

RED RIVER GORGE

TRANSPORTATION PLANNING STUDY

POWELL, MENIFEE, AND WOLFE COUNTIES, KY
FINAL REPORT | JULY 2023

PROJECT LOCATION
KY 77/KY 715



PREPARED FOR

TEAM KENTUCKY
TRANSPORTATION CABINET

IN PARTNERSHIP WITH

OK
Engineering Planning



COUNTY REFERENCE

Menifee
Powell
Wolfe

A map of the three counties mentioned in the study: Powell, Menifee, and Wolfe. The counties are outlined in black. A central black dot is placed at the intersection of Powell, Menifee, and Wolfe counties, with lines extending to the names of each county.

EXECUTIVE SUMMARY

Study Background

The Kentucky Transportation Cabinet (KYTC) initiated a corridor study in January 2022 to explore anecdotal mobility issues within the Red River Gorge (RRG), specifically along KY 715 and KY 77 that provide access through the area. **Figure ES-1** shows the study area limits.

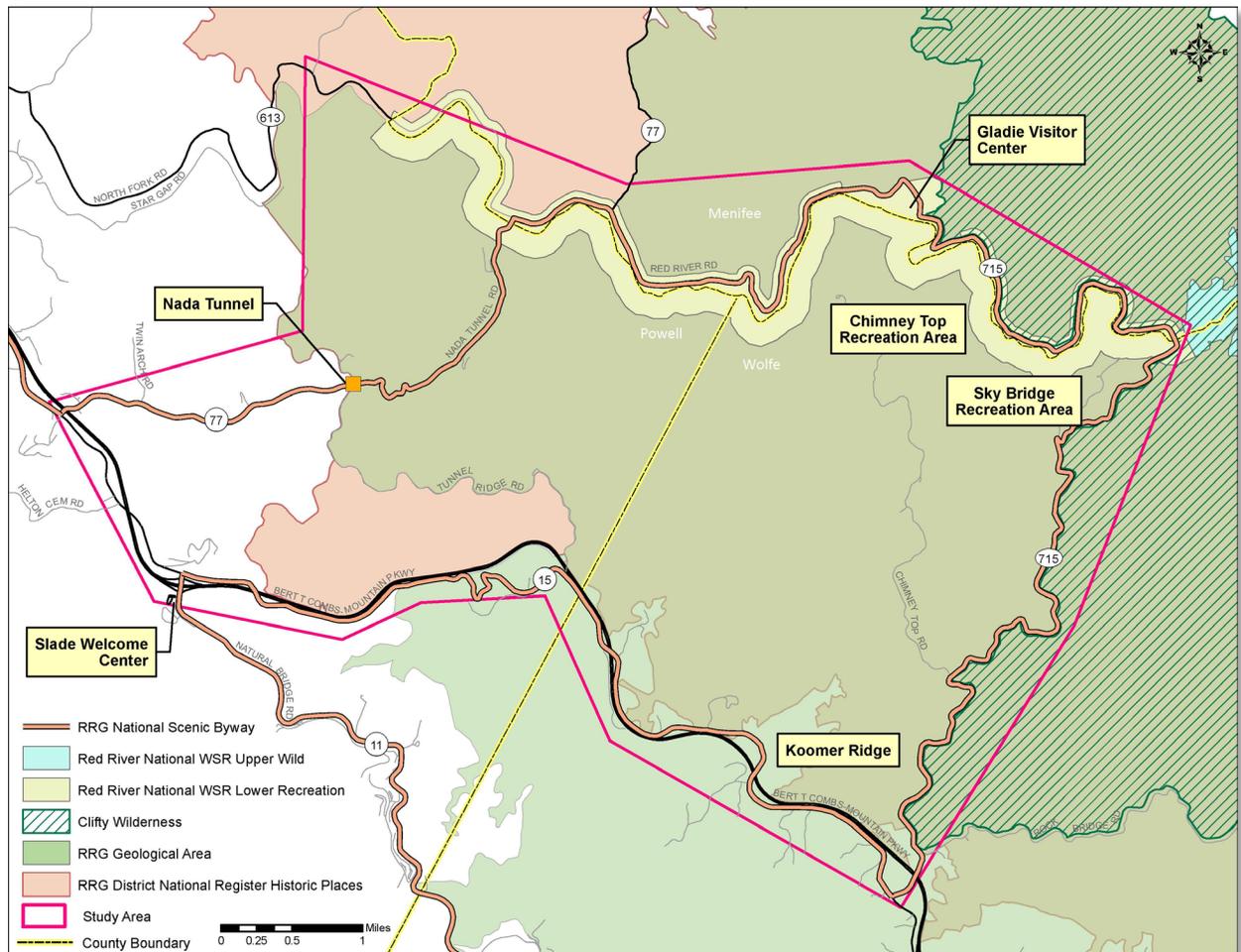
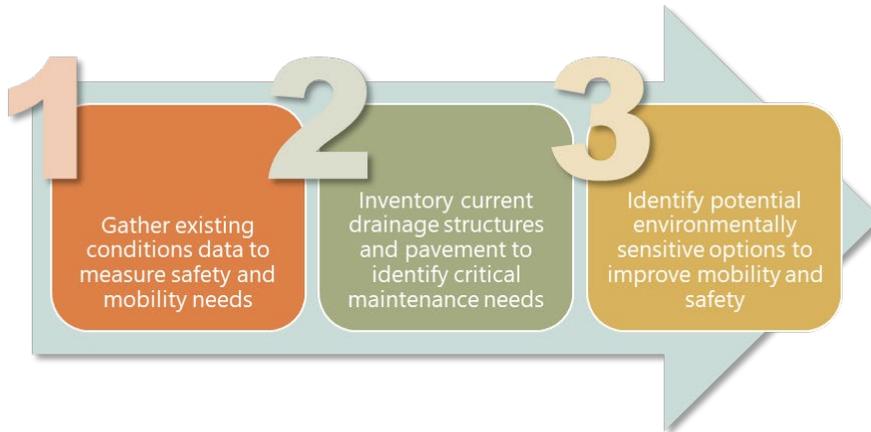


Figure ES-1: Study Area Boundary

The Red River Gorge Geological Area—within the Daniel Boone National Forest in east-central Kentucky—is certified as a National Natural Landmark and listed on the National Register of Historic Places. The 29,000-acre RRG features natural sandstone arches, high sandstone cliffs, natural bridges, rock shelters, and scenic waterfalls. It is a popular destination for climbers, campers, hikers, and other outdoor recreational users. Since 2020, the number of annual visitors

has been increasing, resulting in more traffic using the narrow roadways and limited parking—especially during fair-weather weekends in the spring and fall.

The study goals are three-fold:



Existing Conditions

Through the study area, KY 77 and 715 are classified as rural major collectors with two travel lanes (each 8-9 feet wide) and 1-foot or less of paved shoulder width. Some paved pull-offs are designated parking areas. Much of the 18.2-mile study corridor is composed of steep grades and sharp curves, necessitating a slower travel speed than the posted 35 mph limit. Both routes are state secondary routes, part of the Forest Highway System, and part of the RRG National Scenic Byway. There are eight bridges along the study corridor, plus 118 smaller pipes and culverts to support drainage flows. While structures are in Good or Fair condition, most pipes/culverts require maintenance or replacement to function properly. Pavement condition is also a concern, with several areas in poor condition or demonstrating evidence of past slips/slides.

Along KY 77 near MP 2.2 in Powell County, Nada Tunnel is roughly 900 feet long, 12 feet wide, and 13 feet high. The tunnel's narrow width and low vertical clearance create a one-way traffic bottleneck.

Crash data from 2017-2021 showed 71 crashes occurred throughout the study area: 42 along the KY 77/KY 715 corridor and the remainder associated with other highways. By severity, there was one fatality, 16 injury collisions, and 54 crashes resulting in property damage only (PDO). The majority are single-vehicle crashes (63%), followed by angle crashes (13%). Overall, 70% of reported study area crashes are classified as roadway departures, one of the emphasis areas identified by KYTC's Office of Highway Safety.¹

¹ Online at <https://transportation.ky.gov/HighwaySafety/Pages/default.aspx>

Standard practice to measure average daily traffic (ADT) flows on highways involves counting vehicles over several weekdays, focusing on typical peak commuter flows during AM and PM peak hours. KYTC counts over the past few years estimate the ADTs at 700 vehicles per day (vpd) on KY 77 and 200 vpd on KY 715. However, peak traffic volumes at RRG do not follow typical highway patterns as they are more influenced by seasonal recreational traffic than by commuters.

This study included an extensive traffic data collection effort to analyze true peak traffic, focusing on two fair-weather weekends in both April and October 2022. Summarized in **Figure ES-2**, Saturdays showed the highest weekly volumes and fall volumes (shown as red and yellow) were roughly double spring volumes (blue and green). When looking at hourly flows for Saturdays, the busiest time of day occurs in the early afternoon: 1 PM to 4 PM. Pedestrians, motorcycles, and bicyclists commonly use KY 77/KY 715 through RRG, in addition to passenger cars.

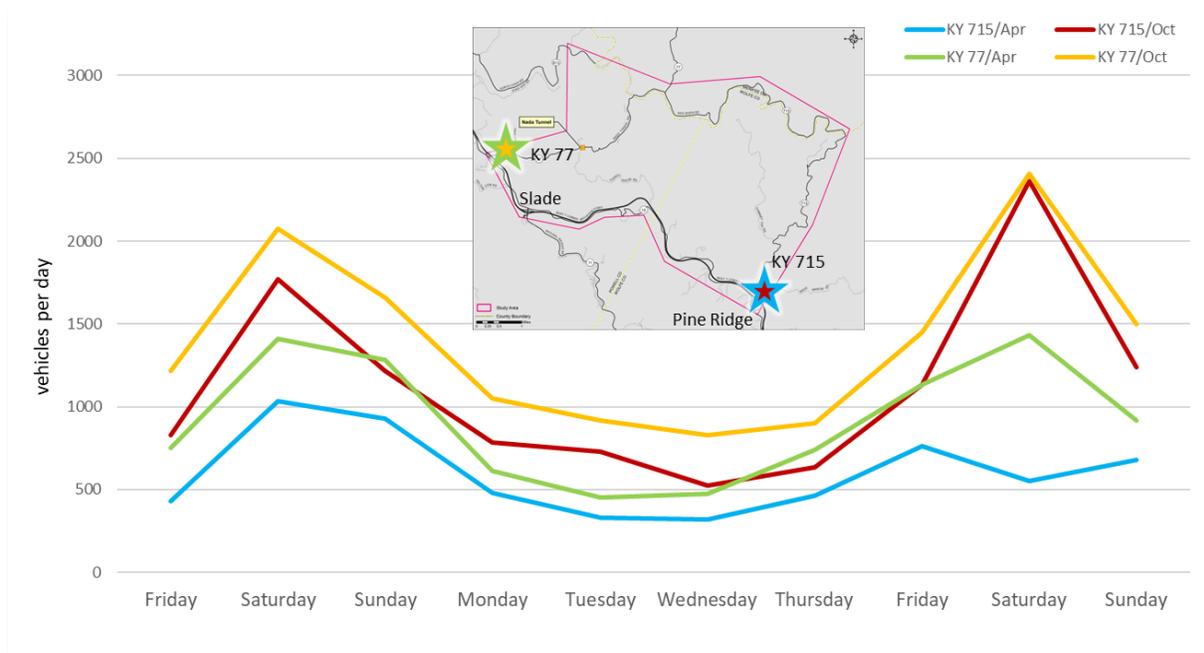


Figure ES-2: Seasonal Traffic by Day of Week

KYTC collected multiple days of spring and fall video footage at either end of the Nada Tunnel to measure these weekend traffic patterns, with key findings summarized in **Table ES-1**.

It should be noted that the west approach to the tunnel has a sharp curve blocking the view for eastbound drivers. Video footage showed multiple instances of drivers entering the tunnel

eastbound and having to back out to make space for oncoming traffic—in some instances with multiple cars backing out as a group.

Table ES-1: Performance Metrics at Nada Tunnel, October 2022

Metric*	Eastbound Entering RRG	Westbound Exiting RRG
12-hour volume entering tunnel	1033 vehicles	1297 vehicles
12-hour volume entering without delay	52%	46%
Average wait time for busiest hour	65 seconds	40 seconds
Platoons waiting 2+ minutes to enter tunnel	8%	5%
Longest wait observed	8.9 minutes 29 vehicles in queue	5.4 minutes 4 vehicles in queue

*Metrics reported for busiest of four observed Saturdays, which occurred Oct. 15, 2022

Study Goals

The intent of this study is to explore anecdotal mobility issues and maintenance needs within the RRG, specifically along KY 715 and KY 77. Analyses focus on current conditions, independent of any future development visions for the area that may influence travel demands. The study is designed to quantify transportation needs, and then present the costs, benefits, and impacts of potential improvements, so decision-makers can weigh which options are a good fit for RRG. Beyond hard data, another important piece of the study is to engage with the larger community of stakeholders—including residents, visitors, elected officials, and resource agencies. Any improvement concepts considered should be developed to minimize impacts to the environmentally sensitive area.

Build Concepts

Based on the data collection activities described above, analysts were tasked to define a list of potential improvement concepts that could address observed needs. Potential improvements were sorted into three groups:



Maintenance/Repairs



**Nada Tunnel
Delay Options**



**Other Operational
Options**

Each group is organized from less impactful, lower cost solutions to those having higher costs and greater impacts. Construction cost estimates are presented in FY 2022 dollars.

Maintenance/Repairs

Pipe Repairs. Field inventory identified 118 pipes/culverts along KY 77/KY 715, with 102 or 86% needing repairs or replacement: cleaning/repairing, adding an element (e.g., a missing headwall), or replacing. The combined construction cost estimate to address the needs is \$3.3 million.

Small Scale Pavement Projects. This catch-all covers several repair types at specific locations to address poor pavement conditions: curve widening, vegetation clearing, ditch lining, resurfacing, cribbing, ditch reconstruction, replacing guardrail, and signage. Divided among 15 locations, construction costs total an estimated \$8.6 million.

Nada Tunnel Delay Options

No-Build. With this option, the tunnel would continue to operate as it does today: one lane of traffic, with “Yield” signs at either entrance.

Temporary Signal. During busy weekends in the spring and fall, this option would set out a temporary traffic signal like those KYTC uses at construction zones with alternating one-way traffic. Adding a signal would increase delays due to required clearance times, with longer wait times for 84% of platoons versus measured delays during a busy Saturday in October 2022. While estimated up-front costs are relatively low, there would also be practical concerns with the system.

Peak Flaggers. This option would operate similarly to the signal option but rely on trained personnel to direct traffic flow through the tunnel during peak spring and fall weekends. As with the signal option, delay would increase compared to 2022 data. In addition, staffing expenses would increase as would potential safety risks for field personnel.

Signage. This option would add to existing advance warning signs to alert motorists unfamiliar with the tunnel. Today, warning signs exist near the KY 77 intersections with KY 11 and KY 715. “Share the Road” signs could also encourage motorists to watch for cyclists and pedestrians.

Realign Approach. The eastbound tunnel approach contains a curve, limiting visibility for travelers entering RRG; this option would realign the approach west of the tunnel. Cutting into the adjacent slope would be necessary but would not disturb the tunnel itself. Detailed geotechnical investigations, engineering designs, and environmental analyses would be required if this option were to advance. This option could improve drainage, thereby reducing the ponding and icing notorious at the tunnel portal. Planning-level construction costs range from \$450,000-\$1.1 million, depending on the alignment.

Widen Tunnel. With the highest costs and most impacts, widening the tunnel is the only option considered that would allow for two-way traffic flow. Detailed geotechnical investigations, engineering designs, and extensive environmental analyses would be required if this option were to advance. The tunnel is historic and an iconic RRG gateway; widening would significantly impact its character. The estimated construction cost is \$10+ million, plus additional costs for the approaches.

Other Operational Options

No-Build. The KY 77/KY 715 study corridor would continue to operate as it does today, with two-way traffic and no infrastructure improvements beyond typical maintenance levels.

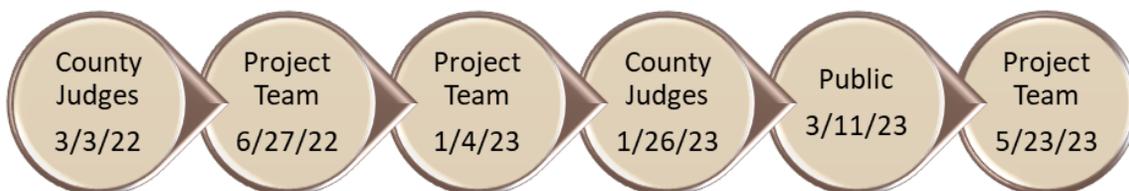
One-Way Travel. The KY 77/KY 715 study corridor would only serve one-way traffic. As the total drive time is around 50 minutes, this would significantly increase travel times and trip lengths for motorists accessing destinations near either endpoint without making a full circuit. Another possible option would make only the narrowest section of the corridor, near Sky Bridge, one-way.

Shuttle Service. Discussed further in the 2022 EA/FONSI published by the US Forest Service (USFS), a private contractor could operate an on-demand shuttle service to help reduce parking demands. Specific stops, parking areas, and operational features have yet to be defined.

Minor Widening. An ultimate, long-term Build solution would include minor widening, consistent striping, and other improvement measures to create a consistent typical section. This concept includes widening KY 77/KY 715 to provide a consistent typical section (two 10-foot-wide lanes with 1-foot-wide paved shoulders), consistent high-visibility striping, and grout-lined ditches to improve drainage. As appropriate, curve widening, vegetation clearing, and other repairs would be incorporated as well. The proposed concept has minor impacts on capacity but would improve safety and help create a consistent driver expectation for the corridor. Construction costs are estimated to total \$48 million.

Coordination Meetings

Three project team meetings, two briefings for the county Judge/Executives, and one public open house, paired with a study website, helped engage with key stakeholders and the community.



During February and March 2023, surveys were collected to obtain community perspectives on the proposed concepts. Overall, 69 completed surveys were submitted. After working through initial questions to think about how transportation influences their experience, participants were asked whether improvements were needed to address traffic/safety: 75% agreed that improvements are needed. Overall, survey participants love RRG and prefer less invasive improvements to preserve its natural beauty and ecosystems. Several participants suggested other improvement concepts.

As shown in **Figure ES-3**, adding a temporary traffic signal during peak seasonal weekends received the most support: 18 participants supportive and 18 participants strongly supportive, compared to 7 individuals who opposed or strongly opposed a signal. The signal, flaggers, and increased signage received more support than opposition. Realigning the eastbound approach received an even split between support and opposition, while widening the tunnel was strongly opposed by most individuals.

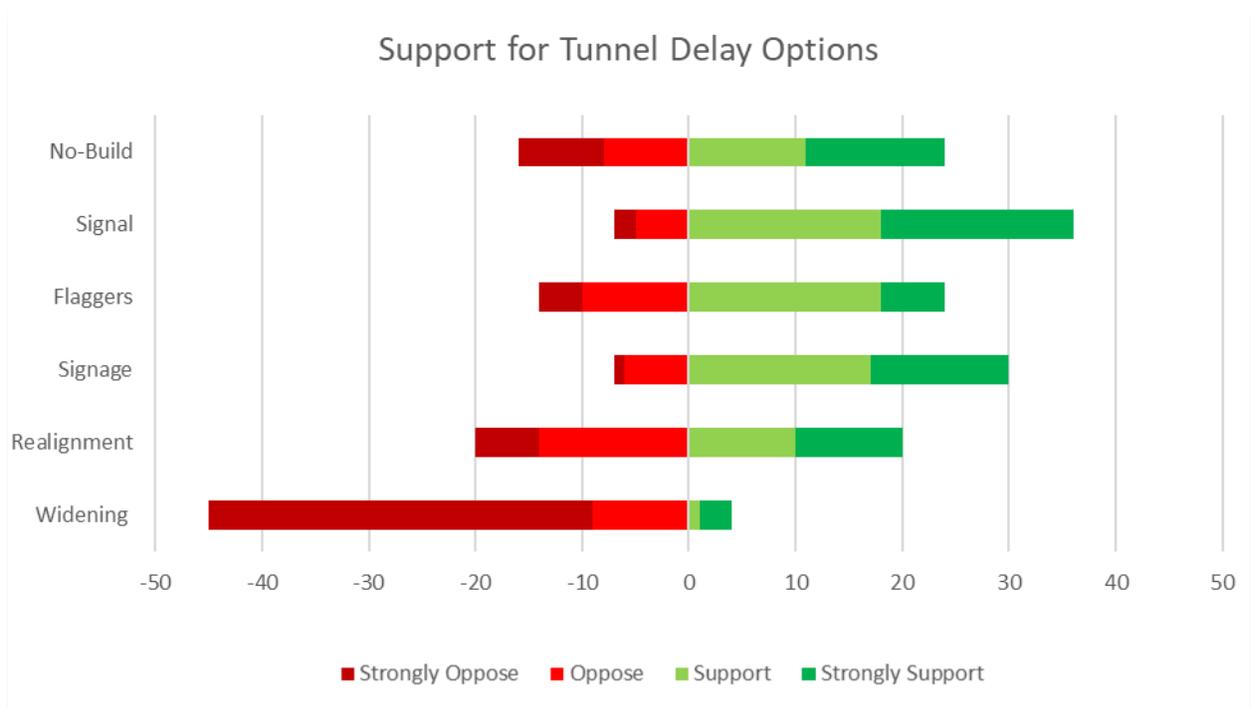


Figure ES-3: Survey Preferences for Tunnel Delay Options

Looking at options for the larger KY 77/KY 715 study corridor (**Figure ES-4**), minor widening and a shuttle service received more support than opposition. But opposition to the one-way routing concept (i.e., 17 individuals strongly opposed plus 7 individuals opposed) outweighed support (i.e., 6 individuals supporting or strongly supporting). Responses were evenly split regarding a No-Build solution.

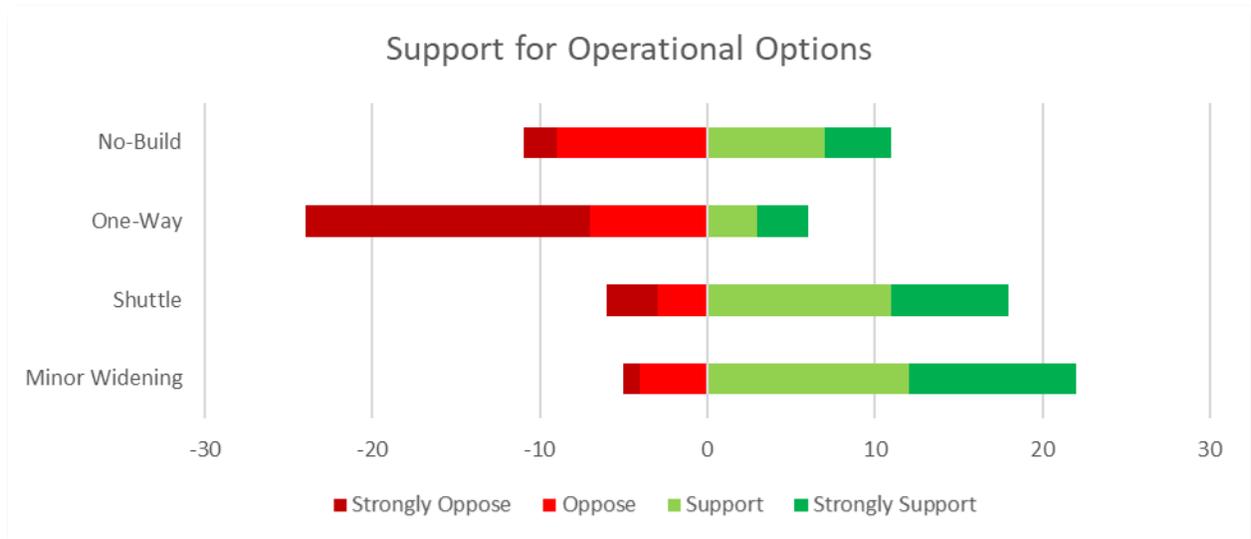


Figure ES-4: Survey Preferences for Other Operational Options

Recommendations

Based on engineering judgement, costs weighed against benefits, and input from both local officials and the public, both maintenance concepts (pipe repairs and small-scale spot improvements) are recommended to advance to maintain the corridor in a state of good repair.

Two measures are recommended to address delay at Nada Tunnel:

- Additional signage, primarily to increase alerts for oversize motorists or drivers unfamiliar with the area before reaching the one-lane, low clearance tunnel.
- Realigning the eastbound approach to the tunnel so motorists can see oncoming traffic without crossing the centerline or entering the portal.

Regarding other operational options, KYTC supports USFS coordination to launch a third-party shuttle service, although implementation is beyond KYTC's purview. Long-term, the minor widening concept is also a priority for implementation.

Project sheets in **Section 8.3** of the main report provide additional information on recommended measures.

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ACRONYMNS LIST

ADD	Area Development District
ADT	Average Daily Traffic
CE	Categorical Exclusion
CHAF	Continuous Highway Analysis Framework
EA	Environmental Assessment
EEC	Excess Expected Crashes
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
FY	Fiscal Year
HDM	Highway Design Manual
HIS	Highway Information System
IRI	International Roughness Index
KYTC	Kentucky Transportation Cabinet
LEP	Limited English Proficiency
LOSS	Level of Service of Safety
MP	Milepoint
MPH	Miles Per Hour
NBI	National Bridge Inventory
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
PDO	Property Damage Only
RRG	Red River Gorge
SHIFT	Strategic Highway Investment Formula for Tomorrow
TED	Transportation Enterprise Database
USFS	US Forest Service
vpd	vehicles per day

1.0 INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) initiated a corridor study in January 2022 to explore anecdotal mobility issues within the Red River Gorge (RRG), specifically along KY 715 and KY 77 that provide access through the area. **Figure 1** shows the general location of the study area within the region and **Figure 2** shows the study area limits.

The Red River Gorge Geological Area—within the Daniel Boone National Forest in east-central Kentucky—is certified as a National Natural Landmark and listed on the National Register of Historic Places (NRHP). The 29,000-acre RRG features natural sandstone arches, high sandstone cliffs, natural bridges, rock shelters, and scenic waterfalls. It is a popular destination for climbers, campers, hikers, and other outdoor recreational users. Since 2020, the number of annual visitors has been increasing, resulting in more traffic using the narrow roadways and limited parking—especially during fair-weather weekends in the spring and fall.

State-maintained highways KY 77 and KY 715 provide the primary access to and through the RRG and form the focus of this *Red River Gorge Transportation Planning Study*.



Figure 1: Project Location



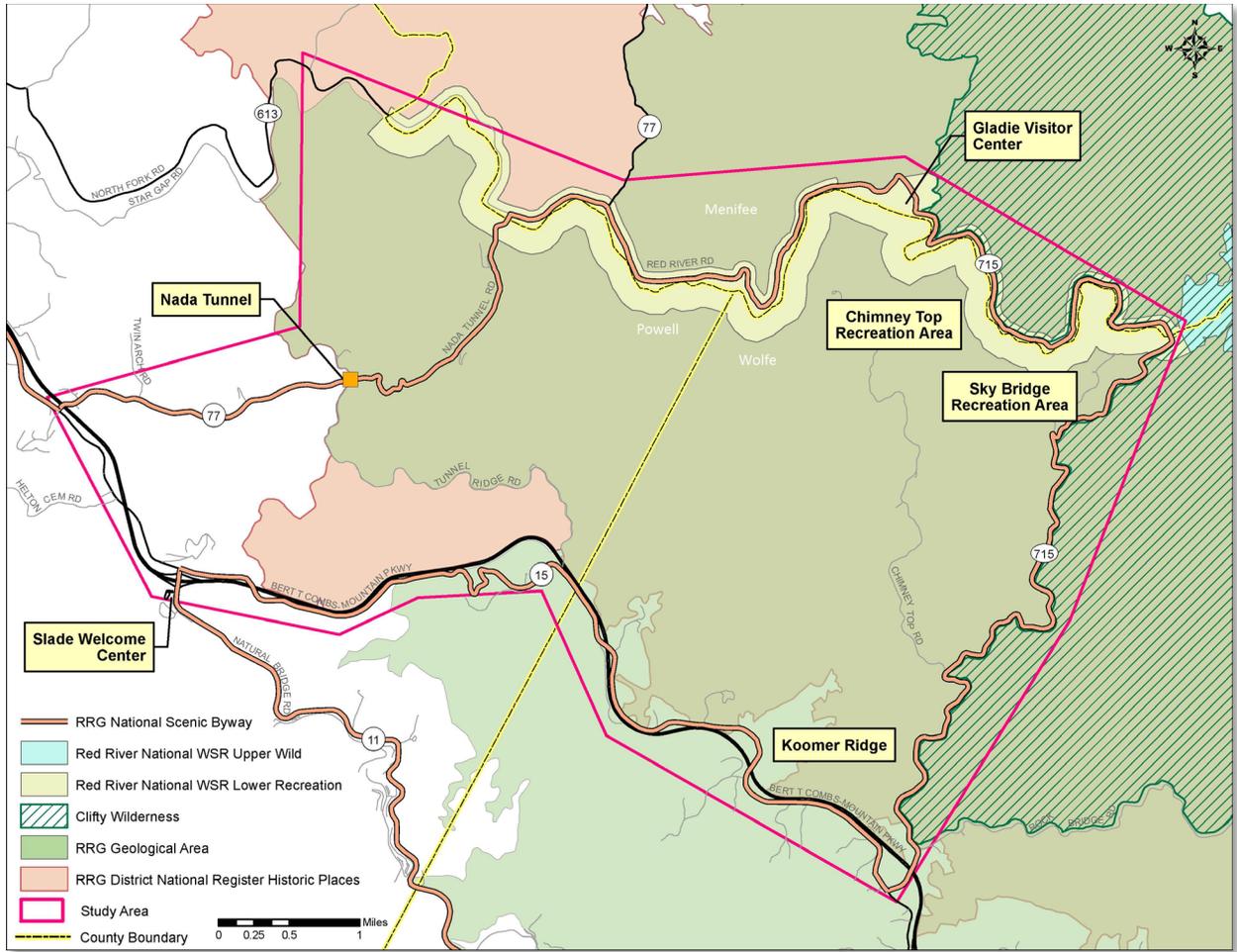
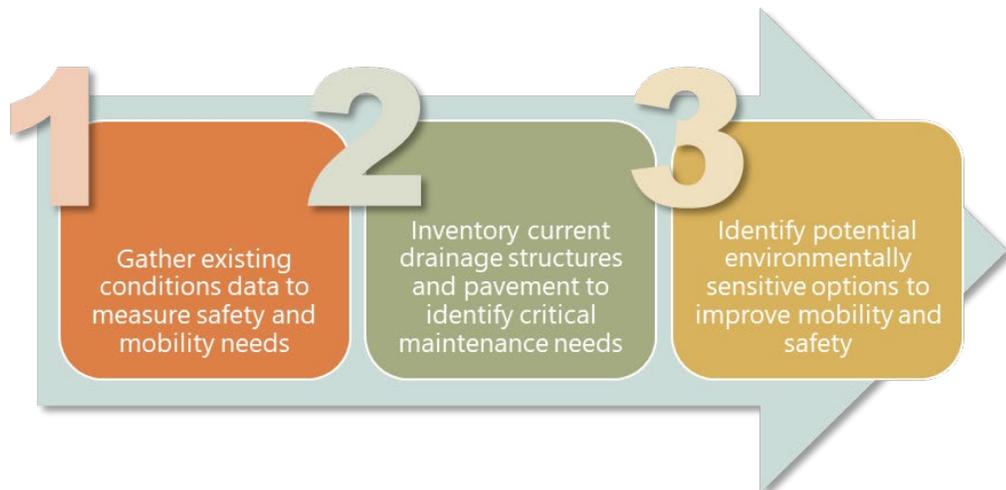


Figure 2: Study Area Boundary

The study goals are three-fold:



This study is intended to present costs, benefits, and impacts of potential improvements, so decision-makers can weigh which options are a good fit for RRG. The following chapters step through the results of the study.

2.0 EXISTING CONDITIONS

Existing transportation conditions of the corridor are described in the following subsections. Information on the characteristics of the roadway geometry, systems, bridges, traffic volumes and operations, and crash history were obtained from KYTC's Highway Information System (HIS) database, KYTC's Transportation Enterprise Database (TED), bridge inspection reports, traffic counts, and field reviews.

A series of large maps in **Appendix A** summarize existing conditions, with key findings discussed in the following subsections. Milepoint (MP) limits for state-maintained study area highways are listed in **Table 1**.

Table 1: Study Area Highways

County	Route	Begin MP and Feature		End MP and Feature	
Wolfe	KY 715	5.765	KY 15	11.988	Menifee County Line
Menifee	KY 715 (Red River Rd.)	0.000	Wolfe County Line	6.870	KY 77 (Tarr Ridge Rd.)
Menifee	KY 77 (Forestry Rd.)	0.000	Powell County Line	0.780	KY 715
Powell	KY 77 (Nada Tunnel Rd.)	0.000	KY 11 (Campton Rd.)	4.039	Menifee County Line
Wolfe	KY 15 (Campton Rd.)	14.882	KY 715	18.704	Powell County Line
Powell	KY 15 (Campton Rd.)	0.000	Wolfe County Line	3.493	KY 11 (Campton Rd.)
Powell	KY 11 (Campton Rd.)	3.598	KY 15 (Campton Rd.)	5.094	KY 77 (Nada Tunnel Rd.)

2.1 Roadway System Designations

Functional Class. Functional Classification is the process of grouping streets and highways according to the character of travel service and access to adjacent land uses they provide. This classification system recognizes that travel involves movement through a hierarchical system of facilities that progress from lower classifications handling short, locally oriented trips to higher classifications serving longer distance travel at higher mobility levels. A roadway's classification is further designated as urban or rural based upon whether it is within FHWA's Adjusted Urban Area boundaries.

Additionally, functional classification is used as a tool for transportation agencies and designers. A roadway's functional class suggests expectations about roadway design: specifically, vehicle

speed, capacity, and the roadway's relationship to land use development. Federal legislation uses functional classification in determining eligibility under the Federal-aid program. Transportation agencies typically describe roadway system performance, benchmarks, and goals by functional classification. The major functional classes are briefly defined below.

Freeways & Interstates	Provide high speed, high mobility links for long distance trips.
Principal Arterials	Serve major centers for metropolitan areas, provide a high degree of mobility, and can also provide mobility through rural areas.
Minor Arterials	Provide service for trips of moderate length, serve geographic areas smaller than their Principal Arterial counterparts, and offer connectivity to the Principal Arterial system.
Collectors	Gather traffic from local roads and funnel to the arterial network, are classified as either a major or minor collector, and generally serve intra-county travel and shorter trips.
Local Roads	Not intended for long distance travel, except at the origin or destination end of the trip, due to their direct access to abutting land. Often designed to discourage through traffic.

Within the study area, both KY 77 and KY 715 are classified as rural major collectors. Functional classifications for state-owned routes near the study area are shown in **Figure A.1** in **Appendix A**.

Highway Systems. KY 77 and KY 715 within the study area are part of the Forest Highway System. Both highways are designated as part of the Red River Gorge National Scenic Byway, which stretches 46 miles from Stanton (Powell County) to Zachariah (Wolfe County).

The Kentucky State Highway System classifies state-maintained roadways by the type of service and function they provide. KY 77 and KY 715 are classified as state secondary routes, meaning they are regionally significant, shorter distance routes that provide mobility and access to land use activity and, generally, serve smaller cities and county seats within a region.

Truck Route. Neither KY 77 nor KY 715 is part of the National Truck Network. KY 715 in Wolfe County is a Tier 4 facility (i.e., a low volume, local connection) within the Kentucky Highway Freight Network. Shown in **Figure 3**, advisory signs along KY 77 warn motorists of the low clearance tunnel near Powell County MP 2.2. However, because KY 77 provides the most direct link between the Mountain Parkway and Menifee County, public GPS mapping services tend to route trips to the corridor.



Figure 3: Tunnel Advisory Sign on KY 77

2.2 Roadway Geometric Characteristics

KYTC's HIS database was queried to obtain route geometric characteristics, including speed limits, number of lanes and lane widths, shoulder type and width, and horizontal curve data.

Lane and Shoulder Widths. Per HIS data, KY 77 in Powell County has 9-foot lane widths while the remainder of the study corridor in Menifee and Wolfe counties has 8-foot lane widths. KYTC's *Highway Design Manual* (HDM) ² recommends 11-foot-wide lanes for rural collector highways carrying 2,000 vehicles per day (vpd) or more. Shoulders are reported as 2 to 3 feet in width (1 foot paved). Some paved pull-offs are designated for parking areas. **Figure 4** shows representative lane and shoulder widths along KY 77/KY 715. Lane and shoulders widths are mapped in **Figures A.2** and **A.3**, respectively (**Appendix A**).

Striping along the corridor varies: double yellow centerlines in some places, white edgelines, or a combination of both. Edgeline rumble strips are provided in a few locations, though deterioration at the edge of pavement has compromised their effectiveness.

² Online at <https://transportation.ky.gov/Organizational-Resources/Policy%20Manuals%20Library/Highway%20Design.pdf>

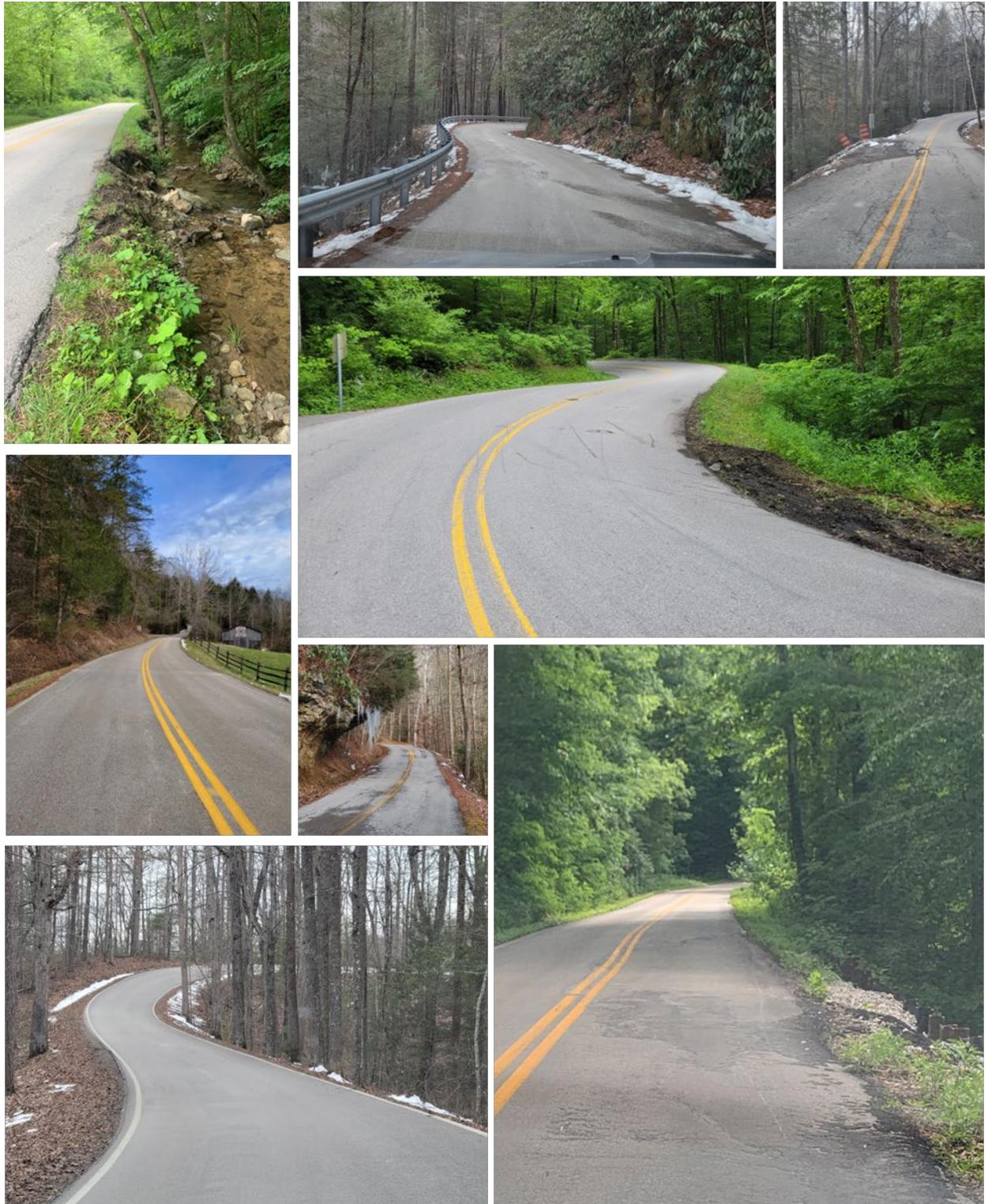


Figure 4: Representative Views of Lanes/Shoulders

Vertical Grades. HIS data were reviewed to identify any substandard grades (i.e., steep hills) along the study routes. At a planning level, KYTC organizes vertical grades into six classes, graded A (flattest) through F (steepest), as shown in **Table 2**. HDM Exhibit 700-023⁴ recommends maximum vertical grades of 6% to 7% for rural collector highways carrying 2,000 vpd or more, varying based on terrain—Class D or better.

Overall, about 50% of the 18.2-mile corridor has Class F grades, including most of the KY 715 alignment in Wolfe County. Additional data are shown in **Figure A.4**.

Horizontal Curves. HIS data were also reviewed to identify any substandard curves along the study routes. At a planning level, KYTC organizes horizontal curves into six classes, graded A (most sweeping) through F (sharpest), as listed in **Table 3**.

There are 15 Class F horizontal curves along the KY 77/KY 715 corridor, with more than half along KY 715 in Wolfe County. Additional data are shown in **Figure A.5**.

Speed Limits. The posted speed limit for KY 77/KY 715 is 35 mph though the sharp curves and steep hills often necessitate a lower travel speed. **Figure 5** provides GPS-based travel speed data, with the slowest speeds at Nada Tunnel and along KY 715 Wolfe County portion of the route.

Pavement Condition. The HIS database also includes a measure of pavement condition, using the International Roughness Index or “IRI” score. Sensors measure bumps and cracks in the pavement, then assign a Good, Fair, or Poor rating based on traffic volumes. The worst pavement scores are along KY 715 in Menifee County, east of Gladie Creek (approximate MP 3.6). Additional data are shown in **Figure A.6**.

Table 2: Vertical Grade Class

Code	Description (percent)
A	0.0-0.4
B	0.5-2.4
C	2.5-4.4
D	4.5-6.4
E	6.5-8.4
F	8.5+

Table 3: Horizontal Curve Class

Code	Description (degrees)
A	0.0-3.4
B	3.5-5.4
C	5.5-8.4
D	8.5-13.9
E	14.0-27.9
F	28+

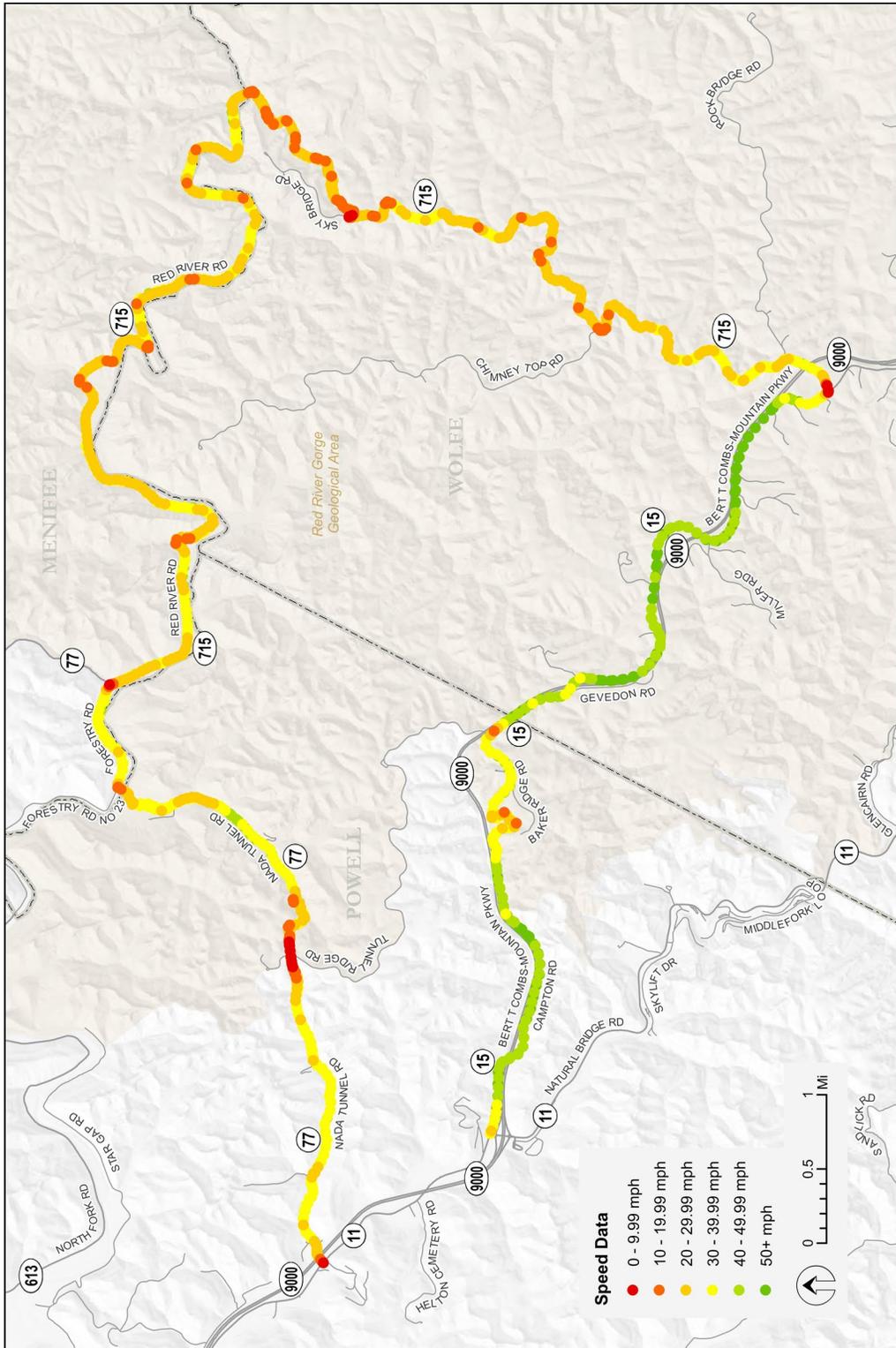


Figure 5: Travel Time around Study Area

2.3 Nada Tunnel

Built in 1910–1911, the Nada Tunnel is roughly 900 feet long, 12 feet wide, and 13 feet high. The tunnel’s narrow width and low vertical clearance create a one-way traffic bottleneck, necessitating the use of signs posted near either entrance encouraging motorists to yield to oncoming traffic.

The tunnel is listed on the NRHP and is an iconic gateway to the RRG area.

KYTC, together with the Federal Highway Administration (FHWA) and US Department of Agriculture–Forest Service (USFS), completed an engineering study on the Nada Tunnel in October 2020. The study noted engineering concerns at the tunnel and its approaches:

- Poor visibility eastbound (entering RRG) requires drivers to cross the centerline to see if the tunnel is clear to enter.
- Poor drainage at either portal leads to roadway ponding—or icing in cold weather, which further reduces the vertical clearance.
- Steep slopes with trees and jagged rocks restrict the clear zone³ and contribute to drainage concerns.
- Opportunities exist to enhance signing, striping, and sight distance.



Figure 6: Ice at East Tunnel Portal, Jan. 2022

The impacts of the one-way tunnel on traffic flow are discussed further in **Section 2.6.1**.

2.4 Bridges and other Drainage Structures

Another component of the existing conditions assessment examined drainage structures: bridges, culverts, and pipes. Wet conditions on pavement can impair its durability as well as contribute to crashes; therefore, good drainage is important to both pavement maintenance and driver safety.

The National Bridge Inventory (NBI) condition rating is determined by the lowest rating for the deck, superstructure, substructure, or culvert. A bridge is considered structurally deficient if any bridge component (deck, superstructure, substructure, or culvert) is in poor condition, warranting

³ Clear zone is a recovery area alongside the roadway that is free of fixed objects and traversable enough to allow a vehicle that leaves the roadway to safely return to the road or stop before crashing/rolling.

monitoring or repairs. There are eight bridges along the study corridor. Bridge inventory data are in **Table 4** and mapped on **Figure A.7** in **Appendix A**.

Table 4: Bridge Inventory Data

Bridge ID	Route	MP	Crosses	Inspected	Condition	Built
119B00026N	KY 715	6.00	Mountain Parkway	Sept 2022	Fair	1961
083B00015N	KY 715	0.01	Red River	Aug 2022	Fair	1950
083B00032N	KY 715	0.11	Copperas Creek	May 2021	Fair	1950
083B00037N	KY 715	3.60	Gladie Creek	May 2021	Good	1998
083B00031N	KY 715	5.54	Wolfpen Creek	May 2021	Good	1930
099B00029N	KY 77	4.30	Red River	Sept 2022	Fair	1935
099B00030N	KY 77	3.87	Martin Fork/Red River	Nov 2022	Fair	1938
099B00028N	KY 77	0.02	Middle Fork/Red River	Nov 2022	Fair	1937



Figure 7: Study Area Bridges

In addition, engineers field surveyed 118 pipes/smaller culverts below KY 77 and KY 715, noting their locations, sizes, materials, and conditions. These drainage structures were concentrated along the northern portion of the study area: KY 77 and the section of KY 715 north of Sky Bridge Road (Wolfe County MP 10.652). No additional pipes/culverts were identified beyond these limits. Some represent typical corrugated metal pipes while others are Depression-era stone structures with potential historic significance. Of the 118, 16 are located west of Nada Tunnel, outside the limits of the RRG Geological Area. A representative sample of pipes/ culverts are shown in **Figure 8**; recommended repairs are discussed further in **Section 6.1**. **Appendix B** contains detailed inventory information for each.



Figure 8: Sample of Inventoried Pipes/Culverts

2.5 Crash History

Historical crash data retrieved from KYTC’s TED warehouse were evaluated for study area roadways for a five-year period (January 2017 through December 2021). Crash location, severity, and manner of collision are shown on **Figure A.8** in **Appendix A** mapping. During this timeframe, 71 crashes occurred throughout the study area: 42 along KY 77/KY 715 and the remainder associated with other highways. A table of corresponding crash data is in **Appendix C**.

Manner of Collision. The manner of collision breakdown is shown in **Figure 9**. The majority are single-vehicle crashes (63%), followed by angle crashes (13%).

Overall, 70% of reported study area crashes are classified as roadway departures, i.e., the vehicle departed the travel lane to the right or left. Roadway departures are one of the emphasis areas identified by KYTC’s Office of Highway Safety.⁴

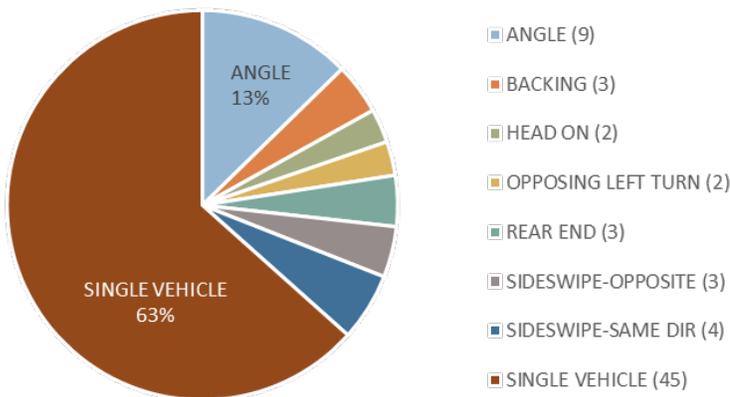


Figure 9: Crashes by Manner of Collision

Severity. By severity, there was one fatality, 16 injury collisions, and 54 crashes resulting in property damage only (PDO). The fatality occurred in August 2019, involving a motorcyclist making a left turn from KY 77 onto KY 11. Injury crashes can be further subdivided

⁴ Online at <https://transportation.ky.gov/HighwaySafety/Pages/default.aspx>

based on their severity; there were two severe injuries, eight non-severe injuries, and six possible injuries.

Other noteworthy trends include:



14 crashes (20%)
involved a motorcycle.



15 crashes (21%)
occurred in wet weather.



11 crashes (15%)
occurred after dark.

2.5.1 Level of Service of Safety

Level of Service of Safety (LOSS) is a refined statistical methodology in the *Highway Safety Manual* and is used to evaluate safety needs. It replaces the former critical rate factor analyses. LOSS categories 1 and 2 represent sites with fewer than anticipated crashes, while categories 3 and 4 represent sites with more than anticipated crashes. Because LOSS 4 sites experience such elevated crash rates, there is a higher probability that safety countermeasures at these locations will result in larger improvements.

Each portion of the study corridor, by county, registers as LOSS 3 considering all severities: 4.3 miles of KY 77 in Powell County, 6.9 miles of KY 715 in Menifee County, and 6.3 miles of KY 715 in Wolfe County.

2.6 Year 2022 Traffic

Standard practice to measure average daily traffic (ADT) flows on highways involves counting vehicles over several weekdays, focusing on typical peak commuter flows during AM and PM peak hours. KYTC counts over the past few years estimate the ADTs at 700 vpd on KY 77 and 200 vpd on KY 715.

However, peak traffic volumes at RRG do not follow typical highway patterns as they are more influenced by seasonal recreational traffic than by commuters. This study included an extensive traffic data collection effort to analyze true peak traffic, focusing on a pair of fair-weather weekends in both April and October 2022. Data collection periods were synchronized around school calendars to include breaks and were extended as needed to capture two warm, sunny weekends.

First, tube counters were set out over multiple weeks at either entrance to the study corridor to measure daily variations. As shown in **Figure 10**, Saturdays showed the highest weekly volumes and fall volumes (shown as red and yellow) were roughly double spring volumes (blue and green).

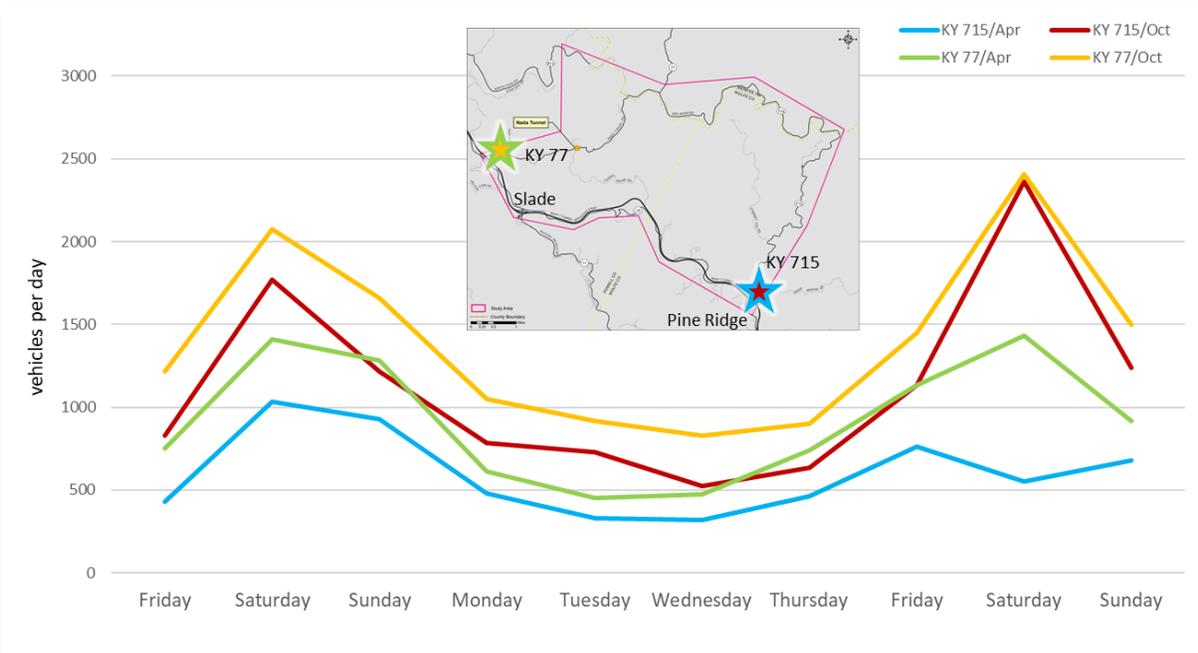


Figure 10: Seasonal Traffic by Day of Week

When looking at hourly flows for Saturdays (**Figure 11**), the busiest time of day occurs in the early afternoon. Turning movement counts were collected at several intersections during April and October, classifying vehicles into one of five categories: motorcycles, cars, buses, single-unit trucks, and articulated trucks. Standard traffic capacity analyses show that intersections along both KY 77 and KY 715 within RRG have more than enough capacity to handle peak hour traffic operations. Each intersection operates at Level of Service B or better, graded on an A (best) to F (worst) scale.

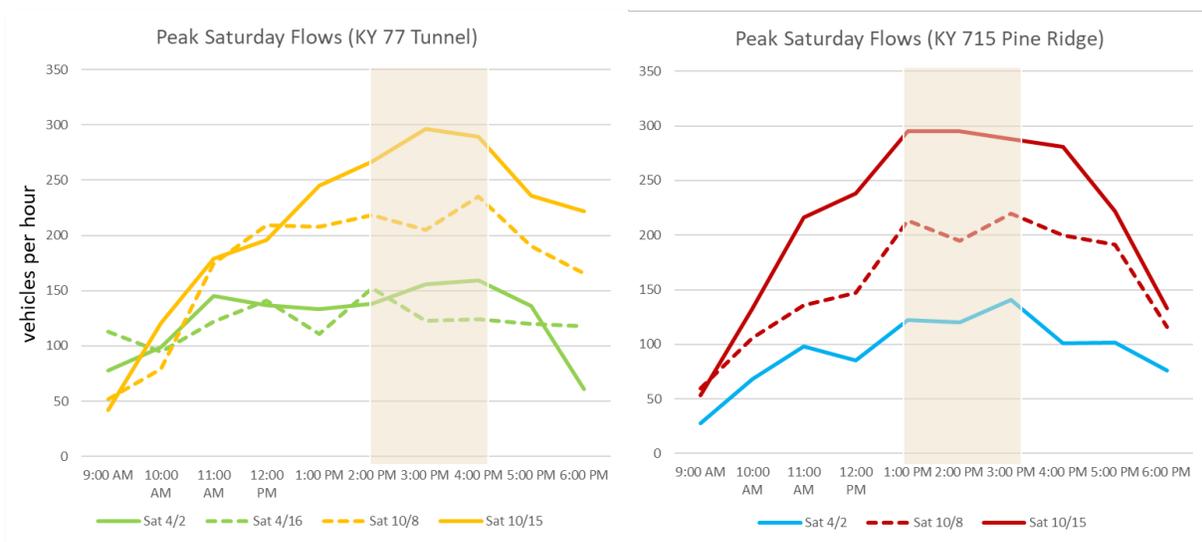


Figure 11: Seasonal Saturday Traffic by Time of Day

2.6.1 Delay at Tunnel

KYTC also set out video cameras at either end of the Nada Tunnel to measure weekend traffic patterns: How long did each car have to wait for the tunnel to clear? How many cars backed up while waiting? Statistics are presented for two metrics: by vehicle and by platoon, defined as a group of cars traveling closely together.

Eastbound or entering RRG, **Figure 12** shows the distribution of vehicles by time entering the tunnel during the busiest observed Saturday during October 2022. Between 7 AM and 7 PM, 1,033 eastbound vehicles approached the tunnel, with 52% of them (shown as the dotted line in the chart) able to enter the tunnel without waiting as there was no oncoming traffic. For comparison, 572 eastbound vehicles approached the tunnel during the busiest April Saturday, with 55% able to enter without waiting.



Figure 12: Eastbound Vehicles at Tunnel

It should be noted that this approach to the tunnel has a sharp curve blocking the view for eastbound drivers. Video footage showed multiple instances of drivers entering the tunnel eastbound and having to back out to make space for oncoming traffic—in some instances with multiple cars backing out as a group.

From the October data, average delay for each hour is shown in **Figure 13**. Delay was measured by platoon, starting when the first vehicle in each group pulled up to the entrance.

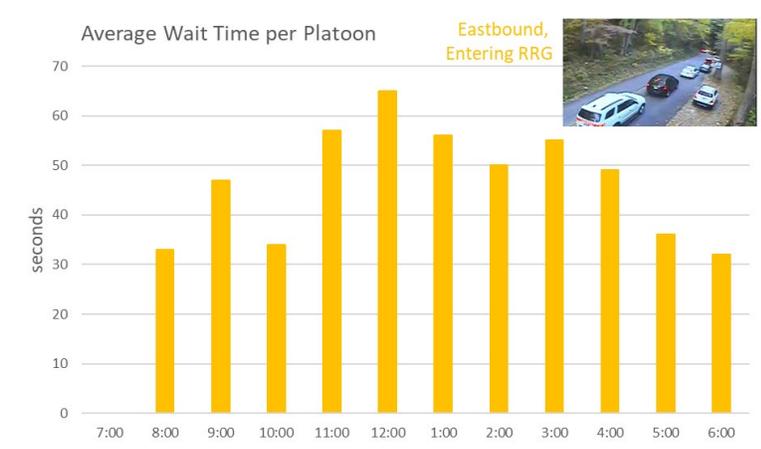


Figure 13: Eastbound Delay at Tunnel

the longest average wait time was 65 seconds, occurring between noon and 1 PM. Only 8% of platoons had to wait 2 minutes or longer to enter the tunnel. The eastbound longest wait time observed on any Saturday was 8.9 minutes; 29 vehicles lined up in a single platoon during this wait.

Westbound or exiting RRG, **Figure 14** shows the distribution of vehicles by time entering the tunnel during the busiest observed Saturday during October 2022. Between 7 AM and 7 PM, 1,297 westbound vehicles approached the tunnel, with 46% of them (shown as the dotted line in the chart) able to enter the tunnel without waiting. For comparison, 697 westbound vehicles approached the tunnel during the busiest April Saturday, with 51% able to enter without waiting.

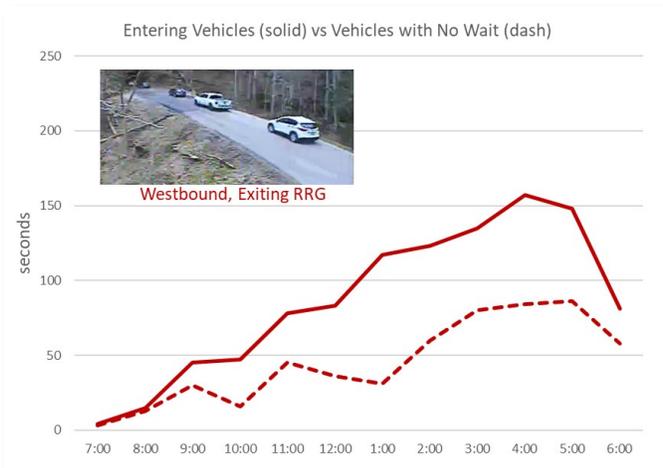


Figure 14: Westbound Vehicles at Tunnel

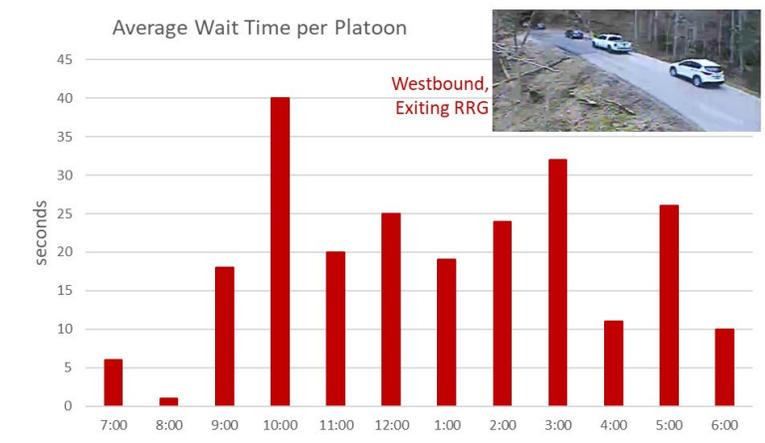


Figure 15: Westbound Delay at Tunnel

From the October data, average delay for each hour is shown in **Figure 15**. The longest average wait time was 40 seconds, occurring between 10 AM and 11 AM. Only 5% of platoons had to wait 2 minutes or longer to enter the tunnel. The westbound longest wait time observed on any Saturday was 5.4 minutes; four vehicles lined up in a single platoon during this wait.

2.6.2 Other Roadway Users

Besides passenger cars, pedestrians, motorcycles, and bicyclists are also common along KY 77/KY 715. KYTC adopted a *Complete Streets Policy*⁵ in September 2022, committing to partnering with other agencies to:

- Identify opportunities to promote and provide safe, convenient access and travel for all users of the transportation network while reducing crash rates and the severity of crashes.
- Improve mobility and accessibility for all individuals.

⁵ Online at <https://transportation.ky.gov/BikeWalk/Pages/Complete-Streets.aspx>

- Support mode shift to non-motorized transportation.
- Ensure early coordination to identify potential actions/strategies.

Consideration of the needs of all modal users is critical throughout the planning and project development process.

3.0 FUTURE PROJECTS AND PLANS

Three KYTC projects have been identified within the study area limits:

- Item No. 10-176.00 includes minor widening along KY 15, from MP 0.000 to MP 3.450 in Powell County. *Kentucky's 2022–2028 Enacted Highway Plan*⁶ (Highway Plan) includes design funding in Fiscal Year (FY) 2024, with right-of-way and utility funds projected in FY 2025.
- Item No. 10-177.00 includes minor widening along KY 15, from MP 13.600 to MP 18.704 in Wolfe County. The Highway Plan also includes design funding in FY 2024, with right-of-way and utility funds projected in FY 2025.
- IP20200034 in the CHAF database⁷ denotes improvements to KY 77 to help with maintenance and operational issues at the Nada Tunnel. Associated costs are estimated at \$1.9 million.

In addition, USFS prepared the *Red River Gorge Management Plan*,⁸ the purpose of which was to explore and identify “proactive and adaptive management of [Red River Gorge] resources to address visitor use and protect these resources for the future.” **Table 5** provides a high-level summary of the approved management actions, although some activities extend beyond the defined study area for this RRG *Transportation Planning Study*. Additional information is accessible online.

⁶ Online at <https://transportation.ky.gov/Program-Management/Pages/2022-Enacted-Highway-Plan.aspx>

⁷ KYTC’s Continuous Highway Analysis Framework or “CHAF” database lists identified project concepts and provides the starting point for the biennial prioritization process that evolves into the Highway Plan’s two-year budget cycle.

⁸ Online at <https://www.fs.usda.gov/project/?project=59892>

Table 5: Management Actions in 2022 USFS EA/FONSI

Activity	Maximum Number
Designate Campsites	350 sites
Designate Trails	50 miles new routes in addition to approximately 70 miles of existing trails
Establish Parking	530 spaces, removing user-created spots
Designate Shuttle Stops	28 stops
Construct Restrooms	36 restrooms
Construct Boat Launches	3 launches
Designate River Access Points	5 river access points
Stabilize/Harden Cliffside Locations	12 sites
Decommission/Restore Unauthorized Campsites	650 sites
Decommission/Restore Unauthorized Trails	150 miles
Misc. Rehab/restore impacted areas along Red River and issue orders to guide/restrict select usage activities	

4.0 STUDY GOALS AND OBJECTIVES

The intent of this RRG *Transportation Planning Study* is to explore perceived mobility issues and maintenance needs within the RRG, specifically along the KY 715 and KY 77 study corridor. Analyses focus on current conditions, independent of any future development visions for the area that may influence travel demands. The study is designed to quantify transportation needs, and then present the costs, benefits, and impacts of potential improvements, so decision-makers can weigh which options are a good fit for RRG. Beyond hard data, another important piece of the study is to engage with the larger community of stakeholders—including residents, visitors, elected officials, and resource agencies.

Any improvement concepts considered should be developed to minimize impacts to the environmentally sensitive area.



5.0 ENVIRONMENTAL CONSIDERATIONS

Extensive studies have been completed to document the unique environmental, geological, and cultural features that contribute to the RRG. This planning study does not attempt to duplicate that research but does acknowledge its uniqueness and conservation-minded strategies that guide its management. Two planning-level analyses were completed in support of KYTC's study, discussed in this chapter.

5.1 Geotechnical Overview

KYTC conducted a geotechnical overview of the study area based upon research of available published data and the Geotechnical Branch's experience with highway design and construction within the region. General geotechnical and geologic characteristics of the study area have been identified and are discussed in this memo, included as **Appendix D**.

The study area is on the eastern flank of the Cincinnati Arch, a broad regional anticline. On the arch's eastern flank, Mississippian carbonates dip toward the southeast into the central Appalachian Basin. Eastward, progressively younger Mississippian strata and overlying Pennsylvanian strata are exposed. The hills and ridges are very rugged and highly dissected with vertical relief in the magnitude of 520 feet. Cliffs, narrow valleys, and ravines are common and characteristic. Thick, resistant Pennsylvanian quartzose sandstone caps the ridges and Mississippian limestone, shale, and siltstone are exposed on the lower slopes and in valleys. Surface drainage is directed towards either the west-flowing Red River to the north or the northwest-flowing Middle Fork of the Red River to the southwest.

The ridgetops and gentle slopes consist of residual soils, derived in-place from weathering of the parent bedrock material. The hillsides and their flanks may consist of colluvium—rubble consisting of limestone/sandstone slabs and blocks in a silty clay matrix. Alluvium deposits occupy stream channels and floodplains.

Mapping shows the entire study area is not prone to karst potential; however, there are karst features within the area. Shafts and caves are present just beneath sandstone cliffs, formed as slightly acidic groundwater dissolves the limestone and shales beneath. Adequate drainage with any new design or construction will be important to minimize environmental impacts by surface runoff into the underlying karst network.

Coal beds in this area have little commercial potential but have been mined on a small scale for local use. No mines are operating at this time. The limestone is of good quality for road construction and agricultural purposes—active and inactive quarries are nearby, but beyond the study area boundary.

Engineering considerations for any future roadway design efforts include:

- Geotechnical drilling will be needed for roadway cut/fills and structures.
- Rock cuts in durable bedrock can generally be 1H:2V presplit slopes on approximate 30-foot vertical intervals with 18- to 20-foot intermediate benches or 15-foot overburden benches.
- Slope configurations for non-durable bedrock or soils are generally constructed on 2H:1V slopes or flatter.
- Cuts encountering shale typically experience slope stability and maintenance issues with exposed bedrock. Slope configurations of 2H:1V or flatter should be anticipated. To limit falling rock hazards, roadside ditch benches are often recommended.
- Cut slopes on ridge flanks in deep deposits of colluvium should be avoided.
- The project area is notorious for unstable fill slopes. Special shale compaction construction, flatter side slopes, partial rock embankment, and constructed embankment platforms are among the techniques used to address instability issues.
- Most of the anticipated excavated materials should be suitable for use in project embankments constructed on 2H:1V slope configurations or flatter, up to 20 feet tall. Any embankments built 20 feet or taller will require stability analysis and may require flatter slopes.
- There are several stream channels and possibly springs within the area. Any saturated or unstable areas encountered within embankment foundation limits may need to be stabilized, and the stream channel may need to be redirected or have pipes installed.

5.2 Socioeconomic Study

The study area covers portions of three Area Development Districts (ADD): Kentucky River, Bluegrass, and Gateway. Kentucky River ADD prepared a socioeconomic study (**Appendix E**), comparing US Census demographic data for area populations. The analysis examines six block groups in the vicinity (**Figure 16**), comparing statistical concentrations of minority, low-income, elderly, disabled, and Limited English proficiency (LEP) populations. It should be noted that most of the people in each block group live beyond the study area boundary.

Table 6 summarizes key characteristics from *2016–2020 American Community Survey* estimates for each geographic area. Red text identifies block groups that exceed the threshold for the encompassing county. Five of six block groups demonstrate at least one exceedance. Further,

Wolfe County has substantially higher concentrations of low-income and disabled populations than the other two counties.

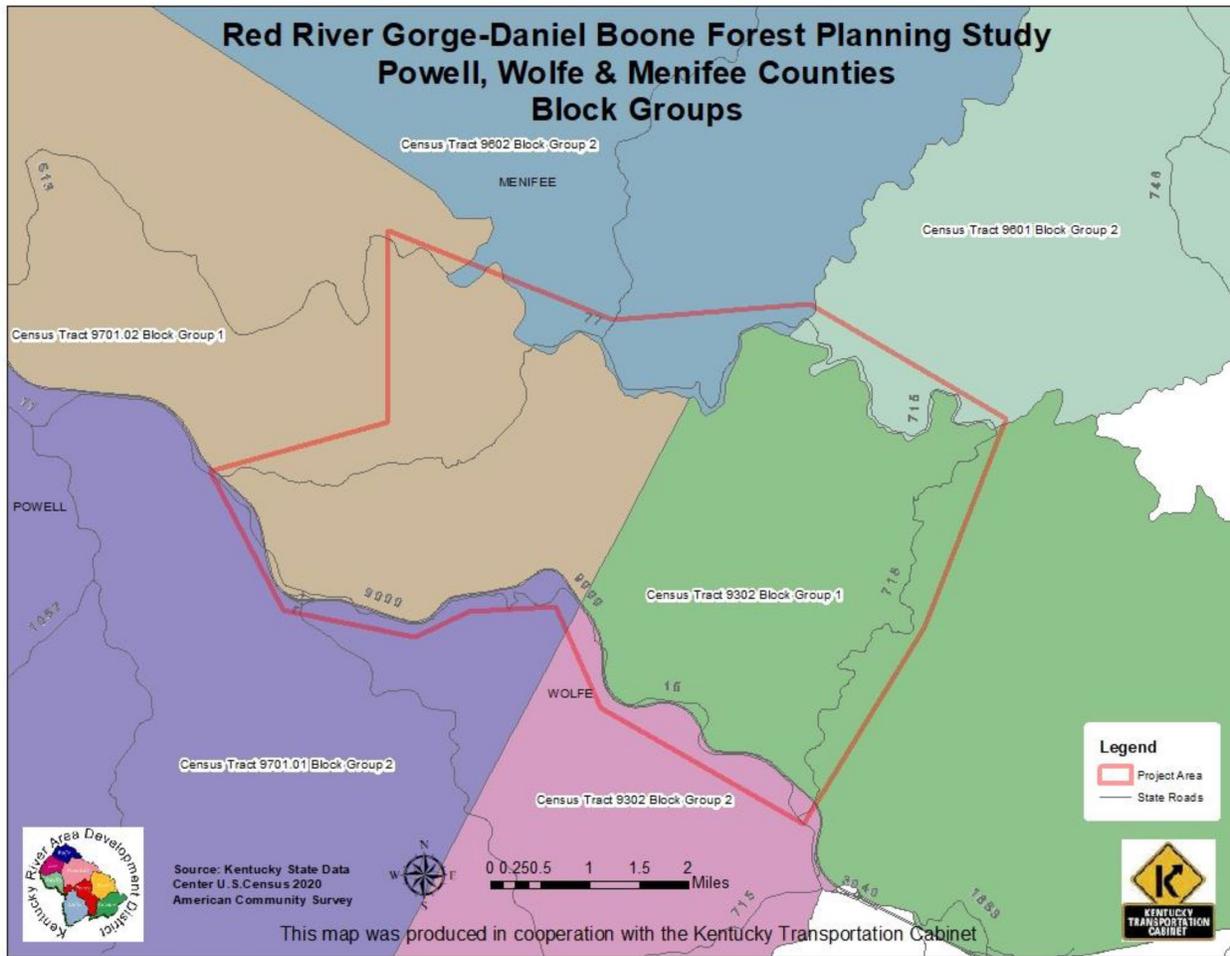


Figure 16: Socioeconomic Study Area Geographies

Table 6: Key Demographic Metrics

Geography	Population	Minority	Low-Income	Aged 65+	Disabled	LEP
Kentucky	4,461,952	15.9%	16.6%	16.0%	21.2%	2.3%
Menifee County	6,463	4.8%	20.7%	21.3%	29.6%	0%
T 9601 BG 2	740	0%	19.9%	28.0%	35.2%	0%
T 9602 BG 2	1,027	2.6%	6.5%	26.8%	28.9%	0%
Powell County	12,283	4.5%	21.0%	15.6%	28.1%	0.6%
T 9701.01 BG 2	967	0%	13.7%	15.9%	25.0%	0%
T 9702.02 BG 1	2,064	0%	4.3%	14.5%	14.6%	0%
Wolfe County	7,188	2.4%	36.1%	19.3%	47.1%	0.6%
T 9302 BG 1	1,357	5.3%	1.6%	9.1%	36.8%	2.9%
T 9302 BG 2	803	0.6%	56.2%	17.6%	45.6%	0%

6.0 CONCEPT DEVELOPMENT

Based on the data collection activities described above, analysts were tasked to define a list of potential improvement concepts that could address observed needs. Potential improvements were sorted into three groups:



Maintenance/Repairs



Nada Tunnel
Delay Options



Other Operational
Options

Each group is organized from less impactful, lower cost solutions to those having higher costs and greater impacts. Construction cost estimates are presented in FY 2022 dollars.

6.1 Maintenance/Repair Options

Pipe Repairs. Discussed in **Section 2.4**, the field inventory identified 118 pipes/culverts along KY 77/KY 715, 86% of which need repairs or replacement. Recommended repairs are classified into one of four categories, shown in **Figure A-9** in **Appendix A**: needing no work (13 sites), cleaning/repairing (52 sites), adding an element (e.g., a missing headwall, three sites), or replacing (50 sites). The combined construction cost estimate to address the needs is \$3.3 million: \$1.2 million for culvert work plus \$2.1 million to repave the impacted length of roadway.

From an environmental perspective, most structures can be repaired or replaced in-kind with minimal clearances—processed as a KYTC *Categorical Exclusion [CE] for Minor Projects*, with no USFS involvement.

Small Scale Pavement Projects. This catch-all covers several repair types at specific locations to address poor pavement conditions. With construction costs totaling an estimated \$8.6 million, project sites are shown on **Figure A-10**. Improvement types include:

- Resurfacing to add a fresh layer of pavement.
- Widening Curves (**Figure 17**) to provide extra width at sharp curves where vehicles track off pavement.



Figure 17: Curve Widening
Example

- Clearing Vegetation to remove limbs, brush, and/or selected trees that limit visibility or create a canopy that blocks sunlight from drying the pavement.
- Repairing Ditches to ensure runoff flows free from debris and cannot seep under the road.
- Adding T-Rail/Cribbing (**Figure 18**) to reinforce steep side slopes leading to pavement slips and slides.
- Installing Gabions (**Figure 18**), which are a type of rock-filled wire cage, to reinforce/support shoulders and reduce erosion.
- Replacing substandard guardrail.



Figure 18: Examples of Cribbing (left) and Gabions (right)

Table 7 summarizes recommended spot improvement measures corresponding to the map shown in **Appendix A**. Measures were developed based on field observations during June 2022.

Table 7: Descriptions of Small-Scale Pavement Projects

Map ID	Location	Description	Cost (2022 \$)
A	KY 77 Powell Co. MP 2.4-2.5	Widen inside curve, clear vegetation, line ditch, correct superelevation, resurface	\$150,000
B	KY 77 Powell Co. MP 2.7-2.8	Widen inside curve, clear vegetation, line ditch, correct superelevation, resurface	\$170,000
C	KY 77 Powell Co. MP 3.1-3.3	Install Gabions along Grays Branch to stabilize slope; resurface where disturbed	\$340,000
D	KY 77 Powell Co. MP 4.1-4.17	Add T-Rail and cribbing	\$620,000
E	KY 715 Menifee Co. MP 5.85-5.95	Resurface	\$90,000

Map ID	Location	Description	Cost (2022 \$)
F	KY 715 Menifee Co. MP 5.4-5.5	Widen inside curve, clear vegetation, line ditch, correct superelevation, resurface	\$240,000
G	KY 715 Menifee Co. MP 3.2-3.3	Resurfacing and extend T-Rail 125 feet	\$260,000
H	KY 715 Menifee Co. MP 3.0-3.1	Resurface	\$110,000
I	KY 715 Menifee Co. MP 2.1-2.3	Add T-Rail and cribbing	\$1.7 million
J	KY 715 Menifee Co. MP 1.4-1.6	Add T-Rail and cribbing	\$1.7 million
K	KY 715 Menifee Co. MP 1.0-1.1	Add T-Rail and cribbing	\$850,000
L	KY 715 Menifee Co. MP 0.4-0.5	Add T-Rail and cribbing	\$870,000
M	KY 715 Menifee Co. MP 0.0-3.5	Resurface, reconstruct ditches	\$1.1 million
N	KY 715 Wolfe Co. MP 10.6-11.1	Resurface, reconstruct lined ditches, replace guardrail	\$250,000
O	KY 715 Wolfe Co. MP 9.0-10.6	Resurface, clear vegetation inside curves	\$190,000
-	Entire KY 77/KY 715 Study Corridor	Install chevron signs at Class E/F curves	\$20,000

While no deed research was completed for this transportation study, improvement limits fall within existing pavement and ditch lines, assumed to correspond to KYTC right-of-way. Although most spot improvements can be processed as a CE requiring no USFS involvement, USFS requested that tree clearing be coordinated with the staff silviculturist prior to any tree removal.

6.2 Tunnel Delay Options

Lengthy delays at the one-way Nada Tunnel are a common complaint. As discussed in **Section 2.6.1**, analysts measured delay for platoons entering Nada Tunnel during the busiest Saturday in October 2022. **Figure 19** presents the observed delay in seconds for each platoon approaching the tunnel—the yellow line indicates eastbound drivers entering RRG and the red line indicates westbound drivers leaving RRG. As seen in the chart:

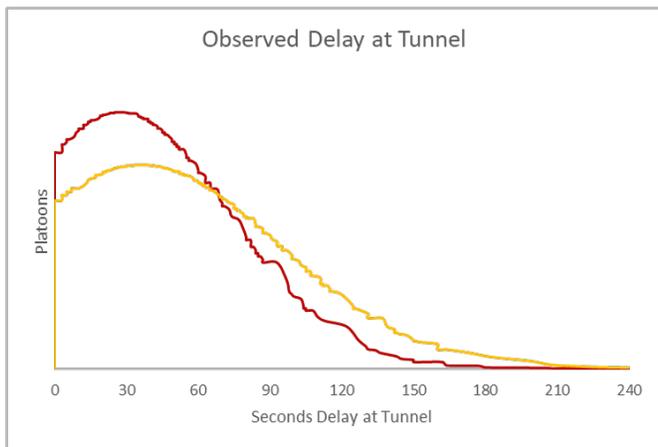


Figure 19: Tunnel Delay by Platoon

- Delays tended to be longer for eastbound motorists.
- Average delays for each platoon were 27 to 36 seconds.
- Over half of the approaching platoons were able to drive through with no wait time.
- Few platoons (7%) had to wait two minutes or longer.

A wide range of options were considered to reduce delays at the tunnel:



No-Build



Temporary Signal



Peak Flaggers



Signage



Realign Approach



Widen Tunnel

No-Build. With this option, the tunnel would continue to operate as it does today: one lane of traffic, with “Yield” signs at either entrance.

Temporary Signal. During busy weekends in the spring and fall, this option would set out a temporary traffic signal like those KYTC uses at construction zones with one-way traffic. Adding a signal would increase delays, as a signal would require about a 200-second cycle, including two 60-second “all red” times that stop vehicles on both sides to take turns clearing the tunnel before permitting opposing traffic to enter. This equates to longer wait times for 84% of platoons versus measured delays during a busy Saturday in October 2022.

While estimated up-front costs are relatively low (\$75,000 to purchase a set of signal controllers), there would be recurring costs to install and remove units each peak season. There would also be practical concerns with the system: would drivers familiar with the tunnel obey the signal, particularly if there were no opposing traffic? The system does not account for increased travel times for cyclists or pedestrians, inconsistent with KYTC’s Complete Streets policy.

A flyer (**Appendix H**) was developed to share with interested parties to help facilitate discussion beyond this study effort.

Peak Flaggers. This option would operate similarly to the signal option but rely on trained personnel to direct traffic flow through the tunnel during peak spring and fall weekends. As with the signal option, delay would increase compared to 2022 data. In addition, staffing expenses would increase as would potential safety risks for field personnel.

Signage. Today, KY 77 signs near KY 11 (Campton Road) and KY 77 (Tarr Ridge Road)/KY 715 warn motorists of a one-lane, low clearance tunnel 2 to 3 miles ahead. “Yield” signs are posted at either entry. This option would add to existing advance warning signs to alert motorists unfamiliar with the tunnel.

Traditional signage options are shown in **Figure 20** (as recommended in the 2020 KYTC/USFS/FHWA study), but innovative technology-based options also exist that could prove effective. For example, one smart sign pilot system in California relies on radar to sense cars approaching blind curves and warn oncoming traffic.

“Share the Road” signage could also help remind motorists to watch for vulnerable road users.

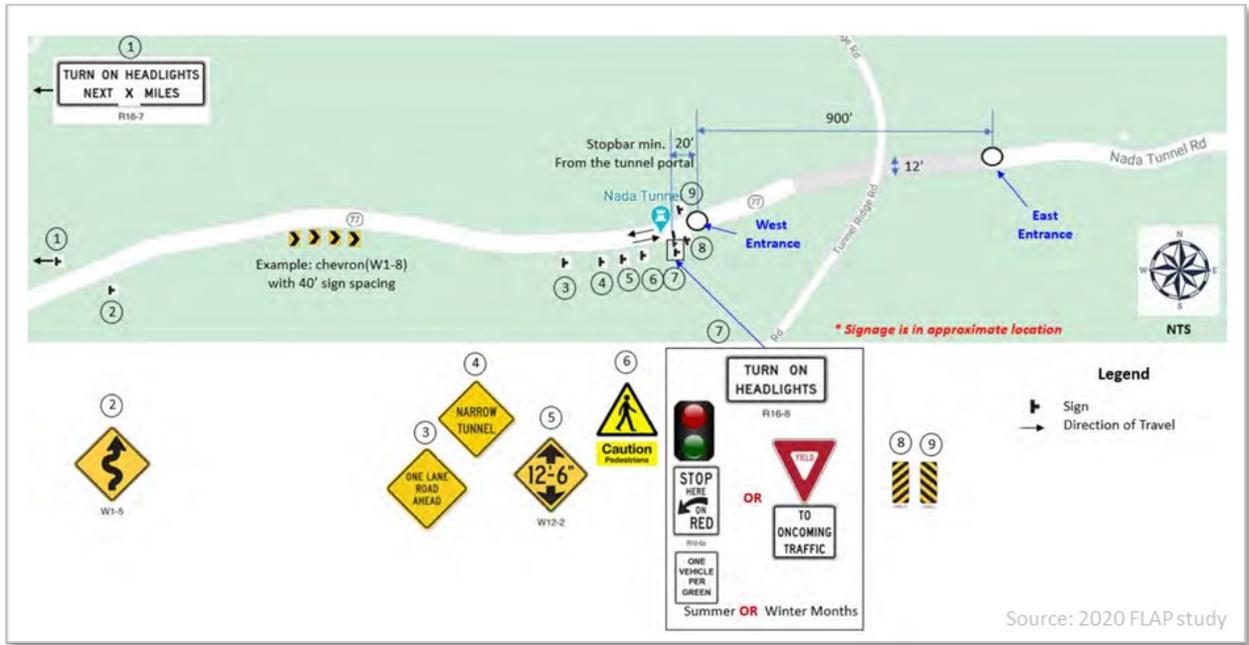


Figure 20: Potential Signing Configuration

Realign Approach. Entering RRG, the eastbound tunnel approach contains a curve, limiting visibility. Delays for this direction of travel were consistently higher than for motorists leaving RRG. This option would realign the approach west of the tunnel to improve visibility. Cutting into the adjacent slope (**Figure 21**) would be necessary but would not disturb the tunnel itself. The roadway would be closed to traffic for a portion of construction; however, the closure could be scheduled to occur in the off-season. Detailed geotechnical investigations, engineering designs, and environmental analyses would be required if this option were to advance.



Figure 21: View west from Tunnel

Unlike previously described options, this option could improve drainage, thereby reducing the ponding and icing notorious at the tunnel portal. Improved visibility adds safety benefits for cyclists and pedestrians as well.

Figure 22 presents a rough approximation of the level of impact and views of the slope that would be affected. The vertical wall in the background of both images represents the face of the cliff

through which the tunnel extends. Construction cost estimates begin at \$450,000 for the smaller footprint (20 mph) or \$1.1 million for the larger (35 mph) but are likely to increase upon detailed geotechnical investigations.

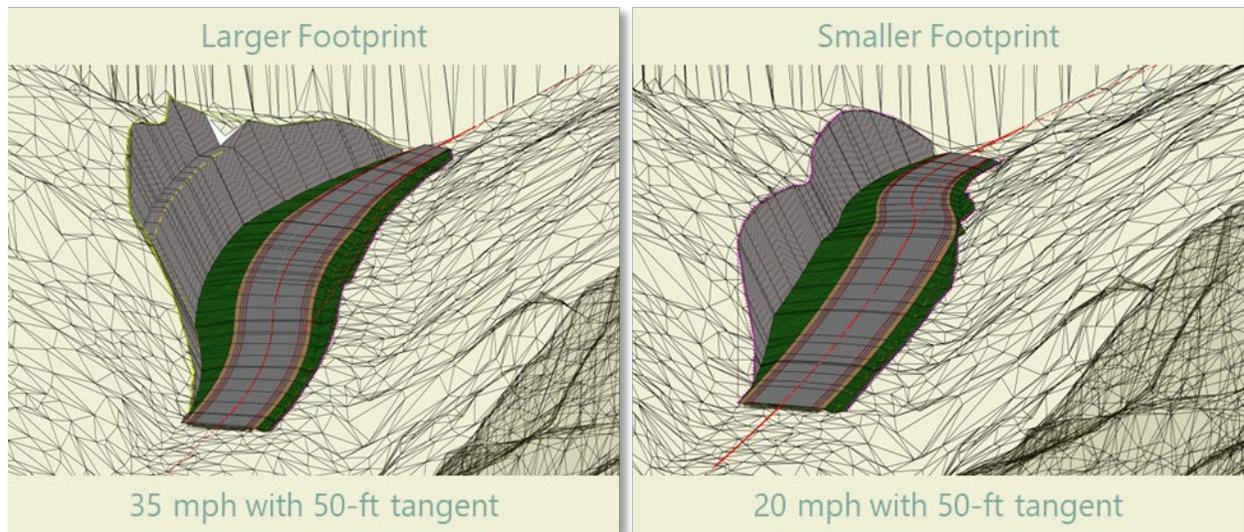


Figure 22: Eastbound Tunnel Approach Realignment Options

The realignment also would provide an opportunity to create a family photo stop, a designated safe place to view/photograph the tunnel beyond the roadway footprint. Built features, such as a retaining wall to minimize earthwork, should be sensitive to the environmental setting and visual characteristics.

Environmentally, additional investigations would be required to assess feasibility and impacts. Beyond geotechnical exploration, the disturb limits potentially represent habitat for federally protected species: bats, migratory birds, short's bladderpod (an endangered plant), and monarch butterflies. There is also the potential to encounter buried archaeological deposits, which are prevalent throughout the RRG area. While the level of analysis may change based on findings, a KYTC Level 2 CE coordinated with/adopted by USFS may suffice.

Widen Tunnel. With the highest costs and most impacts, widening the tunnel is the only option considered that would allow for two-way traffic flow. Detailed geotechnical investigations, engineering designs, and extensive environmental analyses would be required if this option were to advance. The tunnel is an NRHP historic resource and an iconic RRG gateway; widening would significantly impact its character.

The estimated construction cost is \$10+ million, plus additional costs for the approaches. However, the cost is likely to increase upon detailed geotechnical investigations. Environmentally, robust analyses would be necessary, likely culminating in an EA/FONSI or *Environmental Impact Statement* due to the potential for public controversy.

6.3 Other Operational Options

Another range of options was considered to improve operations on the larger KY 77/KY 715 study corridor:



No-Build



One-Way



Shuttle



Minor Widening

No-Build. KY 77/KY 715 would continue to operate as it does today, with two-way traffic and no infrastructure improvements beyond typical maintenance levels.

One-Way Travel. The study corridor would only serve one-way traffic. As the total drive time is around 50 minutes, this would significantly increase travel times and trip lengths for motorists accessing destinations near either endpoint without making a full circuit. While this might not represent a burden for recreational visitors, increased travel time and costs for residents and other motorists who regularly travel the area are a concern. However, simplifying traffic flow would improve safety for vulnerable road users, with the potential to allocate a dedicated pathway for cyclists.

Another possible option would make only the narrowest section of the route, near Sky Bridge, one-way. While this would reduce travel time compared to a fully one-way corridor, the option would also eliminate approximately half the thru-trips because, upon reaching the one-lane section, vehicles headed in the opposing direction would have to make a U-turn and exit via the same route they used to enter. Most segments and intersections have adequate capacity to handle the increase in traffic, but the tunnel still represents a one-lane bottleneck.

The study's traffic data collection proposed to gather GPS origin-destination information simultaneously with traffic counts; however, limited reception compromised the effectiveness of the data. No definitive data is available for comparing the number of thru trips traveling the entire study corridor against the number of trips traveling only a section of it before leaving the study area.

Shuttle Service. Discussed further in the 2022 EA/FONSI published by USFS, a private contractor could operate an on-demand shuttle service to help reduce parking demands. Specific stops, parking areas, and operational features have yet to be defined. Overall, up to 28 stops are envisioned—three along KY 77 and 12 along KY 715—with potential shuttle stops shown in **Figure 23**. Once defined, each is envisioned to include a 10-foot by 30-foot, accessible, paved pad.

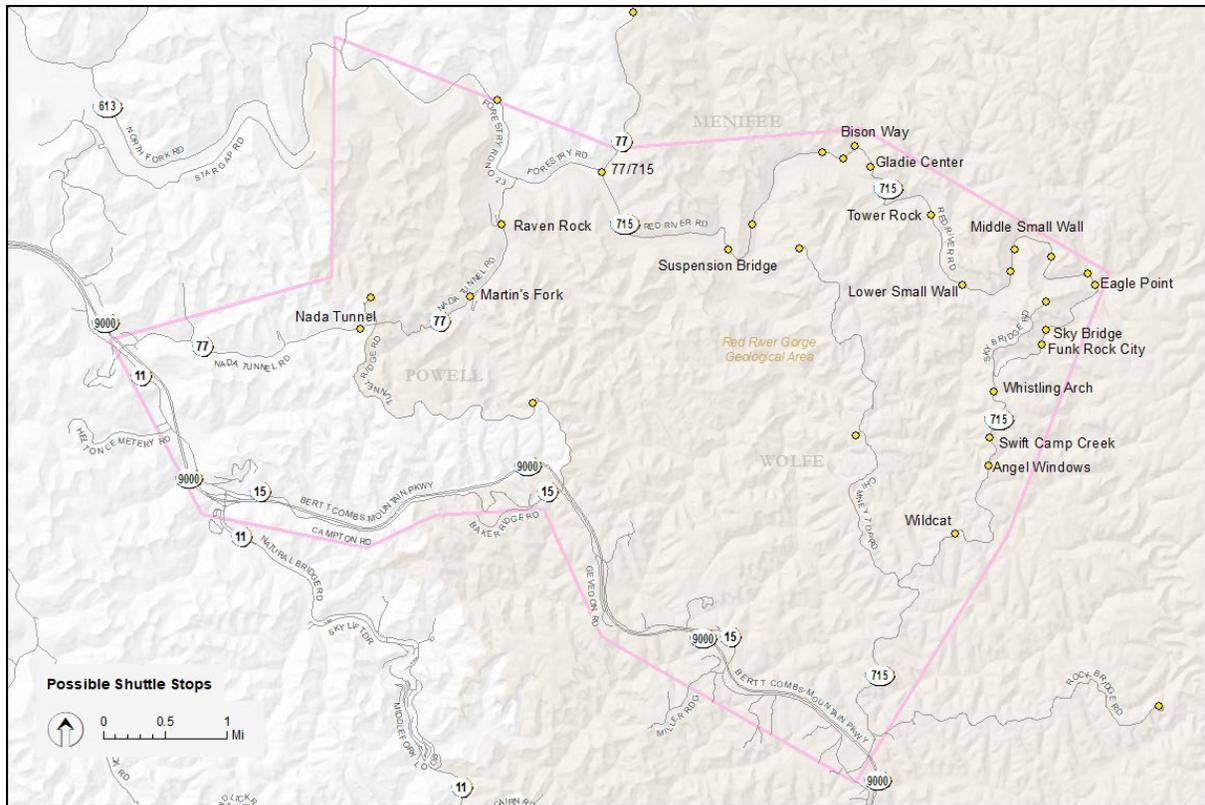


Figure 23: Potential Shuttle Stops

Minor Widening. An ultimate, long-term Build solution would include minor widening, consistent striping, and other improvement measures to create a consistent typical section, similar to that of the US 129 "Tail of the Dragon" highway near Deals Gap, North Carolina. The US 129 corridor, winding through 318 curves along 11 miles, is an international attraction for motorcyclists near Great Smoky Mountains National Park but faces less stringent protections—it is not on federally managed lands and does not abut a Wild and Scenic River. As intended with the Minor Widening Option, the US 129 corridor would balance environmental, transportation, and tourism interests to provide a safe, consistent, context-sensitive highway for all users.

This concept includes widening KY 77/KY 715 to provide a consistent typical section (two 10-foot-wide lanes with 1-foot-wide paved shoulders), consistent high-visibility striping, and grout-lined ditches to improve drainage. As appropriate, curve widening, vegetation clearing, and other repairs discussed in **Section 6.1** would be incorporated as well. Construction costs are estimated to total \$48 million. Geotechnical investigations, engineering designs, and environmental analyses would be required if this option were to advance.

The steep hillside near Sky Bridge (KY 715 Wolfe County MPs 10.6 to 11.1) would have the largest disturbed footprint due to the steeper terrain. Shown in **Figure 24**, this half-mile stretch would result in 100,000+ cubic yards of cut and 4,000 cubic yards of fill to accommodate the proposed typical section.

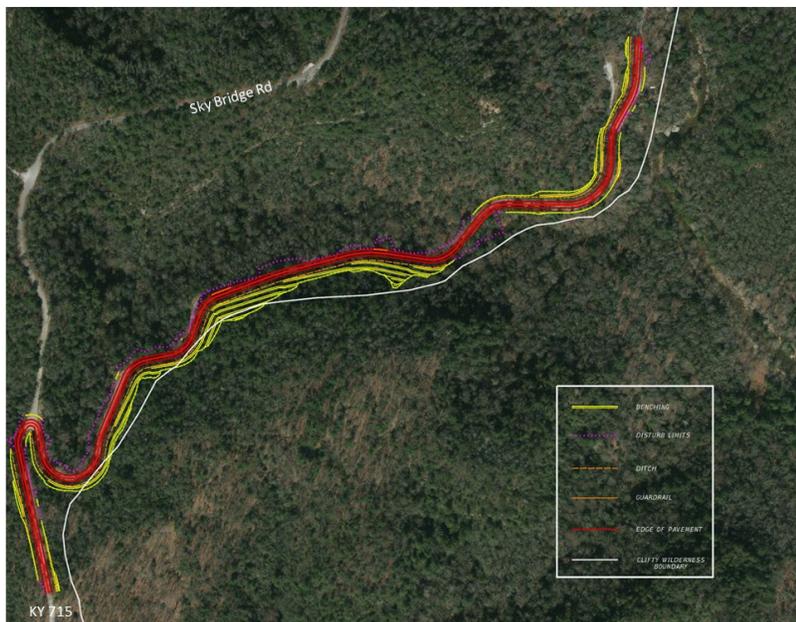


Figure 24: Minor Widening at Wolfe Hillside

To facilitate construction management, potential construction segments have been identified, as presented in **Table 8**. Environmentally, the entire study corridor could be addressed in a single *National Environmental Policy Act* (NEPA) document. While the level of analysis may change based on environmental analyses, a KYTC Level 2 CE coordinated with/adopted by USFS may suffice.

Table 8: Potential Construction Segments for Minor Widening

Construction Section	Length	Construction Cost (2022 \$)
KY 77 Powell MP 0.0–4.3 and Menifee MP 0.0–0.8	5.1 mi	\$5.8 M
KY 715 Menifee MP 0.0–6.9	6.9 mi	\$22.3 M
KY 715 Wolfe MP 10.6–12.0	1.4 mi	\$10.8 M
KY 715 Wolfe MP 5.7–10.6	4.9 mi	\$8.8 M

7.0 COORDINATION MEETINGS

Throughout the course of the study, the project team met at key milestones to discuss study tasks. The project team is composed of staff from the KYTC Central Office and District 10, the local USFS, the three ADDs (Kentucky River, Bluegrass, and Gateway), and the consultants. Meeting summaries for each coordination point are in **Appendix F**, arranged chronologically.

7.1 Kickoff Meeting with County Judges

A kickoff meeting was held March 3, 2022, with the Menifee, Powell, and Wolfe counties' Judge/Executives to discuss the scope of work and seek input from local leaders. In a candid conversation between the Judge/Executives and project team members, specific concerns regarding travel in RRG, the region, and management practices were identified.

- Visitor levels have increased since 2020, with RRG becoming more a year-round attraction than a seasonal destination.
- Ditching, drainage, parking, and overall roadway maintenance are among the biggest transportation concerns. Steep hills on KY 77 and on KY 715 near Sky Bridge are recurring maintenance and safety issues.
- An alternative access point independent of the tunnel is needed; for example, an improved North Fork Road from Stanton.
- A one-way route or change in route ownership would face local opposition.
- Staffing, funding limitations, and environmental/regulatory requirements play a role in project implementation timelines. This planning study is a proactive step to identify needs before conditions necessitate lengthy closures and emergency repairs.
- Any changes will impact diverse user groups—residents who drive the corridor daily, occasional visitors who are critical to the regional economy, agencies and advocacy groups with special interests in the area, etc. Analyses of any Build concepts should consider impacts to each group.

7.2 First Project Team Meeting

The project team met June 27, 2022, to discuss the existing conditions inventory (**Chapter 2.0**) through the April traffic data collection. Besides mobility and safety, USFS also considers the perceived visitor experience. As they impact tourism, public perceptions are also a concern for the County Judges: increased parking opportunities and/or shuttle services may alleviate visitor concerns.

7.3 Second Project Team Meeting

The project team met again January 4, 2023, to review the October traffic data and explore the Build concepts presented in **Chapter 5.0**. Discussions focused on specific Build concepts, regulatory hurdles, and preparation for upcoming community outreach efforts. Key discussion items included:

- Both KYTC and USFS want the roads maintained and in a state of good repair.
- Without documented right-of-way, top of cut to bottom of fill is assumed to represent state-owned right-of-way. Anything beyond this prism would require more intensive environmental investigations, more so if footprints are increased or historic elements are affected.
- Tree canopy plays a significant role in retaining moisture, leading to pavement cracking as sunlight cannot reach the pavement to dry it. As specific designs are developed, a closer look at specific areas for tree/limb clearing will require working with a silviculturist to define a desired condition and context-sensitive approach. Public input will be critical. The extent of tree/limb removal will affect the level of environmental clearance and timelines. Clear explanations and effective visuals can help communicate measures to the public.
- Any changes beyond 100 feet of the centerline in the wilderness area would require a statute enacted by the United States Congress (Act of Congress). Recent USFS outreach efforts have shown the public strongly supports preservation of RRG.

7.4 Second Meeting with County Judges

The project team hosted a second coordination meeting with the three county Judge/Executives January 26, 2023. The briefing included an overview of the Build concepts ahead of the upcoming public meeting. Generally, attendees agreed the Build concepts represent reasonable options and appreciated options to minimize impacts. While not all concepts should advance at this time, attendees concurred tourism will increase in this area and, to address safety issues, the current roadways could be improved with relatively minor impacts.

Attendees were apprised of plans for an upcoming public meeting and survey and encouraged to promote participation in these activities.

7.5 Public Meeting

An open house public meeting was held at the Gladie Visitor Center in RRG Saturday, March 11, 2023. The public meeting and accompanying website/survey were promoted via District 10 and USFS social media accounts, flyers, and other media releases. The project website (RRGstudy.com) contained the same information and survey questions as presented during the in-person meeting. There was no formal presentation, but members of the project team circulated to answer questions. In total, 19 individuals attended the meeting.



Figure 25: Gladie Public Meeting

7.5.1 Survey Responses

During February and March 2023, surveys were collected to obtain community perspectives on the proposed concepts. Overall, 69 completed surveys were submitted.

The first two survey questions asked participants which “good qualities” defined their RRG experience (**Figure 26**) and which “bad qualities” detracted from it (**Figure 27**). Larger text in each figure identifies the more common responses. As shown, several transportation-related themes appear in the negative list (e.g., traffic, parking, etc.), though many other themes related to increased visitor levels were also prevalent.

While 36% of survey participants stated overall traffic congestion rarely or never impacts their RRG experience (**Figure 28**), 48% stated congestion at the tunnel rarely or never impacts their experience. Written comments cited peak seasonal weekends were a concern, as were constraints associated with the one-way tunnel, limited parking areas near key destinations, cyclists, and motorists struggling to navigate narrow, curvy roads. Illegal on-street parking further limits the travel way, compounding these issues. A few participants suggested demand management strategies—fees or permits to help limit the number of vehicles. Motorists who are unfamiliar with or impatient waiting at the tunnel were cited as top operational concerns at the tunnel, more so than its physical characteristics.

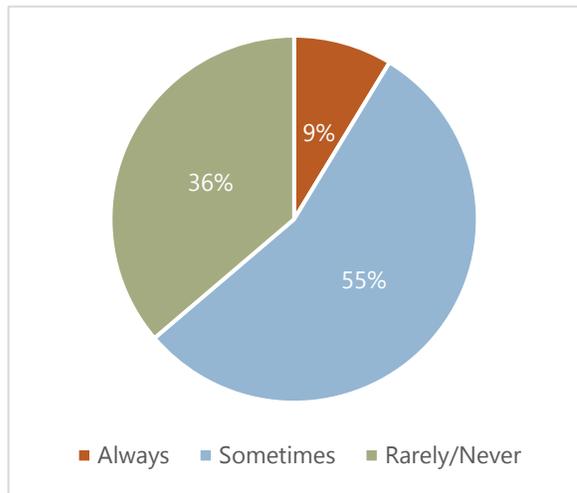


Figure 28: Does Traffic Congestion Impact your RRG Experience?

Respondents were asked what a reasonable wait time at the tunnel should be. Results are shown in **Figure 29**.

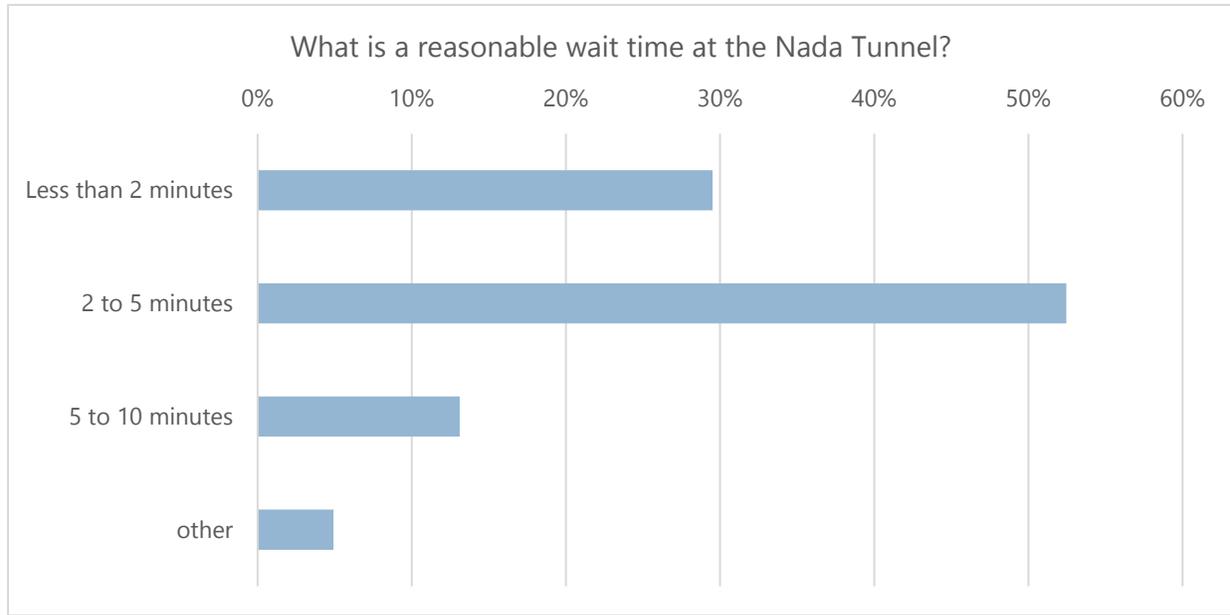


Figure 29: Reasonable Tunnel Wait Times

As shown in **Figure 30**, results were divided regarding the impact of traffic safety on the RRG experience. Open-ended comment themes included:

- Sharing narrow roads among multiple modal users—bikes, pedestrians, motorcyclists, trucks, etc.
- Wet weather, which influences pavement condition, stopping along steep downgrades, and soft shoulders.
- Limited visibility and overcrowding in parking areas.
- Speeding.

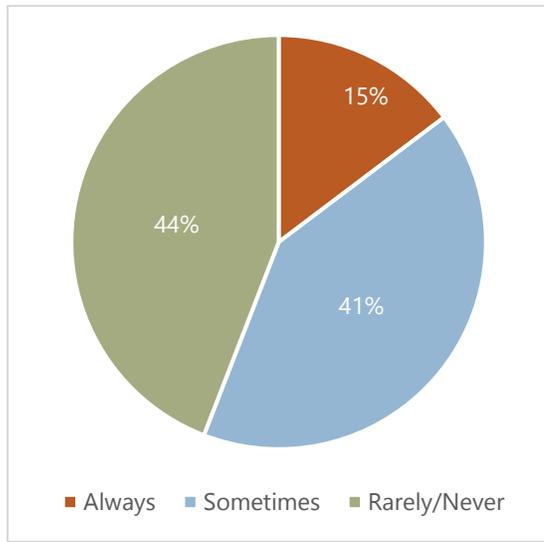


Figure 30: Does Traffic Safety Impact Your RRG Experience?

As with congestion, illegal on-street parking and unfamiliar/impatient motorists further compound safety issues.

After working through these initial questions that encouraged people to think about how transportation influences their experience, participants were asked whether improvements were needed to address traffic. Of 69 responses, 75% agreed that improvements are needed.

The remaining questions asked about support for the tunnel delay options and other operational options discussed in **Chapter 6.0**. Results are presented in **Figure 31** and **Figure 32**.

As shown, adding a temporary traffic signal during peak seasonal weekends received the most support: 18 participants supportive and 18 participants strongly supportive, compared to 7 individuals who opposed or strongly opposed a signal. The signal, flaggers, and increased signage received more support than opposition. Realigning the eastbound approach received an even split between support and opposition, while widening the tunnel was strongly opposed by most individuals.

Looking at options for the larger KY 77/KY 715 corridor, minor widening and a shuttle service received more support than opposition. But opposition to the one-way concept outweighed support. Responses were evenly split regarding a No-Build solution.

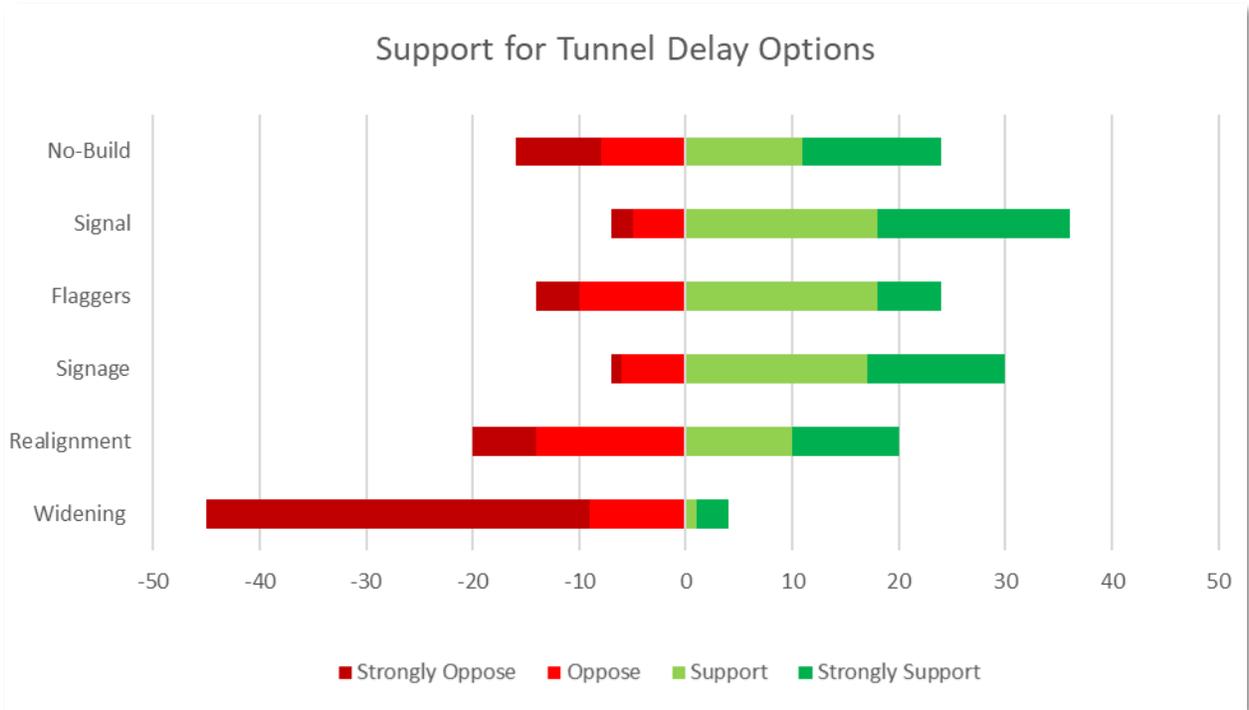


Figure 31: Survey Preferences for Tunnel Delay Options

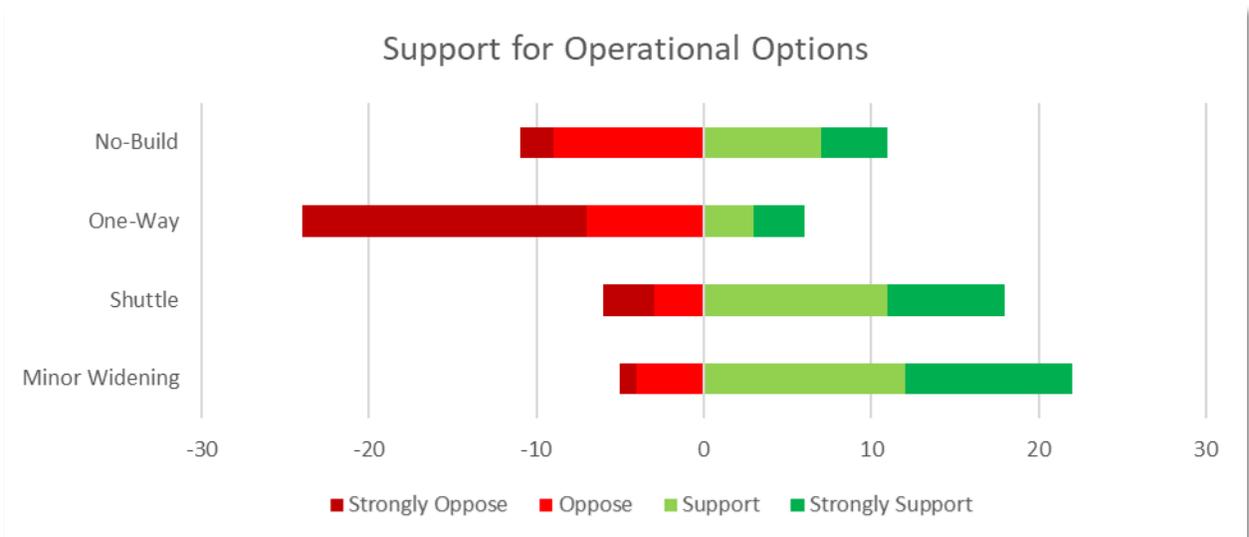


Figure 32: Survey Preferences for Other Operational Options

An open-ended comment offered individuals the opportunity to share any remaining concerns. Overall, survey participants love RRG and prefer less invasive improvements to preserve its natural beauty and ecosystem. Several participants suggested other improvement concepts that could be considered:

- A setup with mirrors, lasers, or flashers at the tunnel to warn motorists of oncoming traffic.
- A system of tolls, parking permits, or other user fees to manage demand and/or restrict which modes can use roadways (e.g. banning pedestrians, cyclists, motorcycles, and/or trucks).
- An improved secondary connection (e.g., Indian Creek or KY 613) to bypass the tunnel, intended for cars and/or cyclists.
- Parking: adding more spaces as well as more intentional correlations between parking areas and trails.
- Increased enforcement.
- More trash cans.

Many observations related more to human behaviors than to transportation issues.

7.6 Resource Agency Coordination

KYTC provided a link to the study website and request for comments to 60 federal and state agencies, advocacy groups, congressional contacts, and other stakeholders. The two responses received are summarized in **Table 9**. Copies of correspondence are included as **Appendix G**.

Table 9: Resource Agency Coordination

Agency	Comment Summary
Appalachian Regional Commission	Since initial construction of Corridor I (Mountain Parkway) within the Appalachian Development Highway System has been completed, the ARC does not have any input or comments at this time.
Water Quality Certification Section at KY Energy and Environment Cabinet	Any impacts to Middle Fork Red River, Red River, Wolfpen Creek, Gladie Creek, or Swift Camp Creek will require an individual Water Quality Certification. Two springs are along roads in the study area.

8.0 RECOMMENDATIONS

Alongside traffic operations and community input, costs and impacts are also important considerations in the decision-making process.

8.1 Final Project Team Meeting

A third project team meeting was held May 23, 2023, at KYTC District 10. The purpose of the meeting was to review input received from stakeholders and resource agencies and to reach a consensus on study recommendations. Key discussion items included:

- USFS is more concerned about larger projects that would impact the aesthetics or character beyond the existing highway. Where feasible, context-sensitive treatments consistent with the natural sandstone color palette should be incorporated.
- The minor widening option would require earthwork beyond assumed KYTC right-of-way. Beyond 100 feet of the roadway centerline, changes within the Clifty Wilderness would require an Act of Congress.
- A secondary link to KY 77/KY 715 using KY 613 to avoid the tunnel is an interesting concept but beyond the scope of this study.

8.2 Recommendations with Construction Costs

As presented in **Table 10**, ten improvement concepts were considered alongside the No-Build option. Within each category, concepts are ranked from least to most impactful on the surrounding environment. Relative support/opposition by different stakeholder groups are also noted alongside an overall recommendation for each. It should be noted that the No-Build option remains a viable solution until a decision is reached later in the project development process, after weighing associated costs, impacts, and community perspectives for proposed improvements as part of any future Phase 1 design work.

Table 10: Build Concepts with Recommendations

Category	Concept	Env. Impact	Judges' Support	Public Support	Recommendation
 Maintenance	Pipe Repairs	Low	Support	N/A	Advance
	Pavement Repairs	Low	Support	N/A	Advance
 Tunnel Delay Options	No-Build	Low	N/A	Even Split	N/A
	Temporary Signal	Low	Oppose	Support	Dismiss
	Peak Flaggers	Low	Oppose	Support	Dismiss
	Signage	Low	Support	Support	Advance
	Realign Approach	Medium	Support	Even Split	Advance
	Widen Tunnel	High	Oppose	Oppose	Dismiss
 Operational Options	No-Build	Low	N/A	Even Split	N/A
	One-Way Travel	Medium	Oppose	Oppose	Dismiss
	Shuttle Service	Medium	N/A	Support	Support
	Minor Widening	High	Support	Support	Long-Term

Both maintenance concepts are recommended to advance to maintain the corridor in a state of good repair. Costs are estimated at \$3.3 million for pipe/culvert repairs and \$8.6 million for the small-scale pavement repairs. Component improvement sites are detailed in **Figures A-9** and **A-10** in **Appendix A**. Additional information about individual culverts is in **Appendix B**.

Two measures are recommended to address delay at Nada Tunnel:

- Additional signage, primarily to increase alerts for oversize motorists before reaching the one-lane, low clearance tunnel. Costs are estimated at \$45,000 for the proposed layout shown in **Figure A-11** in **Appendix A**. "Share the Road" signs could also be placed.
- Realigning the eastbound approach to the tunnel so motorists can see oncoming traffic without crossing the centerline or entering the portal. Construction costs begin at \$450,000 for the 20-mph design speed shown, increasing to \$1.1 million or more for the larger 35-mph footprint. Additional geotechnical investigations, engineering, and environmental analyses are also required.

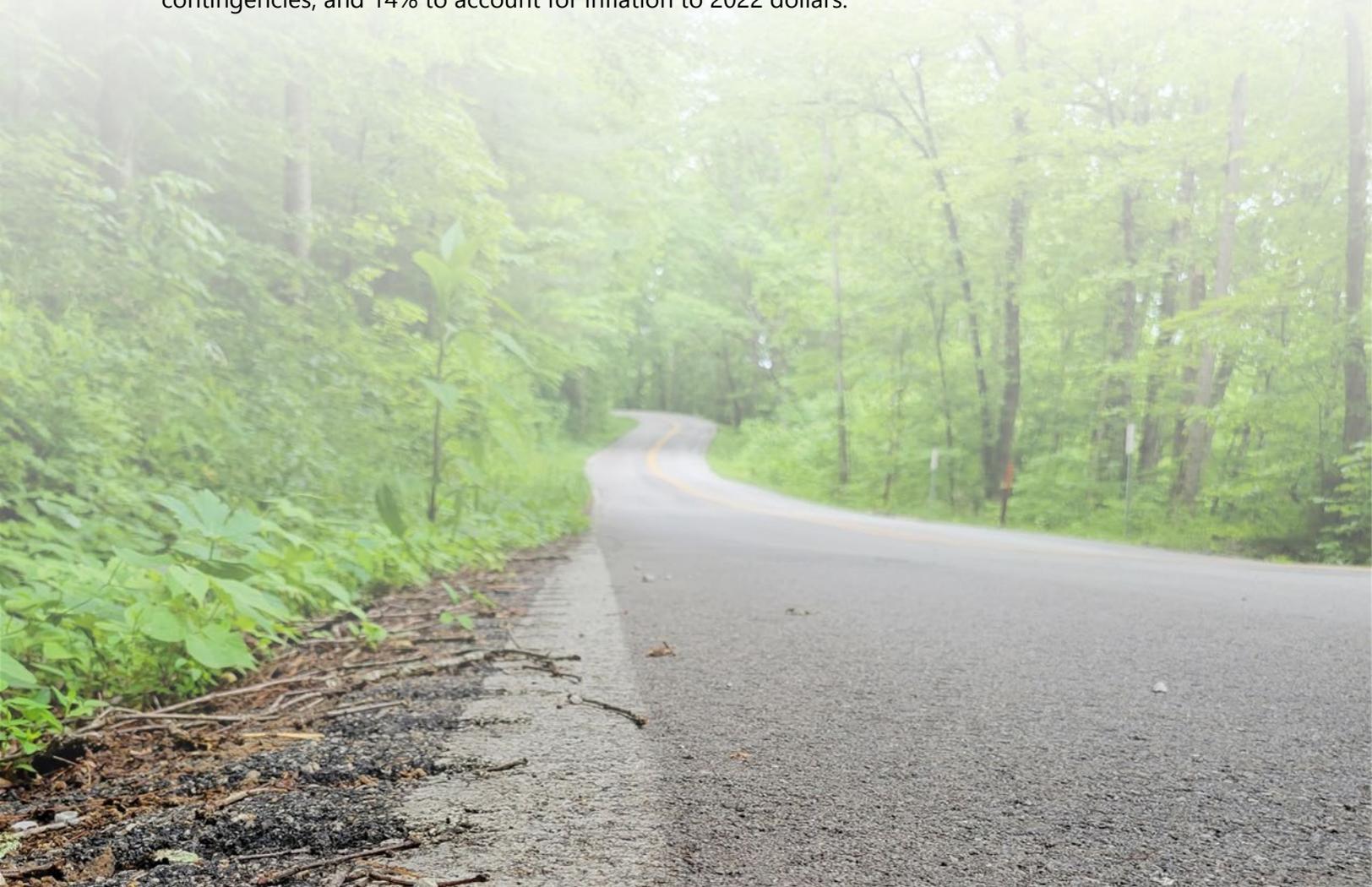
Regarding other operational options, KYTC supports USFS coordination to launch a third-party shuttle service although implementation is beyond KYTC's purview. Coordination is ongoing concurrent with this study to potentially transfer KYTC property at Slade (12275 Campton Road) for use as an off-site parking or operational center.

Long-term, the minor widening concept is also a priority for implementation. With costs estimated at \$48 million for the entire study corridor, the proposed measure has minor impacts on capacity but would improve safety and help create a consistent driver expectation for the corridor. The concept balances environmental, transportation, and tourism interests to provide a safe, consistent, context-sensitive highway for all users by means of a consistent typical section (two 10-foot-wide lanes with 1-foot-wide paved shoulders), consistent high-visibility striping, and grout-lined ditches to improve drainage. Detailed geotechnical investigations, engineering, and environmental analyses are required.

The team also discussed potentially transferring responsibility for KY 715 to federal ownership. This would provide increased flexibility for USFS to operate the route as part of its larger RRG management plan. Initial conversations with local officials suggested reservations regarding a transfer of ownership, but this strategy may be worth further USFS consideration.

8.3 Project Sheets

Individual information sheets for recommended improvement concepts are presented on the following pages. Planning-level cost estimates are based on preliminary quantities for high-cost construction items (e.g., earthwork, pavement, structures) based on 2019 KYTC District 10 prices. Each assumes a 15% to 30% factor for miscellaneous construction costs, 15% to 25% for contingencies, and 14% to account for inflation to 2022 dollars.



Pipe/Culvert Repairs		
Maintenance	KY 77 Powell, KY 77 MP 0-0.8 Menifee, KY 715 Menifee, KY 715 MP 10.6-12 Wolfe	
IMPROVEMENT DESCRIPTION: Repair/replace 105 of 118 inventoried pipes and culverts beneath KY 715 and KY 77: 52 for cleaning/repair, 3 with missing elements to add, and 50 for full replacement. Additional details included in Appendix B .	Estimate	(2022 dollars)
	Construct:	\$1.2 M
	Resurface:	\$2.1 M
	Total Cost:	\$3.3 M
IDENTIFIED NEEDS:		
2022 ADT:	KY 77 carries 700 vpd (weekday); KY 715 carries 200 vpd	
Crashes:	36 crashes (1 fatal, 8 injury) during 2017-2021; 27 involve single vehicle	
Geometry:	Two 8-9-foot-wide travel lanes with 2-3-foot-wide shoulders (1 foot paved) per HIS	
POTENTIAL ENVIRONMENTAL RED FLAGS: Streams (Wild & Scenic Red River adjacent)		
PROJECT LOCATION:		

Small-Scale Pavement Spot Improvements		
Maintenance	Entire KY 77/KY 715 Study Corridor (18.2 mi)	
IMPROVEMENT DESCRIPTION:		
Pavement repairs and small-scale safety improvements at 15 sites, including curve widening, vegetation clearing, ditch lining, resurfacing, cribbing, ditch reconstruction, replacing guardrail, and signage. Site-specific details in Table 7 and Figure A-7 .		
		Estimate (2022 dollars)
		Total Cost: \$8.6 M
IDENTIFIED NEEDS:		
2022 ADT:	KY 77 carries 700 vpd; KY 715 carries 200 vpd	
Crashes:	42 crashes (1 fatal, 9 injury) during 2017-2021; 29 involve single vehicle	
Geometry:	Two 8-9-foot-wide travel lanes with 2-3-foot-wide shoulders (1 foot paved) per HIS	
POTENTIAL ENVIRONMENTAL RED FLAGS: Streams (Wild & Scenic Red River adjacent), bat habitat		
PROJECT LOCATION:		

Increased Signage		
Tunnel Delay	KY 77 Powell MP 0.0-4.3	
IMPROVEMENT DESCRIPTION: Increase signage to alert motorists of one-lane, low clearance tunnel ahead.		
	Estimate	(2022 dollars)
	Total Cost:	\$45,000
IDENTIFIED NEEDS: 2022 ADT: KY 77 carries 700 vpd; KY 715 carries 200 vpd Crashes: 22 crashes (1 fatal, 2 injury) during 2017-2021; 18 involve single vehicle Geometry: Two 9-foot-wide travel lanes with 2-foot-wide shoulders (1 foot paved) per HIS		
POTENTIAL ENVIRONMENTAL RED FLAGS:		N/A
PROJECT LOCATION:		

Realign Eastbound Approach to Tunnel			
Tunnel Delay	KY 77 Powell MP 2.07-2.17		
IMPROVEMENT DESCRIPTION: Realign west approach to Nada Tunnel, improving sight distance for eastbound motorists approaching tunnel and improving drainage *Geotechnical investigation needed to assess feasibility	Estimate	(2022 dollars)	
	Design:	\$300,000	\$300,000
	ROW:	-	-
	Utilities:	-	-
	Construction:	\$450,000	\$1.1M
	Total Cost:	\$750,000 (20 mph)	\$1.4M (35 mph)
IDENTIFIED NEEDS:			
2022 ADT:	KY 77 carries 700 vpd; KY 715 carries 200 vpd		
Crashes:	No crashes during 2017-2021		
Geometry:	Two 8-foot-wide travel lanes with 2-foot-wide shoulders (1 foot paved) per HIS		
POTENTIAL ENVIRONMENTAL RED FLAGS: Protected species habitat, archaeological potential			
PROJECT LOCATION:			
<p>Larger Footprint</p> <p>35 mph with 50-ft tangent</p>		<p>Smaller Footprint</p> <p>20 mph with 50-ft tangent</p>	

Minor Widening

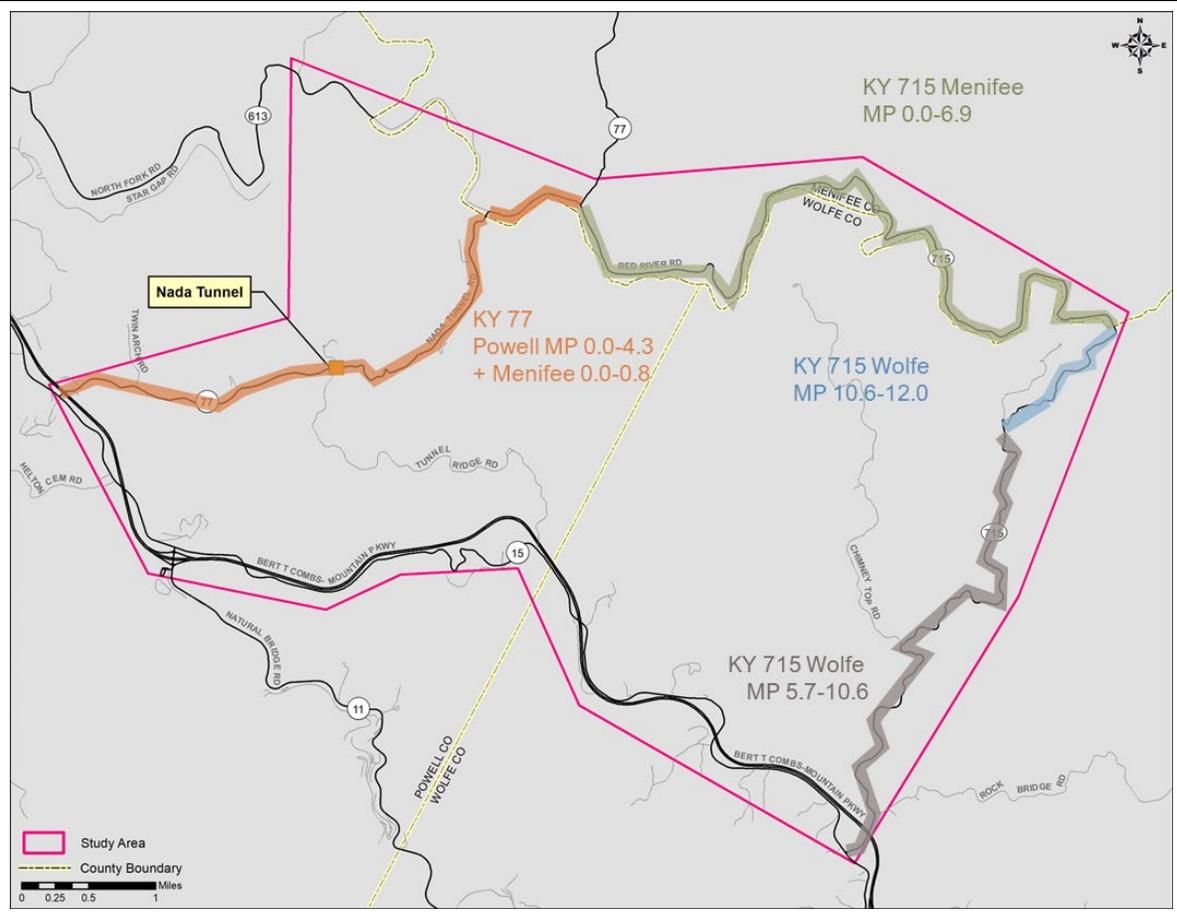
Long-Term	Entire KY 77/KY 715 Corridor (18.2 mi)	
IMPROVEMENT DESCRIPTION: Minor widening to provide two 10-foot-wide lanes with 1-foot-wide paved shoulders, consistent high-visibility striping, and grout-lined ditches to improve drainage. *Geotechnical investigation needed to assess feasibility	Estimate	(2022 dollars)
	Design:	\$5M
	ROW:	-
	Utilities:	-
	Construction:	\$48M
	Total Cost:	\$53 million

IDENTIFIED NEEDS:

2022 ADT:	KY 77 carries 700 vpd; KY 715 carries 200 vpd
Crashes:	42 crashes (1 fatal, 9 injury) during 2017-2021; 29 involve single vehicle
Geometry:	Two 8-foot-wide travel lanes with 2-foot-wide shoulders (1 foot paved) per HIS

POTENTIAL ENVIRONMENTAL RED FLAGS: Wild & Scenic River, Species habitat, archaeology potential

PROJECT LOCATION:



9.0 NEXT STEPS

Recommended repair and signage projects may be initiated through the district's routine maintenance and traffic programs or potentially become part of systematic specialty programs such as the Highway Safety Improvement Program. Further funding will be necessary to advance any improvement concept to the design phase.

A new (2022) federal funding stream for scenic byways relies on competitive grant applications to allocate funding nationwide.

For recommended larger concepts, individual projects should be added to KYTC's CHAF database to be considered alongside other projects in the next SHIFT prioritization cycle. Once funding is identified, the next phase in the project development process is Phase I Design (Preliminary Engineering), paired with geotechnical investigations and environmental analyses. Likewise, KYTC's *Statewide Transportation Improvement Program* should be amended to reflect any future project development phases.

Coordination with USFS, local officials, key stakeholders, and the public will be critical considering the potential for impacts to nearby community resources, particularly for larger scale concepts.

10.0 ADDITIONAL INFORMATION

Written requests for additional information should be sent to:

KYTC Division of Planning
ATTN: Director
200 Mero Street, 4th Floor West
Frankfort, KY 40622
Phone: 502.564.7183