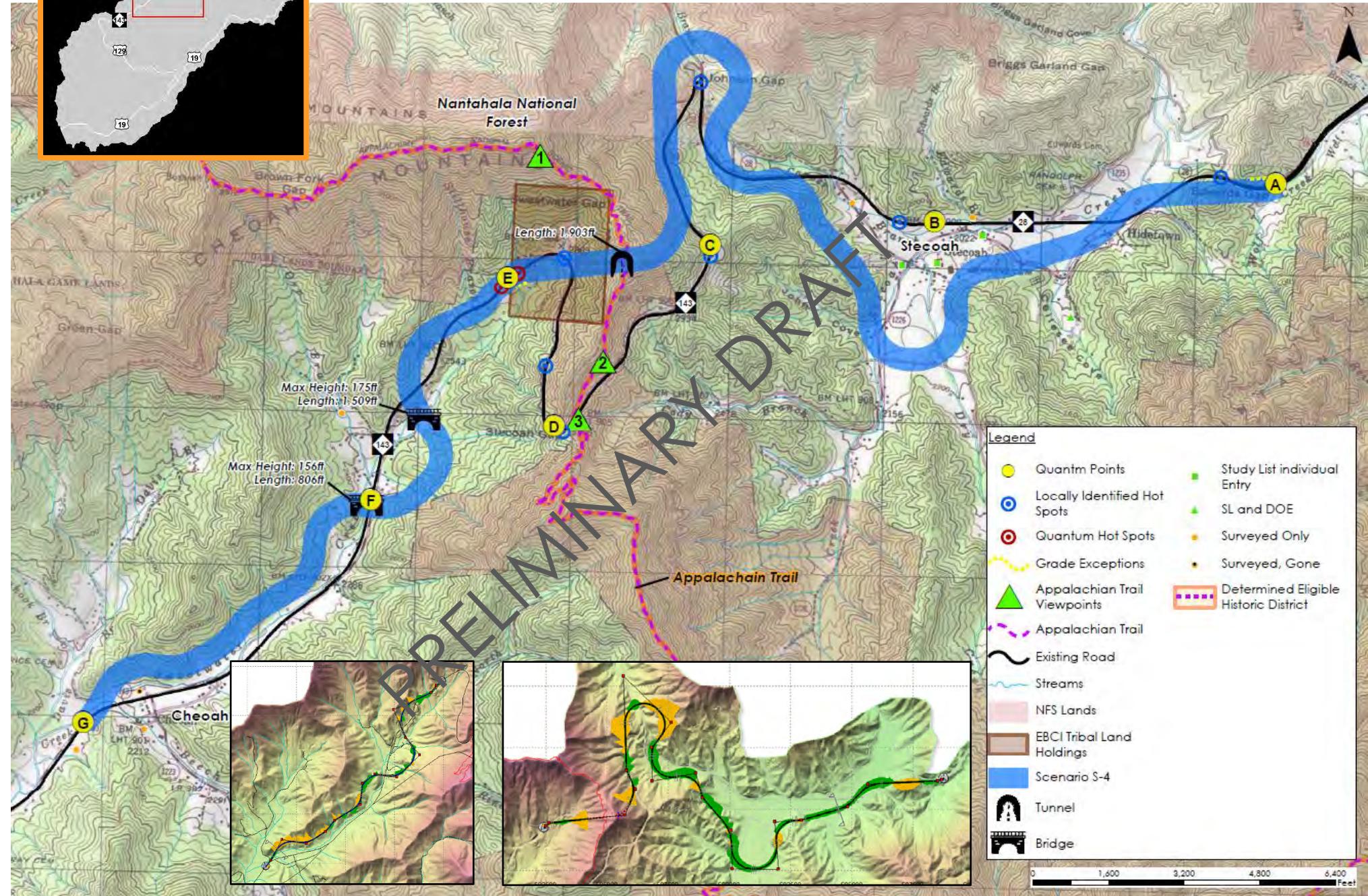
- NOTES:

 1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
 2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
 3. Grade exceptions include grades exceeding desired grade of 6%.
 4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

Scenario S-3



S-4



Scenarios

S-4

Scenario S-4

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-4 originates at Point A and follows the south side of the Stecoah Valley before turning north and passing north of the NC 28/NC 143 intersection, then climbing south to a tunnel under the AT, after which the alignment turns west converging with existing NC 143 at Point E. From Point E to Point G, this scenario realigns existing NC 143 to the meet Quantm model parameters. Because there are short sections of existing NC 143 between Points E and G where roadway grades approach 10%, the Quantm scenario is longer to maintain the desired grade.

Considerations:

- Design: Among longest alignments with high amounts of excavation; among lowest number of bridges; additional design studies could be conducted to assess grade exception required to converge with existing NC 143 at or near Point E continuing westward
- Community: Corridor would have a potential for a medium level impact on commercial properties and extremely high potential for impacts to residences, primarily south of NC 28
- Visual Effects: New location corridor on south side of the Stecoah Valley visible from AT viewpoints
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Crosses AT historic boundary
- Habitat Fragmentation: Would fragment a contiguous segment of the Nantahala Forest to the north and east of Stecoah Gap; moderate level of impacts as compared to other scenarios; potential to reduce fragmentation effects between F and G and, to a lesser extent, between E and F
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AE	5.2	0	1,903	9	50	0.03 (0.5%)	0.20 (4%)	\$123 M
EG	2.9	2,315	0	6	0	0.02 (1%)	0 (0%)	\$27.5 M
Totals	8.1	2,315	1,903	15	50	0.05 (0.6%)	0.20 (3%)	\$151 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

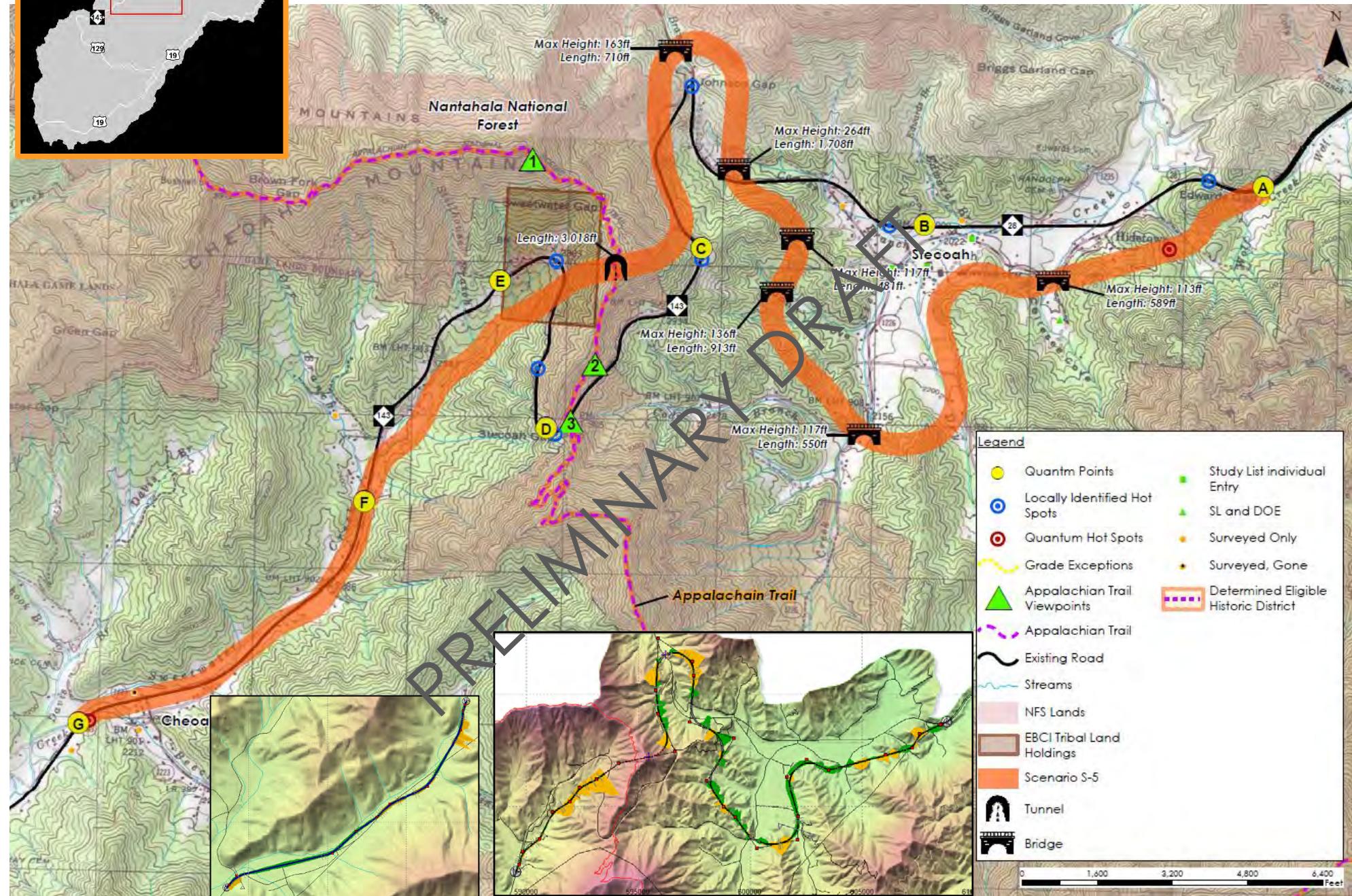
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



S-5



Scenarios

S-5

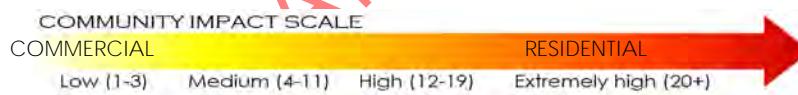
Scenario S-5

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-5 originates at Point A and follows the south side of the Stecoah Valley before turning south of Stecoah and then climbing north of the NC 28/NC 143 intersection, to a tunnel under the AT, after which the alignment turns west converging with existing NC 143 at Point F. From Point F to Point G, this scenario would follow the existing NC 143 corridor.

Considerations:

- Design: High amount of colluvium; high bridge and tunnel lengths; north-facing bridges; potential to reduce curves on NC 143 west of Stecoah Gap between E and F
- Community: Corridor would have a low potential for impacts to commercial properties and extremely high potential for impacts to residences south of NC 28
- Visual Effects: New location south of Stecoah Valley visible from AT viewpoints
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House, Gone) on the north side of NC 143 at Beech Creek Road; crosses AT historic boundary
- Habitat Fragmentation: Would fragment a contiguous segment of the Nantahala Forest to the north and east of Stecoah Gap; moderate impacts to NFS lands
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AF	6.9	4,951	3,018	8	44	0.02 (0.3%)	0.05 (0.7%)	\$173 M
FG	1.6	0	0	4	0	0.07 (4%)	0 (0%)	\$4.6 M
Totals	8.5	4,951	3,018	12	44	0.09 (1%)	0.05 (0.6%)	\$178 M

Notes:

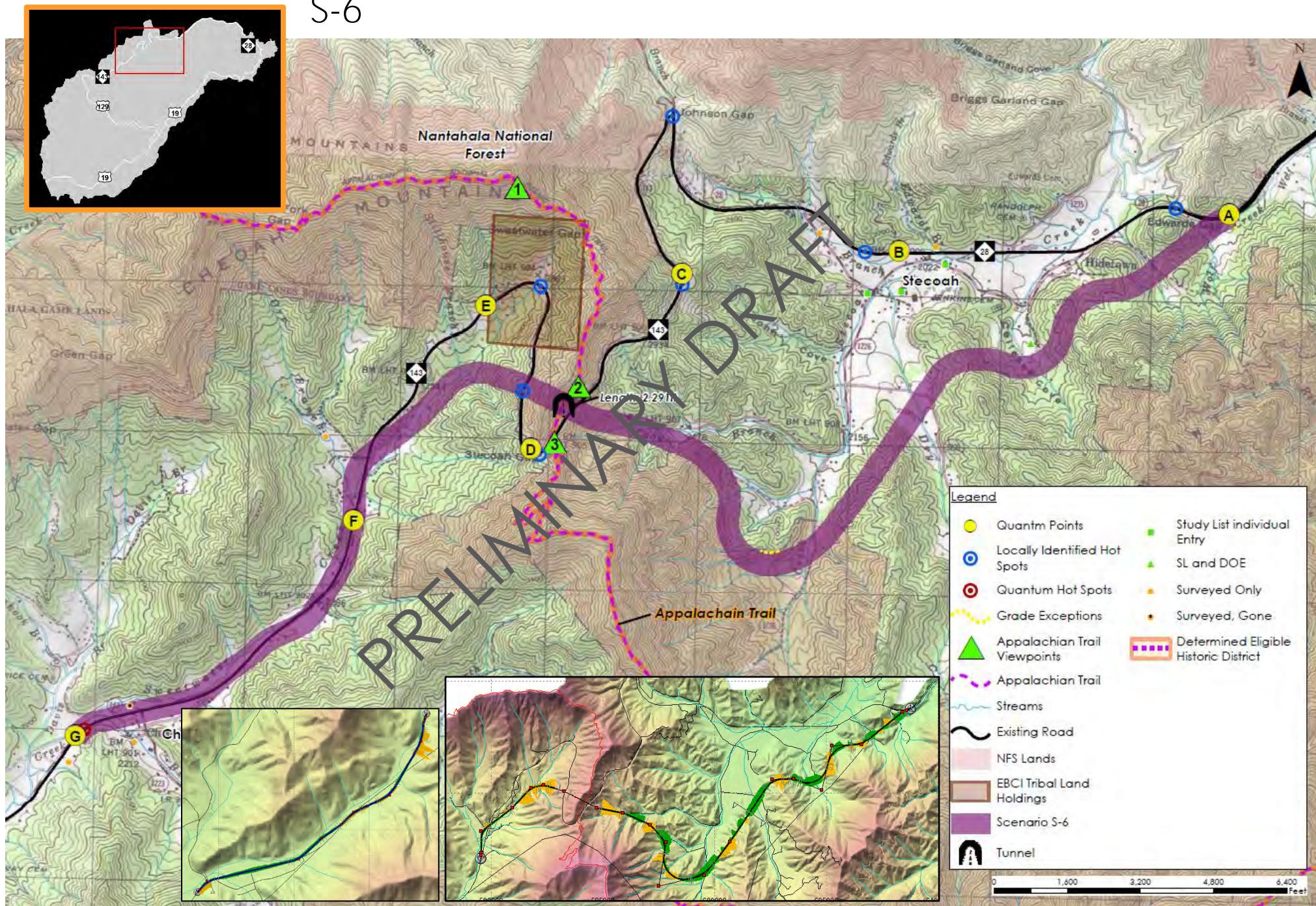
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

S-6



Scenarios

S-6

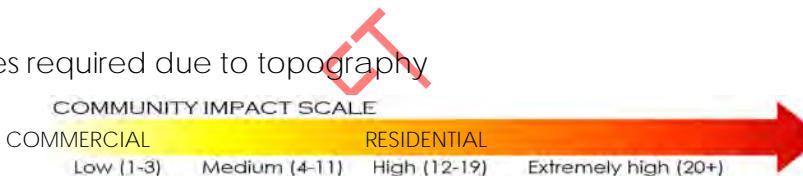
Scenario S-6

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-6 originates at Point A and follows the south side of the Stecoah Valley before turning south running parallel to Cody Branch and then climbing to a tunnel under the AT, after which the alignment turns southwest converging with existing NC 143 at Point F. From Point F to Point G, this scenario would follow the existing NC 143 corridor.

Considerations:

- Design: One of shortest corridors in Stecoah; no bridges required due to topography
- Community: Corridor would not impact commercial properties; potential for high impacts to residences south of NC 28
- Visual Effects: New location south of Stecoah Valley visible from AT viewpoints
- Tribal Land Holdings: None
- Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House) on the north side of NC 143 at Beech Creek Road; crosses AT historic boundary
- Habitat Fragmentation: Would fragment (in multiple places) a contiguous segment of the Nantahala Forest which stretches from northernmost edge of project area north of Stecoah to the Gorge in the east and US 129 in the south; among highest impacts to NFS lands
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AF	5.1	0	2,291	15	74	0 (0%)	0.20 (3%)	\$97.4 M
FG	1.6	0	0	4	0	0.07 (4%)	0 (0%)	\$4.6M
Totals	6.7	0	2,291	19	74	0.07 (1%)	0.20 (2%)	\$102 M

Notes:

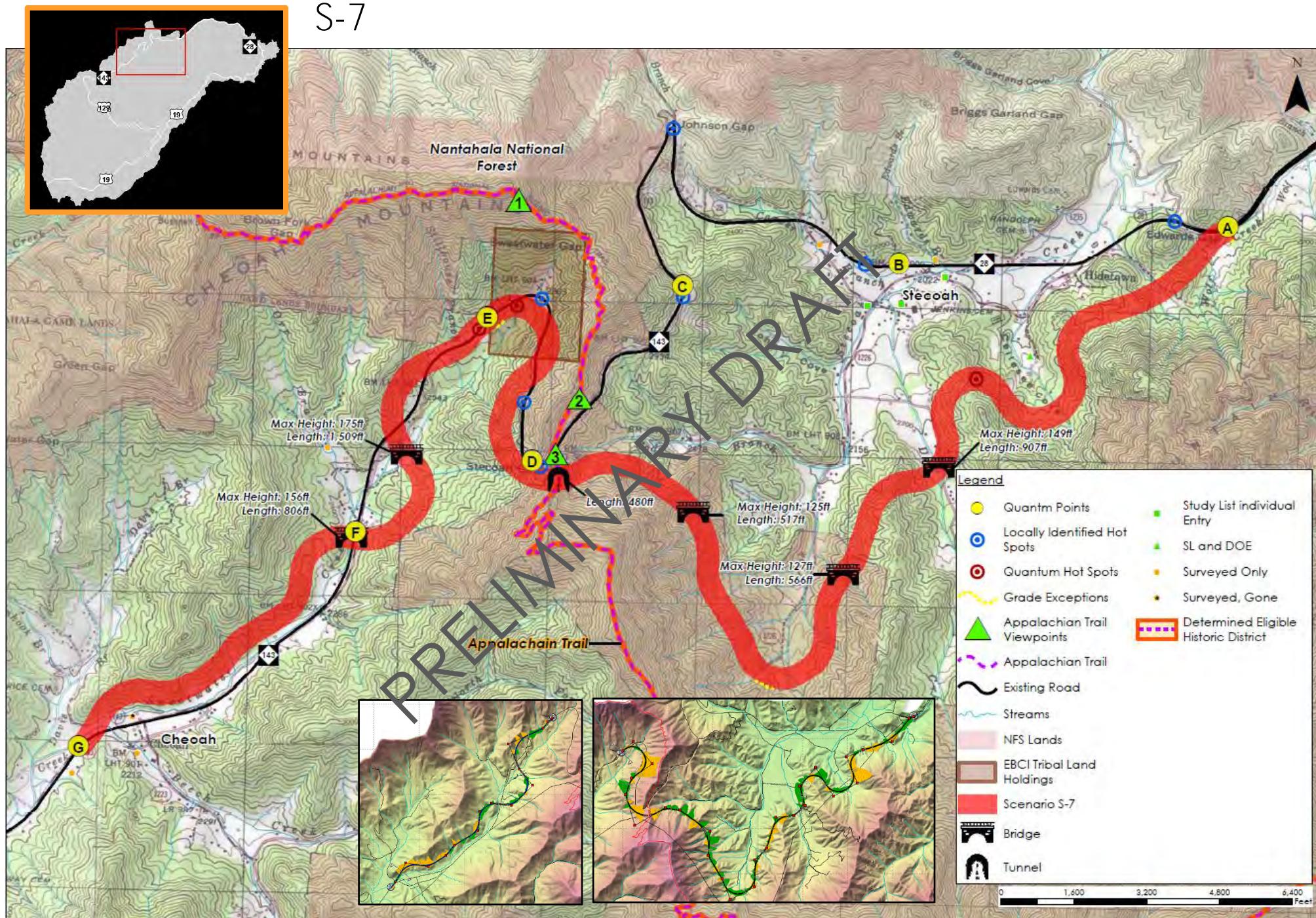
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

S-7



Scenarios S-7

Scenario S-7

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-7 originates at Point A and follows the south side of the Stecoah Valley before turning south running parallel to Cody Branch then climbing to a tunnel under the AT, after which the alignment turns north before converging with existing NC 143 at Point E. From Point E to Point G, this scenario realigns existing NC 143 to the meet Quantm model parameters. Because there are short sections of existing NC 143 between Points E and G where roadway grades approach 10%, the Quantm scenario is longer to maintain the desired grade.

Considerations:

- Design: Longest alignment with high amounts of excavation
- Community: Corridor would have a low impact on commercial properties and high impact on residences south of NC 28
- Visual Effects: High level of visual effects from AT VPs looking eastward from the Stecoah Gap area and northward from AT VPs south of Stecoah Valley
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Crosses AT historic boundary
- Habitat Fragmentation: Would fragment a contiguous segment of the Nantahala Forest south and east of Stecoah Gap; highest impacts to NFS lands in the Stecoah area due to alignment to the south of Stecoah
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AE	5.9	1,990	480	16	131	0.40 (7%)	0.10 (2%)	\$98.6 M
EG	2.9	2,315	0	6	0	0.02 (1%)	0 (0%)	\$27.5 M
Totals	8.8	4,305	480	22	131	0.40 (5%)	0.10 (2%)	\$126 M

Notes:

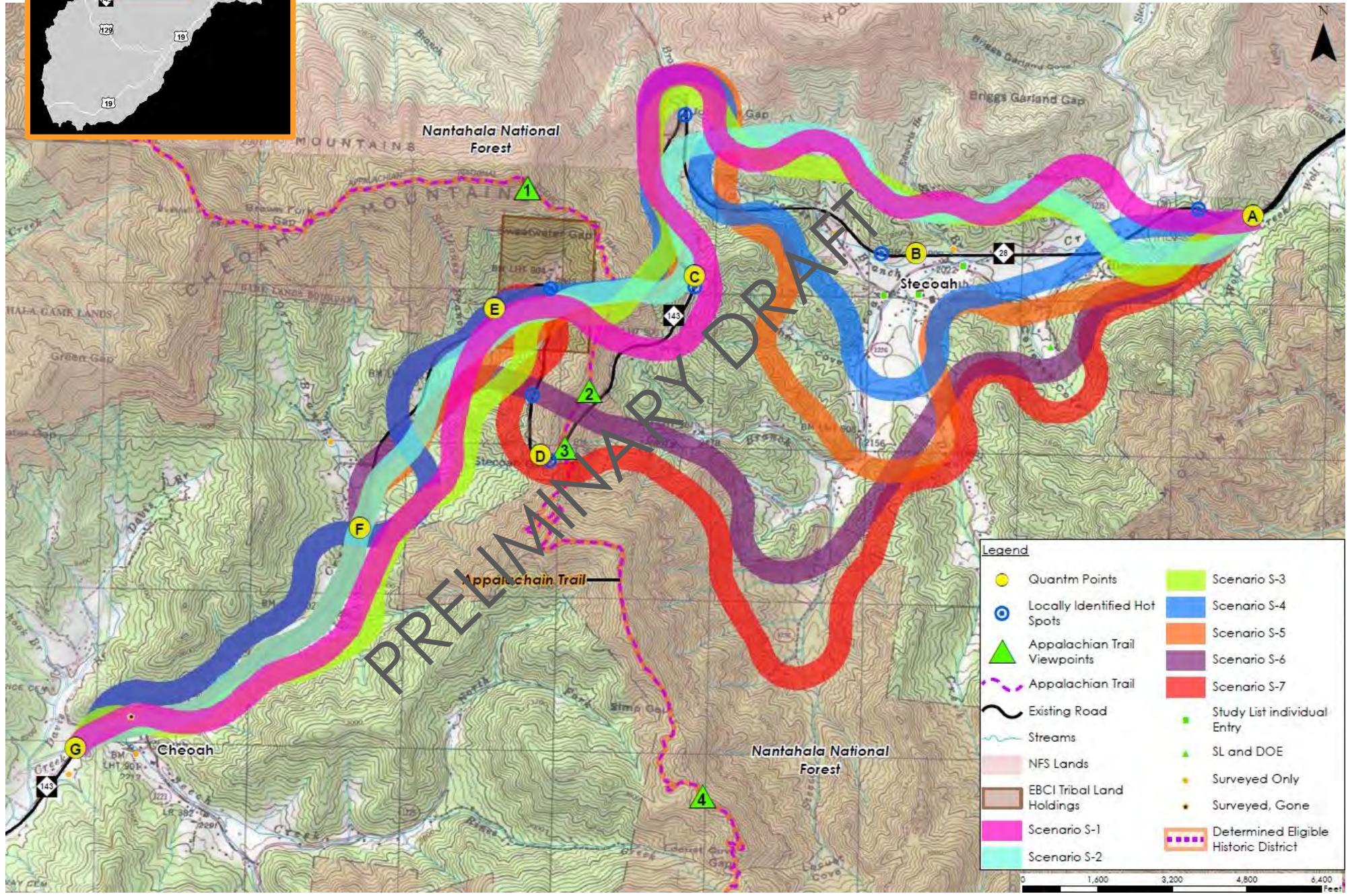
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding 6%

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

Stecoah Scenarios



EVALUATION MATRIX

STECOAH SCENARIOS

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
Scenario S-1	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M
Scenario S-2	6.6	4,449	3,550	16	14	0.40 (6%)	0.20 (2%)	\$157 M
Scenario S-3	6.9	5,746	2,238	12	42	0.07 (1%)	0.02 (0.3%)	\$152 M
Scenario S-4	8.1	2,315	1,903	15	50	0.05 (0.6%)	0.20 (3%)	\$151 M
Scenario S-5	8.5	4,951	3,018	12	44	0.09 (1%)	0.05 (0.6%)	\$178 M
Scenario S-6	6.7	0	2,291	19	74	0.07 (1%)	0.20 (2%)	\$102 M
Scenario S-7	8.8	4,305	480	22	131	0.40 (5%)	0.10 (2%)	\$126 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

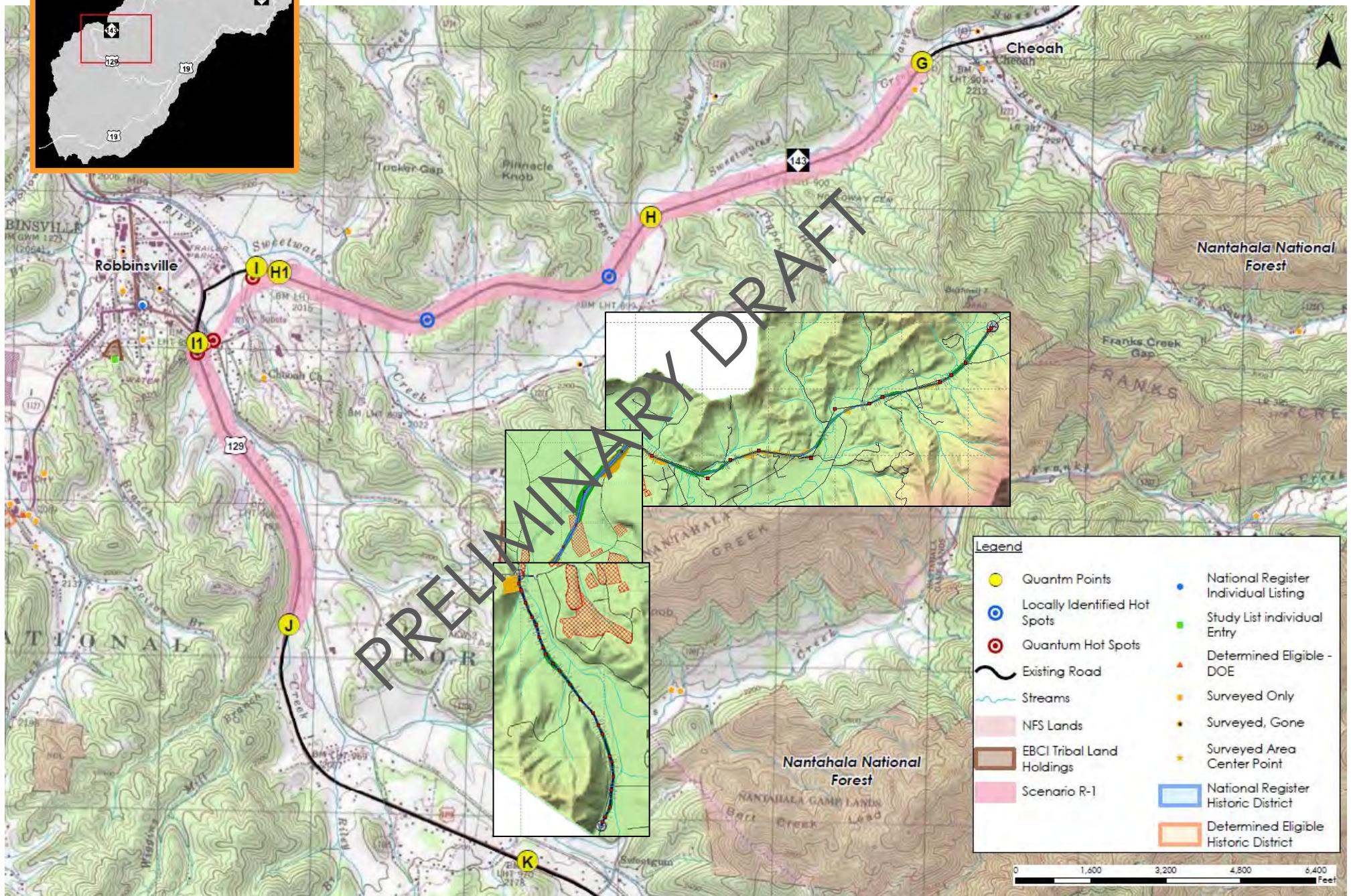
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

STECOAH

R-1



Scenario R-1

Scenario R-1

SR 1220 (Pin Hook Road) to South of SR 1260 (Airport Road)

Scenario Overview: Scenario R-1 originates at Point G and follows the existing NC 143 corridor to point H1, where the corridor turns southwest at Five Point Road continuing to Point I1, then following the existing US 129 corridor to Point J.

Considerations:

- Design: Primarily on fill with some minor cut sections. Additional design investigations needed to determine if R-1 could be a continuous flow traffic movement from NC 143 to US 129. Roundabouts on NC 143 and US 129 could be studied as a way to provide a gateway into Robbinsville and convey a sense of place.
- Community: Corridor would have a medium impact on commercial and residential properties
- Tribal Land Holdings: None
- Historic Structures/Trails: Would affect one "Surveyed-Only" historic structure (identified only as "House" in SHPO database); potential historic structure on west side of Five Point Road
- Habitat Fragmentation: Minimal effects associated with improving existing facility
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 143 and 1 on US 129



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
GH1	3.0	0	0	10	0	0.2 (5.7%)	0 (0%)	\$10.2 M
H1I1	0.4	0	0	2	0	0.2 (50%)	0 (0%)	\$1.4 M
I1J	1.3	0	0	6	0	0.01 (1%)	0 (0%)	\$3.2 M
Totals	4.7	0	0	18	0	0.4 (9%)	0 (0%)	\$14.8 M

Notes:

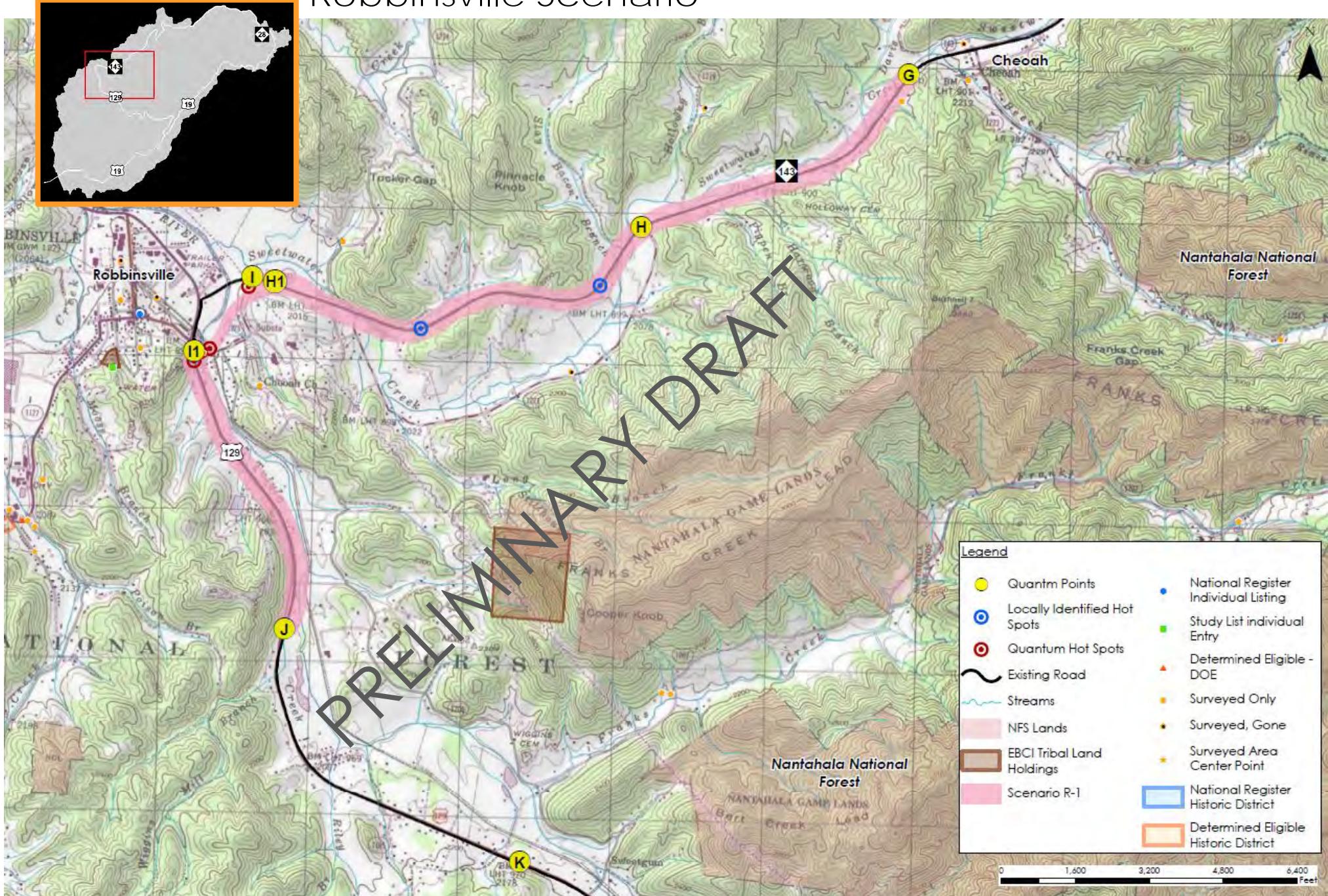
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

Robbinsville Scenario



ROBBINSVILLE

EVALUATION MATRIX

ROBBINSVILLE SCENARIO

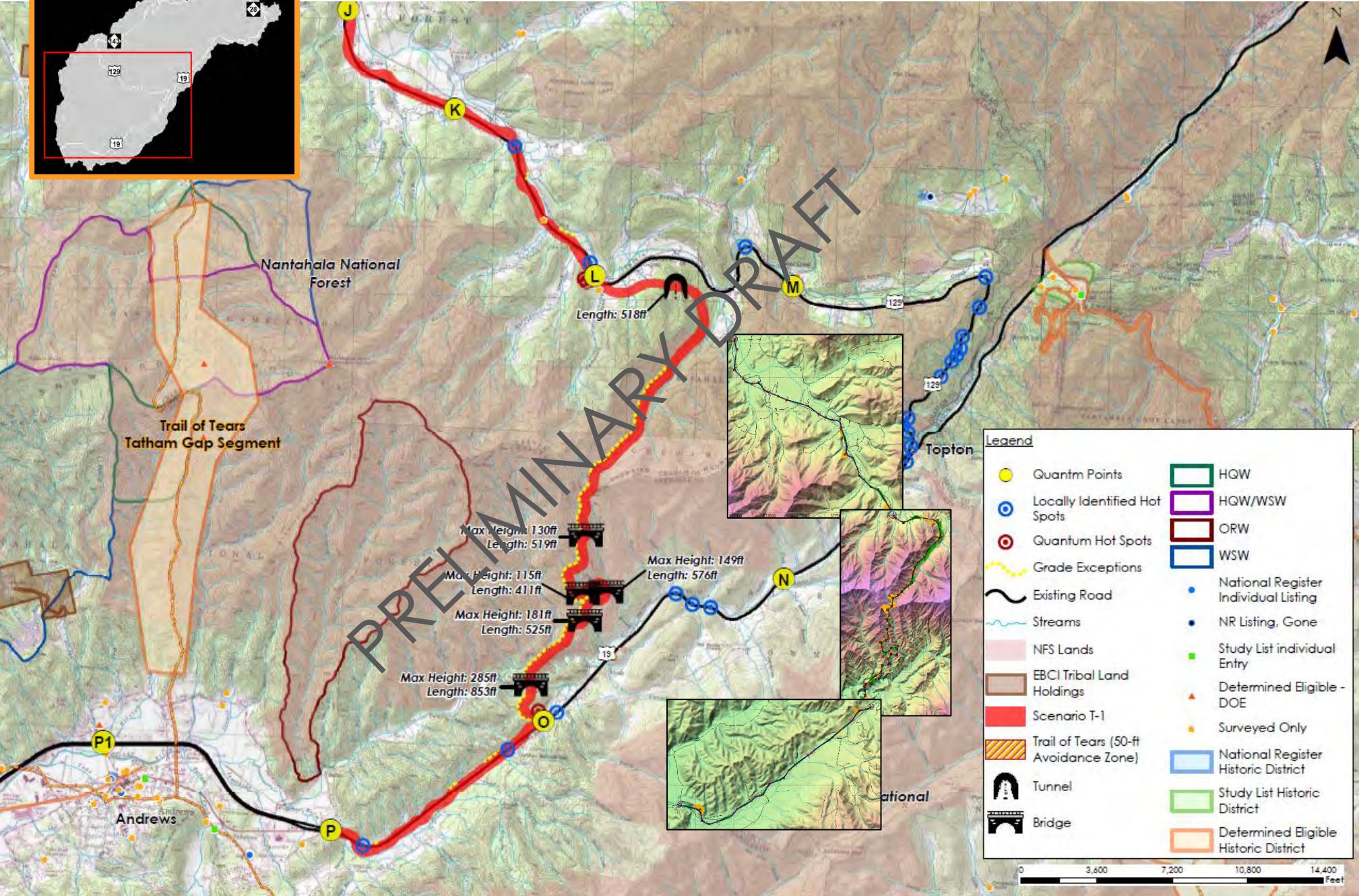
Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
Scenario R-1	4.7	0	0	18	0	0.4 (9%)	0 (0%)	\$14.8 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
3. Grade exceptions include grades exceeding desired grade of 6%.
4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

PRELIMINARY DRAFT

T-1



Scenario T-1

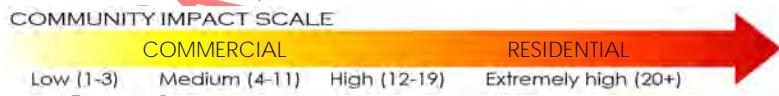
Scenario T-1

South of SR 1260 (Airport Road) to SR 1393 (Wakefield Road)

Scenario Overview: Scenario T-1 originates at Point J and follows existing US 129 to Point L, where the alignment enters a tunnel south of US 129 and turns southwest towards Andrews paralleling Jutts Creek. The alignment continues south on a new location through the Snowbird Mountains and joins existing US 74 at Point O, where it continues along the existing roadway to Point P.

Considerations:

- Design: Lower elevation and lower freeze potential; potential to improve a long section of US 129 while avoiding geologic hot spots between Points M and N and high crash hot spots between Points N and O; high, tall bridges on the south side of the Snowbird Mountains; future design studies should evaluate steepening grades to reduce bridge and tunnel lengths, shifts to the alignment to balance out earthwork and reduce visual effects, and shifts to avoid community impacts
- Community: Corridor would have the potential for medium level impacts to commercial properties and extremely high impacts to residences primarily along existing US 129 between Points J and L and US 74 between Points O and P.
- Tribal Land Holdings: None
- Historic Structures/Trails: Would impact two "Surveyed Only" structures on US 129 (Campbell-Colvard House and identified only as "House" in SHPO database)
- Habitat Fragmentation: High impacts to NFS lands due to new location corridor, bisecting currently undisturbed habitat
- Locally-Identified Hot Spots: Would address 14 hotspots on US 129 and 7 on US 74



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
JL	3.7	0	0	9	0	0.07 (2%)	0.2 (7%)	\$11.5 M
LO	6.3	2,884	518	23	271	0.02 (0.4%)	4.2 (67%)	\$95 M
OP	2.4	0	0	9	0	0 (0%)	0.4 (16%)	\$5.9 M
Totals	12.4	2,884	518	41	271	0.09 (0.8%)	4.8 (39%)	\$112 M

Notes:

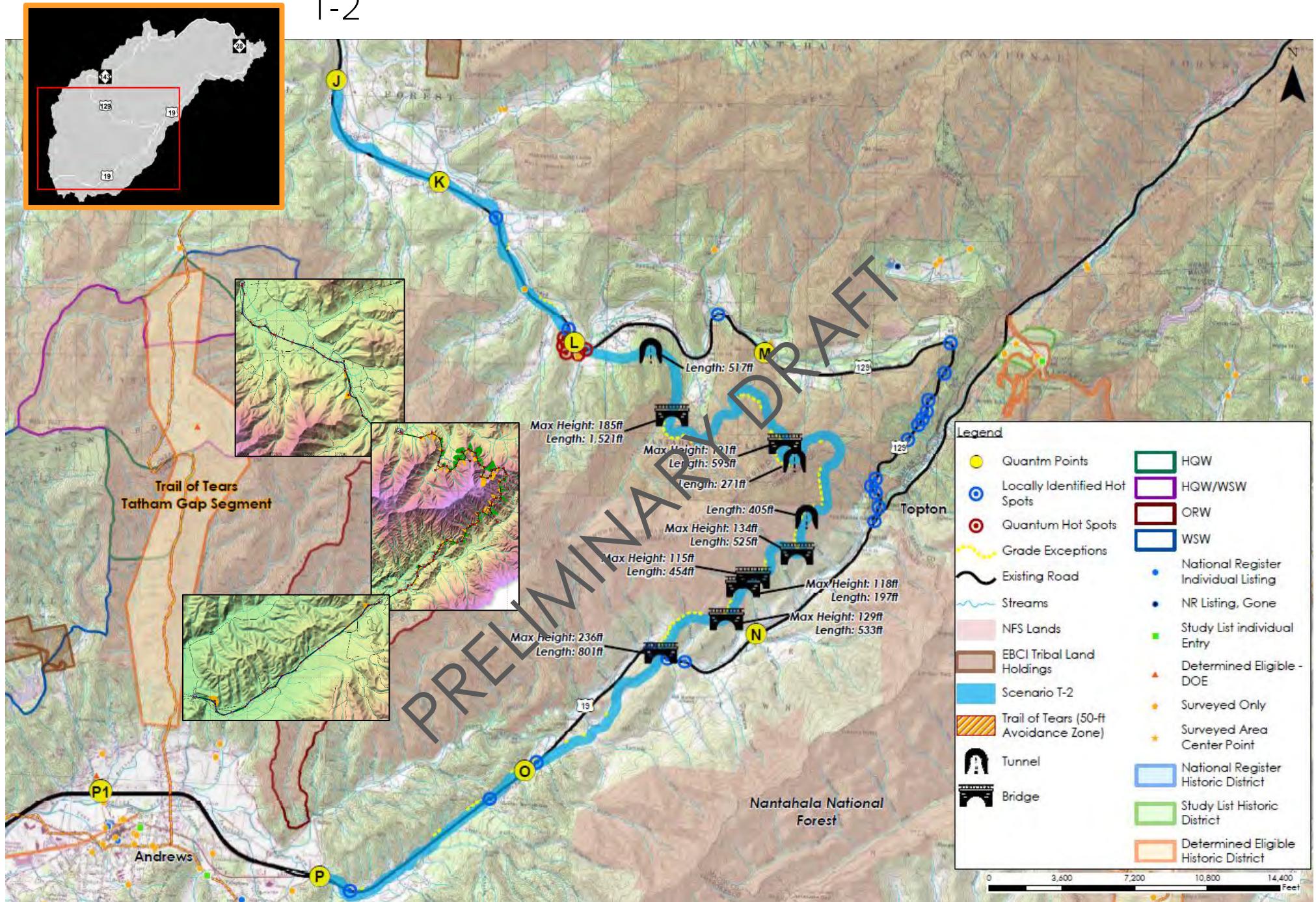
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

T-2



SCENARIO T-2

Scenario T-2

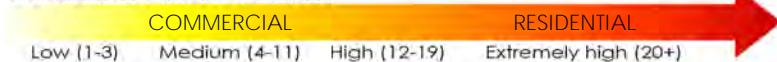
South of SR 1260 (Airport Road) to SR 1393 (Wakefield Road)

Scenario Overview: Scenario T-2 originates at Point J and follows existing US 129 to Point L, where the alignment enters a tunnel south of US 129 before turning south at Jutts Creek and continuing approximately 4,500 feet before turning north, looping back to the south and paralleling existing US 129 and US 74 to the south and west through two tunnels and several bridges. The alignment crosses US 74 at Bryson Branch, paralleling the existing US 74 to the east at Bryson Branch before converging with existing US 74 at Point O, where it continues along the existing roadway to Point P.

Considerations:

- Design: Would allow for steeper rock slopes and less excavation; three tunnels; long high bridges; longest scenario in Topton area; future studies should evaluate Quantm hot spots at Point L; avoids geologic hot spots between Points M and N and high crash hot spots between Points N and O
- Community: Corridor would have a medium level potential to impact commercial properties and extremely high potential to impact residences primarily along the existing US 129 between Points J and L and US 74 between Points O and P
- Tribal Land Holdings: None
- Historic Structures/Trails: Would impact one "Surveyed Only" structure on US 129 (identified only as "House" in SHPO database)
- Habitat Fragmentation: Longest length contributes to highest amount of NFS impacts and longest length of bisected NFS land
- Locally-Identified Hot Spots: Would address 14 hotspots on US 129 and 7 on US 74

COMMUNITY IMPACT SCALE



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
JL	3.7	0	0	9	0	0.07 (2%)	0.3 (7%)	\$11.5 M
LO	9.3	4,626	1,193	29	314	0.08 (0.9%)	3.5 (37%)	\$191 M
OP	2.4	0	0	9	0	0 (0%)	0.4 (16%)	\$5.9 M
Totals	15.4	4,626	1,193	47	314	0.2 (1%)	4.2 (27%)	\$208 M

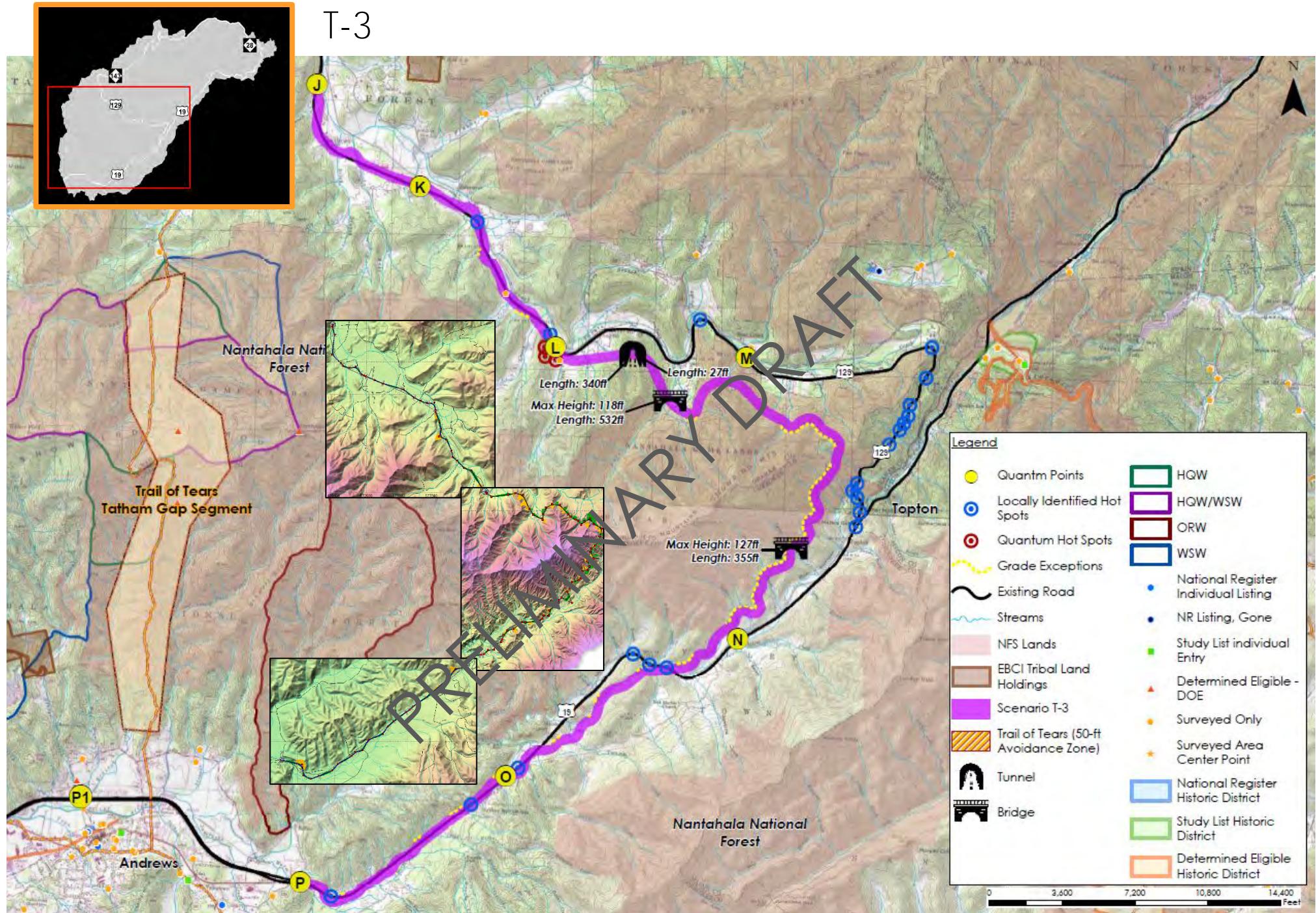
Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



Scenario T-3

Scenario T-3

South of SR 1260 (Airport Road) to SR 1393 (Wakefield Road)

Scenario Overview: Scenario T-3 originates at Point J and follows existing US 129 to Point L, where the alignment enters two short tunnels south of US 129 before turning south towards Jutts Creek. The alignment turns north before looping south, paralleling existing US 129 and US 74 to the south and west. The alignment crosses US 74 at Bryson Branch, paralleling the existing US 74 to the east at Bryson Branch before converging with existing US 74 at Point O, where it continues along the existing roadway to Point P.

Considerations:

- Design: Would allow for steeper rock slopes and less excavation; less bridges than other scenarios in Topton area; future design studies should evaluate tunnels to reduce grade exceptions and potential to straighten curves in the Cherokee County section
- Community: Corridor would have a medium level impact on commercial properties and extremely high impact on residences primarily along existing US 129 between Points J and L and US 74 between Points O and P1.
- Tribal Land Holdings: None
- Historic Structures/Trails: Would impact one "Surveyed Only" structure on US 129 (identified only as "House" in SHPO database)
- Habitat Fragmentation: Higher elevation contributes to shorter length and less fragmentation effects on NFS lands; higher elevation of alignment may have implications for protected species such as the northern flying squirrel or rock gnome lichen that prefer higher elevations
- Locally-Identified Hot Spots: Would address 14 hotspots on US 129 and 7 on US 74

COMMUNITY IMPACT SCALE

COMMERCIAL

Low (1-3)

Medium (4-11)

High (12-19)

Extremely high (20+)

RESIDENTIAL

Extremely high (20+)

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
JL	3.7	0	0	9	0	0.07 (2%)	0.3 (7%)	\$11.5 M
LO	8.5	887	367	28	181	0.04 (0.4%)	3.6 (43%)	\$102 M
OP	2.4	0	0	9	0	0 (0%)	0.4 (16%)	\$5.9 M
Totals	14.6	887	367	46	181	0.1 (0.8%)	4.3 (29%)	\$119 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

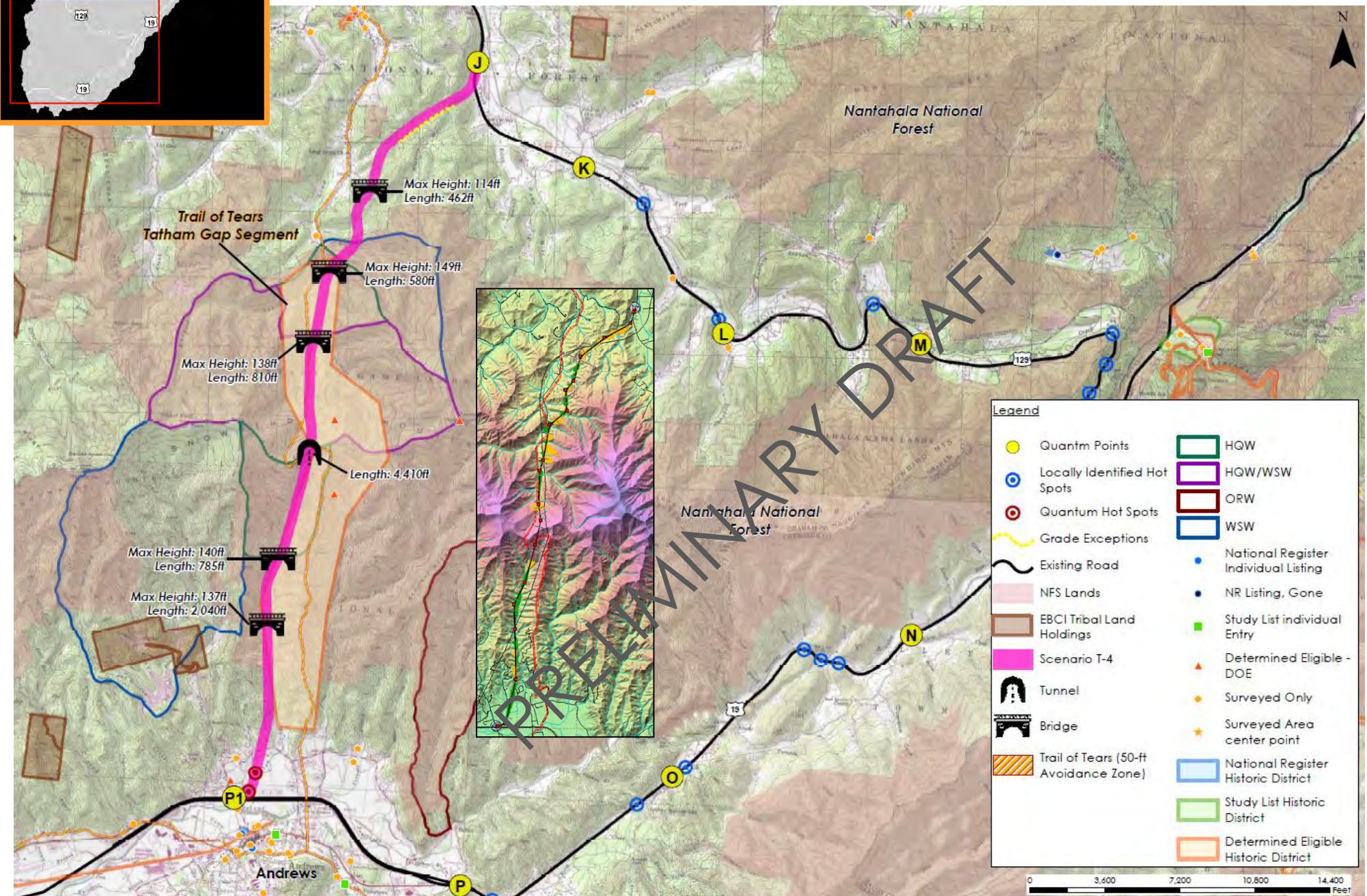
2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



T-4



Scenario T-4

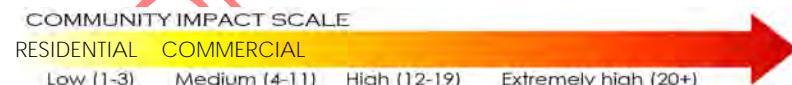
Scenario T-4

South of SR 1260 (Airport Road) to SR 1393 (Wakefield Road)

Scenario Overview: Scenario T-4 begins at Point J where it heads south towards Andrews, paralleling the Trail of Tears and SR 1100 (Long Creek Road). The alignment enters a long tunnel underneath the Snowbird Mountains and ends at Point P1 in Andrews.

Considerations:

- Design: Shortest alignment with the highest total length of tunnels and bridges; more competent rock can allow for steeper cut slopes to minimize earthwork; crosses pyritic rock but in the shortest length possible; presents the smallest length of grade exception areas but more consistently climbing grades; steep grades and number of structures increases concern for icing; very long bridge along southern portion of alignment; additional design studies should investigate potential to reduce structure dimensions
- Community: Corridor would have a moderate impact on commercial properties and a low impact on residences.
- Tribal Land Holdings: None
- Historic Structures/Trails: Parallels and crosses Trail of Tears
- Habitat Fragmentation: High impacts to NFS lands due to new location corridor, bisecting currently undisturbed habitat
- Water Resources: Traverses high quality waters/water supply waters (HQW/WSW) for approximately 3 miles
- Locally-Identified Hot Spots: Would address 14 hotspots on US 129 and 7 on US 74



Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
JP1	7.4	4,677	4,410	24	252	0.2 (2%)	0.6 (8%)	\$221 M
Totals	7.4	4,677	4,410	24	252	0.2 (2%)	0.6 (8%)	\$221 M

Notes:

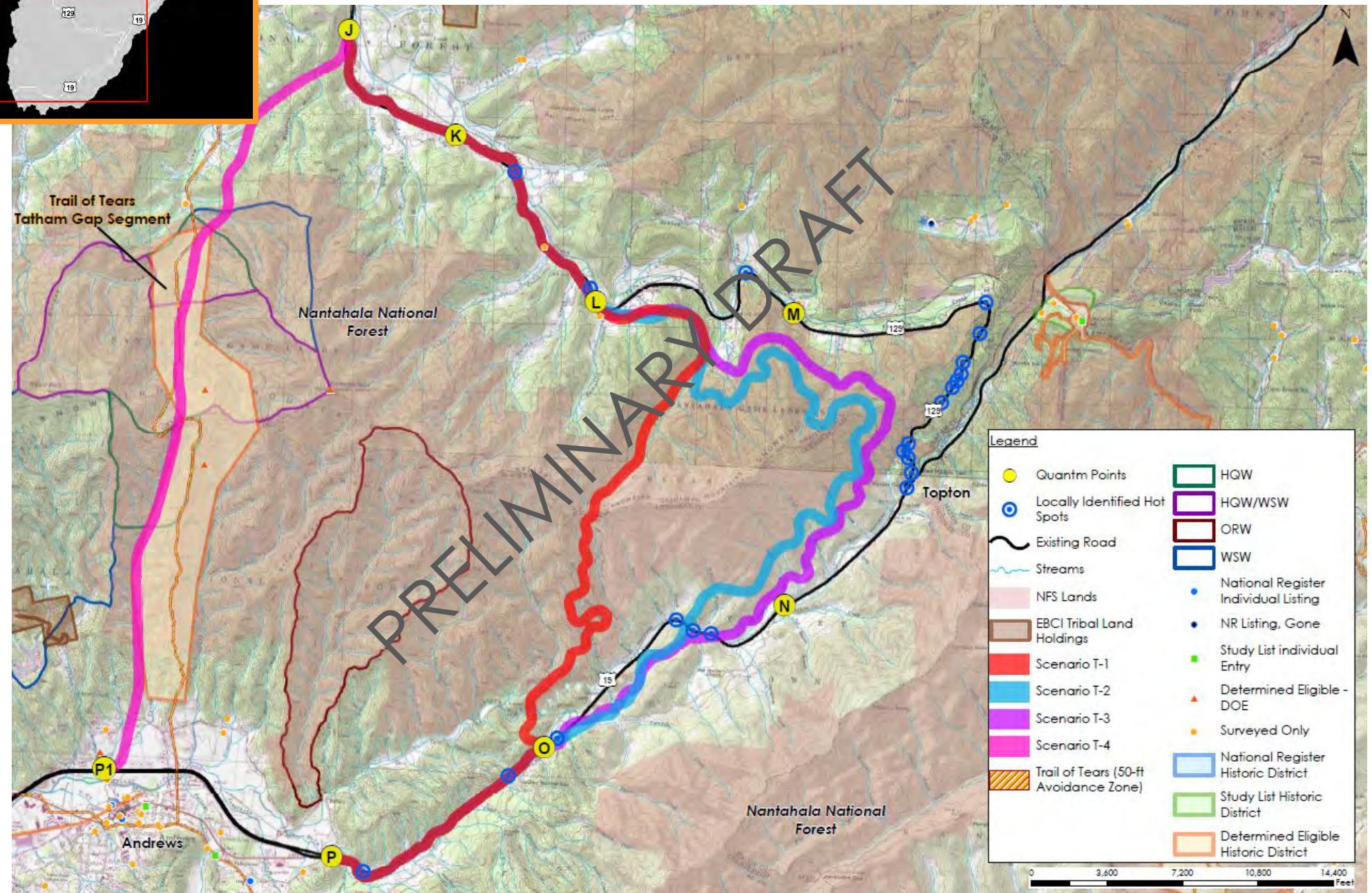
1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

Topton Scenarios



EVALUATION MATRIX

TOPTON SCENARIOS

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
Scenario T-1	12.4	2,884	518	41	271	0.09 (0.8%)	4.8 (39%)	\$112 M
Scenario T-2	15.4	4,626	1,193	47	314	0.2 (1%)	4.2 (27%)	\$208 M
Scenario T-3	14.6	887	367	46	181	0.1 (0.8%)	4.3 (29%)	\$119 M
Scenario T-4	7.4	4,677	4,410	24	252	0.2 (2%)	0.6 (8%)	\$221 M

Notes:

1. Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.

2. Quantm identifies locations where curves exceed desired design criteria and would increase travel times.

3. Grade exceptions include grades exceeding desired grade of 6%.

4. Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.

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Toolbar >> View >> Page Display >> Two Page View

Toolbar >> View >> Page Display >> Two Page View

The screenshot shows a Adobe Acrobat Pro window displaying a map and a scenario overview side-by-side.

Left Panel (Map):

- Page Display:** The "Two Page View" option is selected.
- Map Content:** A topographic map of the Stecoah Valley area. A thick pink line highlights a proposed corridor alignment. Points A through G are marked along this line. Various symbols indicate geological features like Quaternary Points, Locally Identified Hot Spots, Quantum Hot Spots, Grade Exceptions, and Appalachian Trail Weekpoints. A legend provides details on these symbols.
- Inset Map:** A smaller map at the bottom left shows the location of the study area within the Nantahala National Forest.

Right Panel (Scenario Overview):

Section 4-2: **Preliminary Draft November 2018 Scenario S-1**
Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-1 originates at Point A and follows the north side of Stecoah Valley before turning north of the NC 28 and NC 143 intersection, then west and south before turning westward into a tunnel underneath the AT, after which the alignment parallels existing NC 143 to the south to Point G.

Considerations:

- Design: high amount of unstable colluvial soil along the eastern side of NC 143; pyritic rock ("hot rock") to the north of NC 28 and NC 143 intersection; high bridges
- Community: Corridor has low potential for impacts to commercial properties and high potential for impacts to residences, primarily north of NC 28 and along the existing NC 143 between F and G
- Visual Effects: Corridor and earthwork visible along the north side of the Stecoah Valley from AT viewpoints (VPs) 1 and 3; corridor visible in the distance towards Cheoah from VP 3
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House) on the north side of NC 143 at Beech Creek Road; scenario crosses AT historic boundary
- Habitat Fragmentation: Would fragment a section of the Nantahala Forest in the area around Stecoah Gap and the existing intersection of NC 28 and NC 143; among lowest impacts to NFS lands; among longest new location sections
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)

Community Impact Scale: An arrow indicates the scale from Low (1-3) to Extremely High (20+).

Section 4-3: **Scenario S-1**

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost ⁴
				Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	
AG	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M
Total	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M

Notes:

- Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
- Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
- Grade exceptions include grades exceeding desired grade of 6%.
- Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



STUDY CORRIDOR RECOMMENDATIONS

This section presents Quantm scenarios for the project team's review to identify potential study corridors to present to the public. Public outreach is being conducted as part of the A-0009 process and will be used to inform decisions related to the project scope and proposed NEPA study corridors.

As noted previously, the Quantm studies were conducted in order to generate a representational range of alignments and associated costs which can be used by the project team to help determine the project scope.

Although additional design work, geotechnical investigations, and natural resource surveys are required to ultimately refine alignments within these corridors, the scenarios can be used for high-level planning and programming to help identify priorities and set a path forward for NEPA studies.

As shown in the previous section, the study area's terrain and underlying geology contribute to design and construction challenges for all scenarios included in this DSR. All scenarios include large amounts of earthwork and high, long bridges which present design challenges, increased construction costs, and potential safety concerns associated with winter weather.

Scenarios require detailed study to determine optimal locations for climbing lanes, passing lanes, and slow-vehicle turn-outs.

These challenges and design elements are all likely to affect final construction costs; however, from a planning level, all scenarios are compared "apples to apples" in this DSR with the understanding that costs will change based on subsequent detailed studies and design refinements.

While this study focuses on identifying potential new location options, it is noted that future NEPA studies will include an "Improve Existing" option for the NC 28, NC 143, and US 129 corridors.



RECOMMENDATIONS: SCENARIOS IN THE STECOAH AREA

Scenario	Design Considerations	Environmental Considerations	Retain?	Notes
S-1	Large amount of pyritic rock and colluvium; cost and constructability issues due to unstable colluvial material; highest design exceptions	New location on west side of Stecoah Gap not favored by AT stakeholders	No	Unstable colluvium on east side of NC 143; higher construction costs likely due to pyritic rock and other geotechnical concerns
S-2	Shortest length; 1,298 feet less bridges than S-3 on north side of NC 28; parallel route to NC 28 improves system reliability; low amount of design exception areas; potential for passing/climbing lanes on NC 143 west of Stecoah Gap	Lowest impacts to NFS lands; lowest potential for visual impacts	Yes	Additional design studies can be conducted to reduce bridge dimensions, examine geometry of approach at east portal, and assess passing lanes
S-3	Avoids the most pyritic rock and colluvium of options in this area; large cut on west side of Stecoah Gap is in unstable material with a history of large slides; one of shortest scenarios; among lowest design exceptions; high number of bridges could prohibit the addition of passing lanes where viable	Among lowest impacts to NFS land; among lowest relocations; new location on west side of Stecoah Gap not favored by AT stakeholders	No	Major geotechnical concern for landslides along large cut on west side of Stecoah Gap; geotechnical concerns would require flatter slopes creating a larger footprint
S-4	Among longest alignments with high amounts of excavation; among lowest number of bridges	Among highest impacts to NFS land; design studies should be conducted to see if relocations can be refined	No	High construction cost due to high amounts of excavation and high community impacts and NFS land impacts reduce the viability of this scenario
S-5	Among longest scenarios with high amount of colluvium; high construction cost; high bridge and tunnel lengths; increased likelihood for icing on north facing bridges at Johnson Gap	Among lowest impacts to NFS lands; lowest stream crossings	No	Geotechnical concerns, length, and high cost reduce viability of this scenario
S-6	Among shortest alignments; zero bridges; potential for long sections of passing/climbing lanes	High stream impacts; high relocations; design studies should be conducted to see if high number of relocations can be refined	Yes	Avoids tribe-owned land holding on existing NC 143; design studies can be conducted to evaluate impacts to NFS lands
S-7	Longest corridor	High impacts to NFS lands; highest potential for habitat fragmentation on NFS land	No	High amount of excavation; highest potential for environmental impacts due to length



RECOMMENDATIONS: SCENARIOS IN THE ROBBINSVILLE AREA

Scenario	Design Considerations	Environmental Considerations	Retain?	Notes
R-1	No bridges, tunnels, or grade exceptions; would refine the alignment along existing NC 143 and US 129 and create a short new location 'best-fit' alignment just east of Robbinsville.	Avoids impacts to active farmland in the Five Point Road area. Minimizes residential and business relocations. Potential historic property southwest of the mobile home park	Yes	Evaluate alignments that would further avoid/minimize impacts to the community, notably Dollar General and the mobile home park. A traffic analysis is recommended to determine lane requirements. Additional design investigations needed to determine if R-1 could be a continuous flow traffic movement from NC 143 to US 129. Roundabouts on NC 143 and US 129 could be studied as a way to provide a gateway into Robbinsville and convey a sense of place.

PRELIMINARY DRAFT



RECOMMENDATIONS: SCENARIOS IN THE TOPTON AREA

Scenario	Design Considerations	Environmental Considerations	Retain?	Notes
T-1	Lower elevation and lower freeze potential; potential to improve a long section of existing US 129 while avoiding geologic hot spots between M and N and high crash hot spots between N and O; high, tall bridges; lowest cost of Topton scenarios	Medium level impacts to commercial properties and extremely high impacts to residences; high potential for NFS land impacts and habitat fragmentation due to length of new location corridor	Yes	Provides opportunity to improve existing roadways; future design studies should evaluate steepening grades to reduce bridge and tunnel lengths, shifts to the alignment to balance out earthwork and reduce visual effects, and shifts to avoid community impacts between Points N and P
T-2	longest scenario in Topton area; avoids geologic hot spots between M and N and high crash hot spots between N and O; allows for steeper rock slopes and less excavation; three tunnels; long, tall bridges	Medium level impacts to commercial properties and extremely high potential to impact residences; longest length contributes to highest amount of NFS impacts and longest length of bisected NFS land	No	Longest scenario with the second highest tunnel and structure lengths; limited potential to reduce the number of structures and length of grade exception areas reduces the viability of this scenario
T-3	Would allow for steeper rock slopes and less excavation; less bridges than other scenarios in Topton area	Medium level impacts to commercial properties and extremely high residential impacts; higher elevation contributes to less fragmentation effects than T-2; higher elevation of alignment may have implications for protected species that prefer higher elevations	No	The large number of substandard curves on southern portion of the alignment and their proximity to each other reduces the viability of this scenario
T-4	Shortest alignment with the highest lengths of tunnels and bridges; more competent rock allows steeper cut slopes to minimize earthwork; crosses pyritic rock but in shortest length possible; presents smallest length of grade exception areas but most consistent climbing; very long bridge along southern portion of alignment	Medium level impact on commercial properties and low impact on residences; parallels and crosses Trail of Tears; high impacts to NFS lands due to new location corridor, bisecting currently undisturbed habitat; traverses high quality waters/water supply waters (HQW/WSW)	Yes	Need for a high number of tall, long structures and a long tunnel reduces the viability of this scenario; impacts to sensitive watersheds and Trail of Tears may also affect the viability of this scenario; current design does not allow for much refinement to reduce earthwork or reduce structure dimensions; retained to further investigate shortest scenario



RECOMMENDATIONS SUMMARY TABLE

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Environmental Factors (Level 1 Screening)		Design Factors ¹ (Level 1 Screening)		Construction Cost	Retain?
				Stream Crossings	NFS Land (ac)	Quantm Hotspots (mi)	Grade Exceptions (mi)		
Scenario S-1	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M	No
Scenario S-2	6.6	4,449	3,550	16	14	0.40 (6%)	0.20 (2%)	\$157 M	Yes
Scenario S-3	6.9	5,746	2,238	12	42	0.07 (1%)	0.02 (0.3%)	\$152 M	No
Scenario S-4	8.1	2,315	1,903	15	50	0.05 (0.6%)	0.20 (3%)	\$151 M	No
Scenario S-5	8.5	4,951	3,018	12	44	0.09 (1%)	0.05 (0.6%)	\$178 M	No
Scenario S-6	6.7	0	2,291	19	74	0.07 (1%)	0.20 (2%)	\$102 M	Yes
Scenario S-7	8.8	4,305	480	22	131	0.40 (5%)	0.10 (2%)	\$126 M	No
Scenario R-1	4.7	0	0	18	0	0.4 (9%)	0 (0%)	\$14.8 M	Yes
Scenario T-1	12.4	2,884	518	41	271	0.09 (0.8%)	4.8 (39%)	\$112 M	Yes
Scenario T-2	15.4	4,626	1,193	47	314	0.2 (1%)	4.2 (27%)	\$208 M	No
Scenario T-3	14.6	887	367	46	181	0.1 (0.8%)	4.3 (29%)	\$119 M	No
Scenario T-4	7.4	4,677	4,410	24	252	0.2 (2%)	0.6 (8%)	\$221 M	Yes

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Toolbar >> View >> Page Display >> Two Page View

Toolbar >> View >> Page Display >> Two Page View

The screenshot shows the Adobe Acrobat Pro interface with the 'Page Display' menu open, highlighting 'Two Page View'. The main workspace displays a map of the Stecoah Valley corridor, showing the proposed alignment in pink and various geographical features and landmarks. To the right, a document titled 'Preliminary Draft November 2018 Scenario S-1' is displayed in a two-page view. The left page contains a detailed map of the corridor with points A through G marked. The right page provides a scenario overview, considerations, and a table of design factors and construction costs.

**Preliminary Draft
NOVEMBER 2018
Scenario S-1**

Red Barn Hollow Road to SR 1220 (Pin Hook Road)

Scenario Overview: Scenario S-1 originates at Point A and follows the north side of Stecoah Valley before turning north of the NC 28 and NC 143 intersection, then west and south before turning westward into a tunnel underneath the AT, after which the alignment parallels existing NC 143 to the south to Point G.

Considerations:

- Design: high amount of unstable colluvial soil along the eastern side of NC 143; pyritic rock ("hot rock") to the north of NC 28 and NC 143 intersection; high bridges
- Community: Corridor has low potential for impacts to commercial properties and high potential for impacts to residences, primarily north of NC 28 and along the existing NC 143 between F and G
- Visual Effects: Corridor and earthwork visible along the north side of the Stecoah Valley from AT viewpoints (VPs) 1 and 3; corridor visible in the distance towards Cheoah from VP 3
- Tribal Land Holdings: Would impact one EBCI land holding
- Historic Structures/Trails: Corridor contains one historic resource no longer standing (Molt Rice House) on the north side of NC 143 at Beech Creek Road; scenario crosses AT historic boundary
- Habitat Fragmentation: Would fragment a section of the Nantahala Forest in the area around Stecoah Gap and the existing intersection of NC 28 and NC 143; among lowest impacts to NFS lands; among longest new location sections
- Locally-Identified Hot Spots: Would address 2 hotspots on NC 28, 1 at NC 28/143 intersection, and 4 on NC 143 (Points C and D are each located at a hot spot)

COMMUNITY IMPACT SCALE

COMMERCIAL	RESIDENTIAL
Dow (1-3)	Medium (4-11)
High (12-19)	Extremely High (20+)

Environmental Factors (Level 1 Screening)

Section	Length (mi)	Bridge Spans (ft)	Tunnels (ft)	Stream Crossings	NFS Land (ac)	Quantm Hotspots ² (mi)	Grade Exceptions ³ (mi)	Design Factors ¹ (Level 1 Screening)	Construction Cost ⁴
AG	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M	
Total	7.6	4,190	1,207	16	32	0.40 (5%)	0.40 (5%)	\$134 M	

Notes:

- Design characteristics that would increase travel times. Shown in length (miles) and percentage of entire section length.
- Quantm identifies locations where curves exceed desired design criteria and would increase travel times.
- Grade exceptions include grades exceeding desired grade of 6%.
- Construction cost estimated by Quantm does not include hot rock considerations, mitigation, ROW, or utility relocations.



PLANNING CONSIDERATIONS

As noted in previous sections, this DSR is a product of the “pre-NEPA” A-0009 process. The Quantm scenarios and analysis did not include detailed design investigations or environmental impact analyses.

Since the project restart in 2015, the CPT has been documenting items for the project “parking lot” which are items that are not able to be resolved at the current time. These items are included in this DSR to: 1) ensure that they are considered in future studies; and 2) draw attention in an effort to help generate thoughts that could lead to potential solutions in subsequent studies. Some of these considerations, such as those related to scenario design aspects, are noted in previous sections.



The Core Planning Team has documented “parking lot” items and other considerations for consideration in future studies.



DESIGN CONSIDERATIONS

Future design studies will investigate the following:

- Structure dimensions
- Geotechnical feasibility
- Opportunities to reduce earthwork (alignment adjustments, slope adjustments, retaining walls, etc.)
- Anti-icing systems, including geothermal systems
- Areas identified as “Quantm hot spots” where horizontal radii and vertical curves exceed desired design criteria
- Connections between new location and existing facilities

IMPROVE EXISTING ALTERNATIVES

The DSR focuses on identifying areas where new location options can be studied concurrent with options that would improve the existing facilities. For every location where a new location option is being studied, future studies will include an evaluation of improve existing options as well.

TYPICAL SECTIONS

As noted in Section 3, all Quantm models are based on a two-lane typical section with an eight-foot paved shoulder and four-foot grass shoulder. The corridors shown in Section 4 are 500 feet wide to account for additional design elements; however, detailed design studies will be required to identify areas where the typical section may be modified to include passing lanes, climbing lanes, turning lanes, scenic lookouts, slow vehicle turnouts, or other design features.

TRAFFIC & SAFETY

A traffic forecast, capacity analysis, and travel time study will be prepared to identify location-specific improvements related to congestion.

Locations for passing lanes and climbing lanes will be developed in coordination with roadway design efforts and based on 3D models that visualize the behavior of traffic systems in a 3D environment. The model will be used to illustrate/evaluate traffic flow dynamics and overall network performance.

A highway safety analyses will be required to assess and compare the benefits of each design option.



PROJECT ATLAS DATA

Project ATLAS is a GIS-based regional modeling effort that will include model-based GIS layers that span multiple disciplines from protected species to utilities. The goal of Project ATLAS is to streamline project development through GIS-based data.

Because Project ATLAS is currently under development, detailed environmental GIS data was not available for use during the development of this DSR; however, the CPT is maintaining ongoing coordination with NCDOT staff working on Project ATLAS to monitor its development. As soon as relevant data sets are vetted and approved for use, the CPT will acquire data sets and update analyses accordingly.

Because of the iterative nature of Quantm analyses, if new data should change the viability of current options, additional scenarios can easily be developed to avoid or minimize potential impacts.

Moving forward, Project ATLAS data should be referenced in future NEPA studies while being augmented with detailed field survey data. Ideally, this data can be used by the project team to identify likely cumulative effects and potential mitigation strategies.

NATURAL RESOURCES

While the US Geological Survey (USGS) National Hydrography Dataset (NHD) was utilized in Quantm to determine culvert locations, surveys for jurisdictional resources will be needed during the NEPA process to determine exact locations of jurisdictional features and permit requirements.

Surveys for federally protected species will be required to satisfy the requirements of the Endangered Species Act of 1973. It is anticipated that Quantm will be used to help define field survey areas based on anticipated construction limits. Delineation of field survey areas can occur concurrent to and parallel with detailed design investigations.

Recommendations provided by the project team for natural resources will include the minimization of impacts on game lands and critical habitats.

While natural resource factors were not taken into account in the Quantm analysis, further exploration of measures to avoid and minimize impacts to natural resources should be investigated during the NEPA process.



CULTURAL RESOURCES

In accordance with the National Historic Preservation Act, surveys for historic architecture and archaeology resources should be conducted during the NEPA process. Section 4 includes resources identified by NCHPO's HPOWEB GIS Web Service, which includes only previously surveyed historic structures and excludes archaeology resources. Available archeological data from previous A-0009 studies will be referenced in future studies and augmented as needed.

Cultural resource investigations should continue to include coordination with Cherokee Nation, the Eastern Band of Cherokee Indians, and the United Keetoowah Band of Cherokee Indians.

SECTION 4(F) RESOURCES

Historic and archaeological resources, in addition to any new resources identified, will require coordination under Section 4(f) requirements.

VISUAL IMPACT ANALYSIS

As discussed in Section 3, AT stakeholders used the 3D visualizer to review preliminary visual impacts at the AT in the Stecoah area. It was noted that a formal visual impact analysis will be performed as part of future NEPA studies in accordance with US Forest Service and FHWA's guidelines and in coordination with the AT stakeholders.

SECTION 6(F) RESOURCES

The Graham County Recreational Park south of Robbinsville (shown below) was partially purchased through the Land and Water Conservation Fund (LWCF) and is considered a Section 6(f) resource. Improvements in this area are not likely to affect the park; however, it is noted that the resource is included in project mapping and will be referenced as needed as studies progress.

