Enhancing Safety with Automated Tools: KY's Embankment Study Pilot Project

by Mike Vaughn
Traffic Safety Branch Manager, KY Transportation Cabinet
Highway Safety Improvement Program (HSIP)

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Special Thanks

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HIGHWAY SAFETY IMPROVEMENT PROGRAM
HSIP
LEADING THE WAY TO A SAFE SYSTEM

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Vision | Mission | Goal of KY's HSIP

Vision – KY's HSIP is committed to preventing fatalities and serious injuries on all public roadways in KY.

Mission – To help people reach their transportation destinations safely by developing and delivering a data-informed, strategic approach to improving highway safety with a focus on performance.

Goal – To invest in safety improvement opportunities aimed at preventing serious crashes to help achieve KY's Strategic Highway Safety Plan goal of having the annual number of highway deaths at or below 500 by the year 2029, with an eventual ultimate goal of zero deaths from crashes.

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Roadway Departure Improvements to Decrease Crash Severity if a Motorists Departs the Roadway

- Guardrail and End Treatment Upgrades
- Installation of New Roadside Barriers and End Treatments
- Clear Zone Improvements, such as Tree Removal, Flattening Of Roadside Slopes, and Removal/Relocation of Roadside Objects

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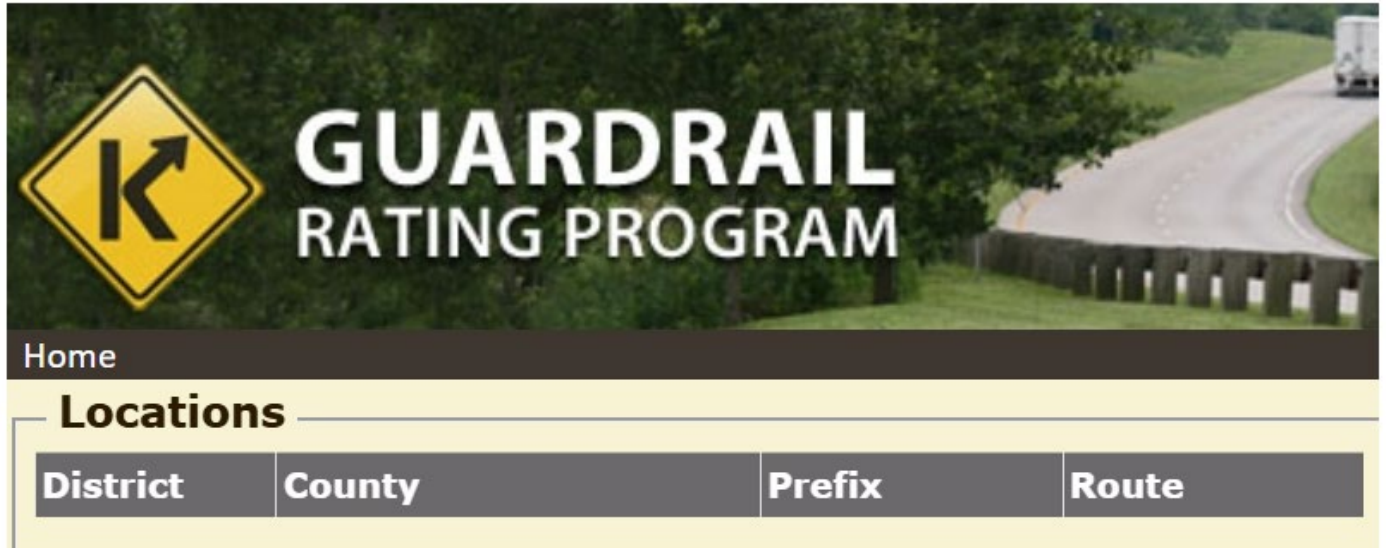
Installation of New Roadside Barriers

- KYTC maintains a database of the locations that warrant guardrail but do not currently have guardrail
- KYTC has developed a Guardrail Rating Program to prioritize the list of locations within the guardrail database

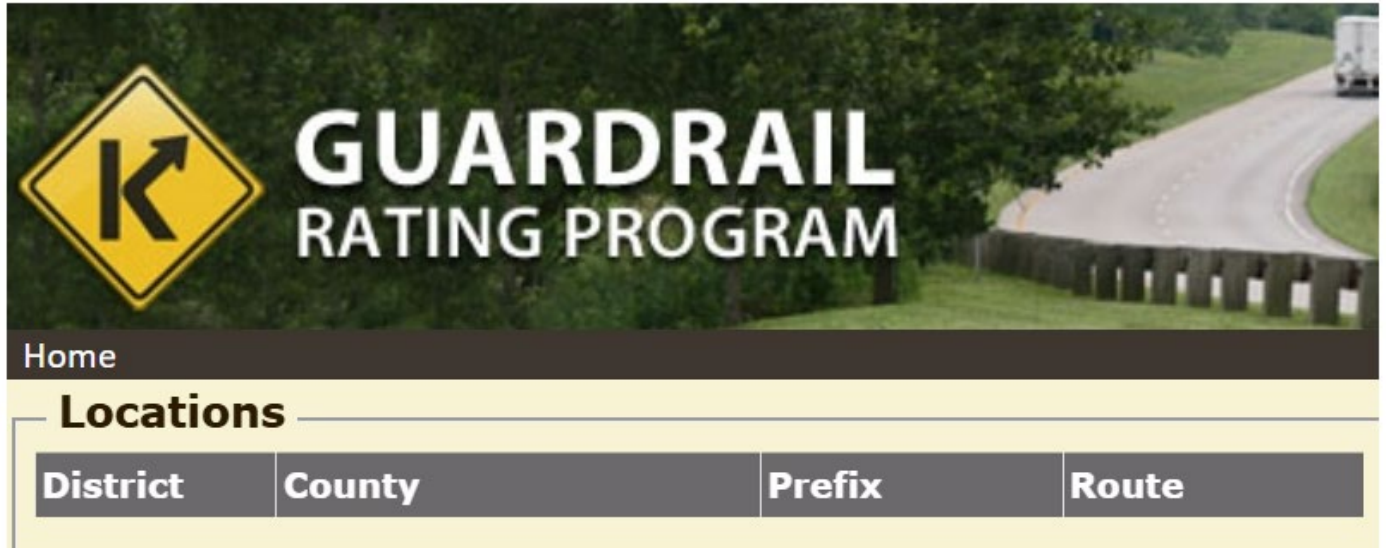
Installation of New Roadside Barriers

- Challenges:
  - Locations are currently identified manually
  - Roadside geometry is measured by hand and entered into the Guardrail Rating Program



Installation of New Roadside Barriers

- Opportunity:
  - Find a tool to automatically evaluate roadsides and determine locations that warrant guardrail
  - Produce a report of those locations for entry into the database



Embankment Study Pilot Project

- **Objective**:
  - Automate the identification of roadside embankments that warrant guardrail

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- **Scope:**
  - Using KYTC-provided parameters, configure RDV's RSA 3D technology to pilot the embankment evaluations of 122.7 miles of various types of roadways

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- **Scope:**
  - Using KYTC-provided parameters, configure RDV's RSA 3D technology to pilot the embankment evaluations of 122.7 miles of various types of roadways
- **Technology & Methodology:**
  - Use RDV's RSA 3D technology and AI algorithms to automate the measurement of embankment geometries and determine which locations warrant guardrail

Embankment Study Pilot Project

- KYTC provided RDV the guardrail warrant parameters
- KYTC used Roadside Design Guide Figure 5-1b as a guide:
  1. Embankment height < 5 feet
     - Generally, guardrail is not warranted
  2. Embankment height ≥ 5 feet, and slope is 2:1 or steeper
     - Guardrail is warranted
  3. Embankment height ≥ 10 feet, and slope is 3:1 or steeper
     - Guardrail is warranted
  4. For embankment heights between 5-10 feet, slope values were interpolated between #2 and #3 above

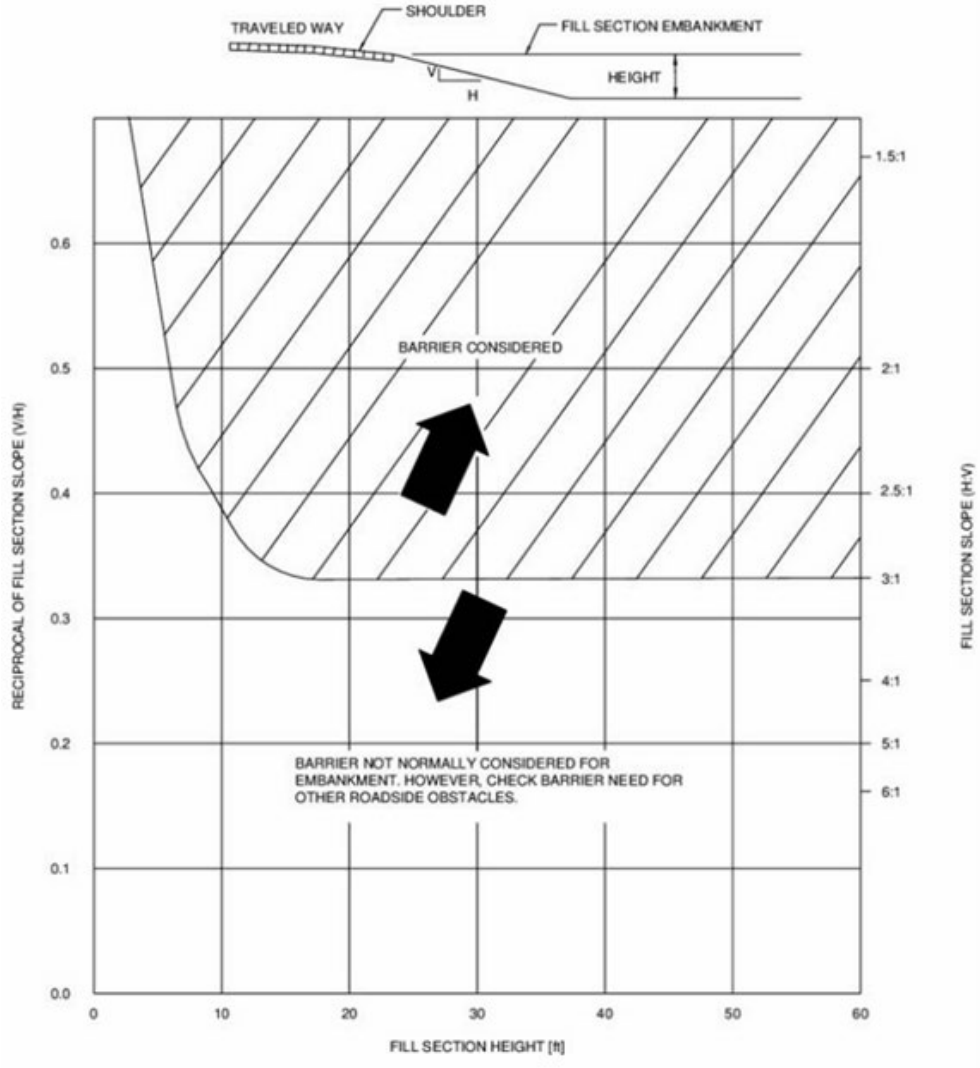

Figure 5-1b. Comparative Barrier Consideration for Embankments (U.S. Customary Units) (15)

Embankment Study Pilot Project

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4. For embankment heights between 5-10 feet, slope values were interpolated

Embankment Height (feet)	Slopes Warranting Guardrail
5 ft	2:1 or steeper
6 ft	2.143:1 or steeper
7 ft	2.308:1 or steeper
8 ft	2.5:1 or steeper
9 ft	2.727: 1 or steeper
10 ft	3:1 or steeper

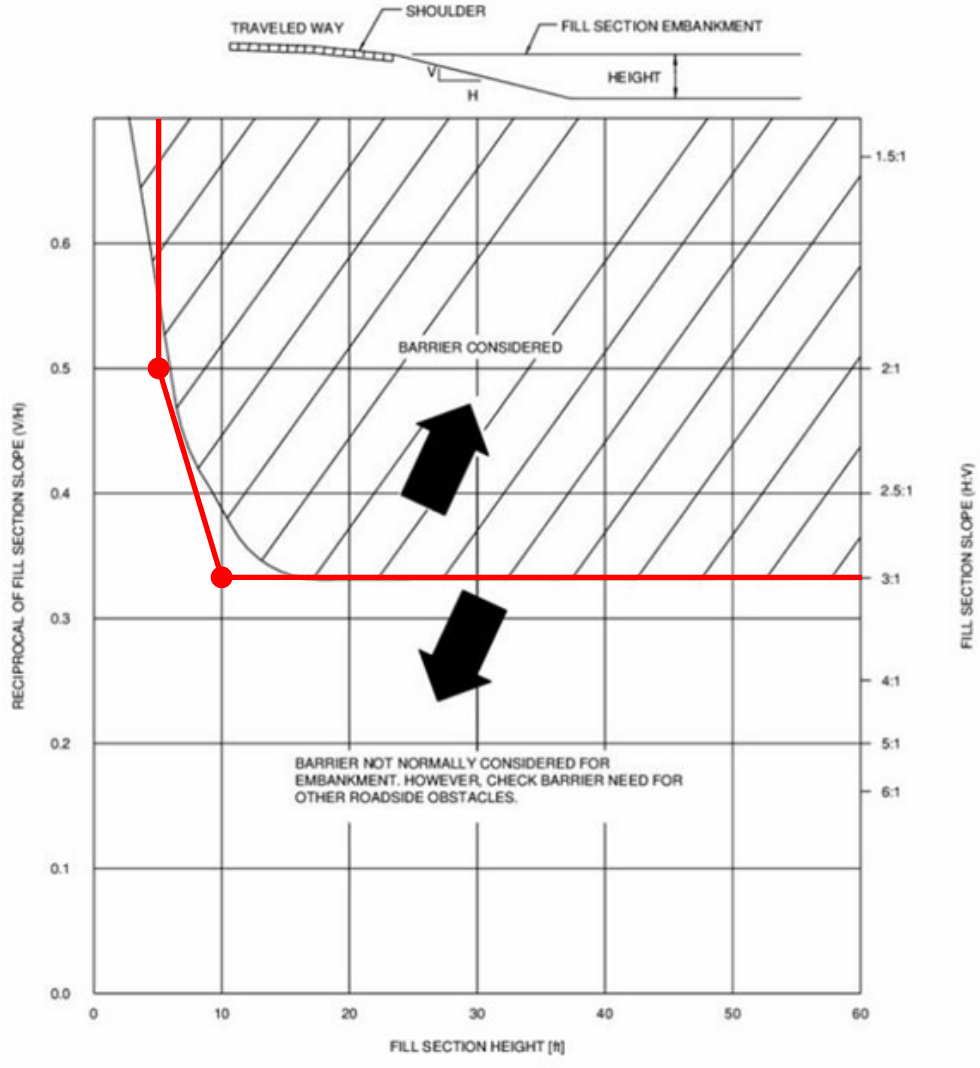
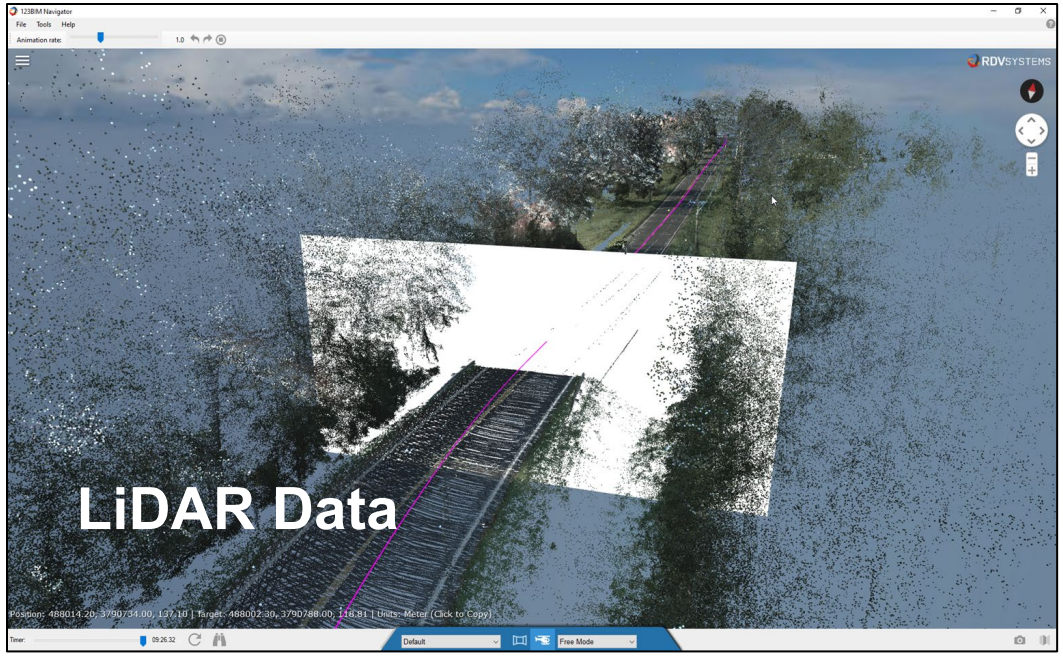


Figure 5-1b. Comparative Barrier Consideration for Embankments (U.S. Customary Units) (15)

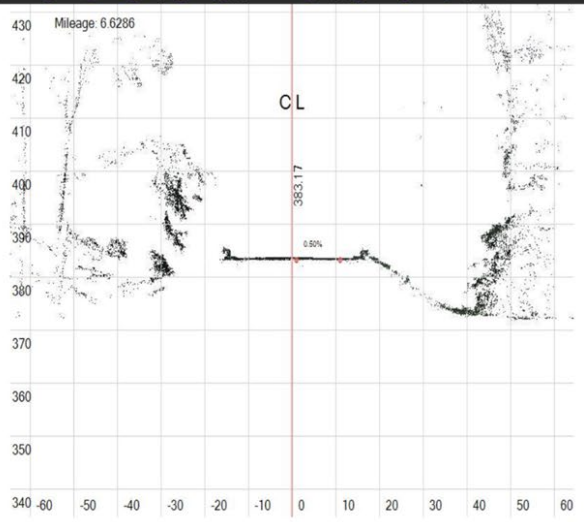
Embankment Study Pilot Project

- **Project Approach:**
  - KYTC provided RDV with mobile LiDAR data for 12 pilot routes
    - 122.7 total miles with diverse roadside/embankment conditions
  - RDV's RSA 3D Simulations and AI algorithms analyzed each route's roadside geometry in 10-foot increments in both travel directions
  - RDV provided results in the following deliverables:
    - GIS Shapefile
    - Comma delimited text files
    - Browser-based reports
    - PDF with a summary of findings


LiDAR Data

Cross Section

Settings	
Report type	Flat Spot Areas
Eye elevation	0
Step distance	10
Units	Feet
Frame dimensions	600 , 800
Eye Offset	0
Cross Slope Offset	1.11

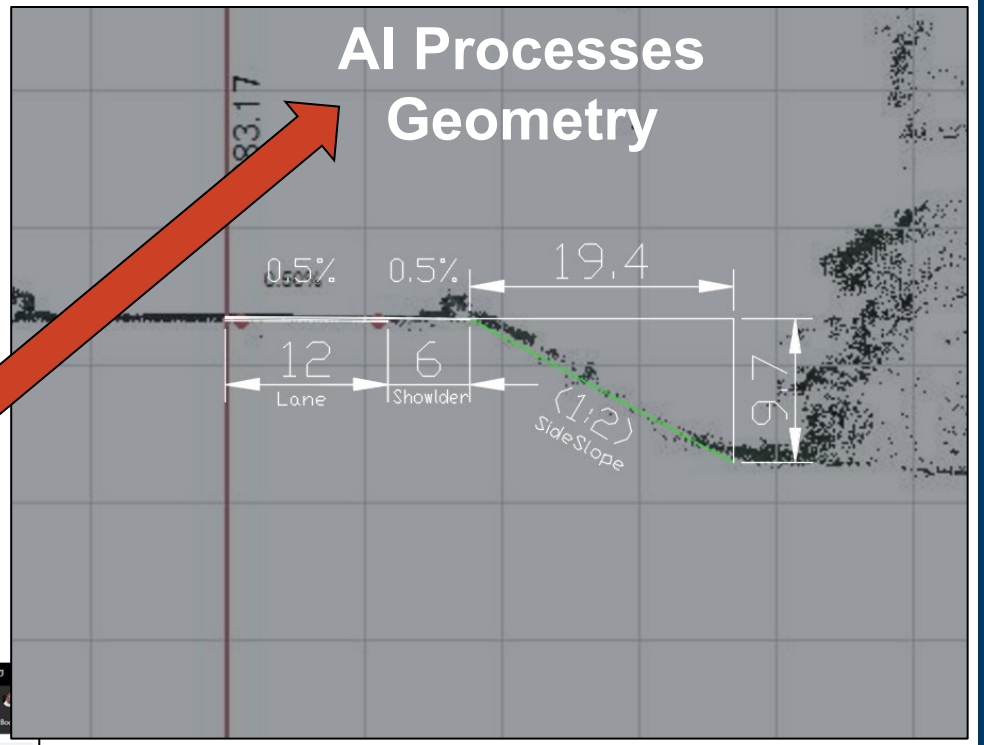


Path EX1-0007-1-LL-P	
Path Code	LL
Start Mileage	4.303
End Mileage	7.1362
Route Number	0007
Path Id	EX1-0007-1-LL-P
Direction	+ (Positive)
Year	2020

Reference Speed between mileages	
0 - 0.5345	35 MPH
0.5345 - 0.6652	45 MPH
0.6652 - 11.2526	55 MPH
11.2526 - 11.3978	45 MPH
12.0949 - 12.0949	40 MPH
12.0949 - 12.5104	45 MPH
12.5104 - 15	55 MPH

[Latitude, Longitude] (Google Maps)	Mileage	Position	Long Slope	Cross Slope	Long Slope[2]
[34.2580 -93.1303]	6.6154	X:487700.75 Y:3790525.00 Z:235.41	-3.50%	-7.09%	-3.63%
[34.2580 -93.1303]	6.6173	X:487700.81 Y:3790531.00 Z:235.18	-4.96%	-7.17%	-2.58%
[34.2580 -93.1303]	6.6192	X:487700.94 Y:3790537.00 Z:234.42	-4.36%	-4.74%	-0.37%


LiDAR Data


AI Processes
Geometry
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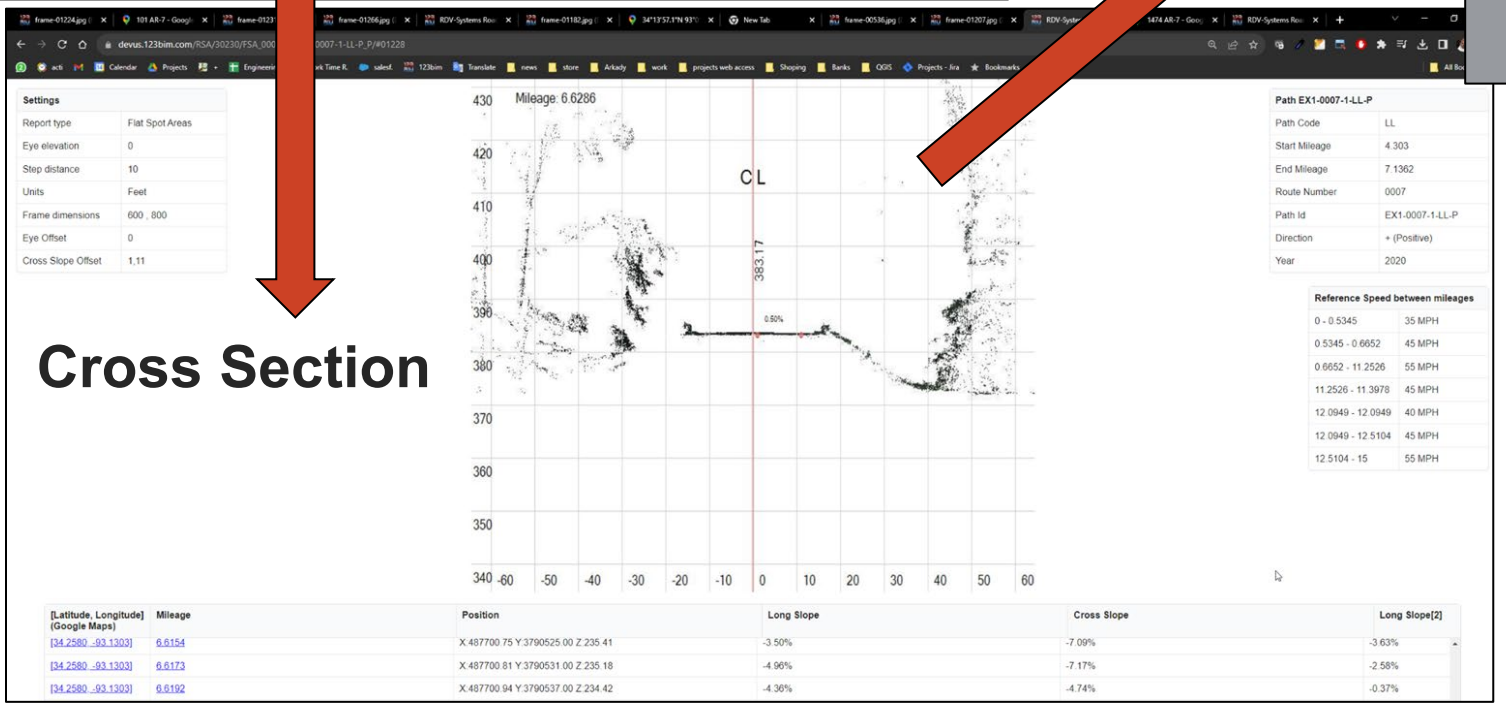
Lane
6
Shoulder
(1:2)
SideSlope
9.7


Cross Section
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Report type
Flat Spot Areas
Eye elevation
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Step distance
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Units
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Frame dimensions
600 , 800
Eye Offset
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Cross Slope Offset
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Mileage: 6.6286
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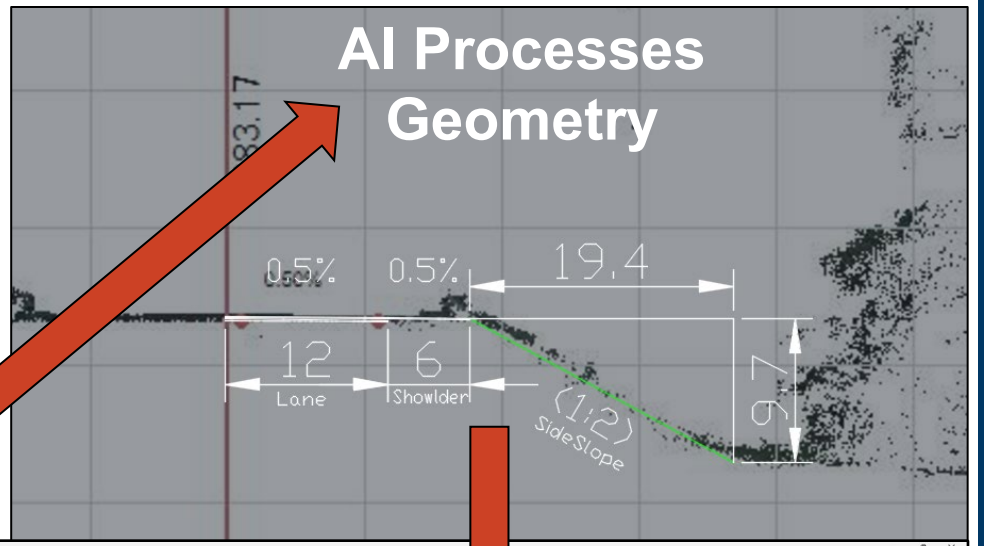
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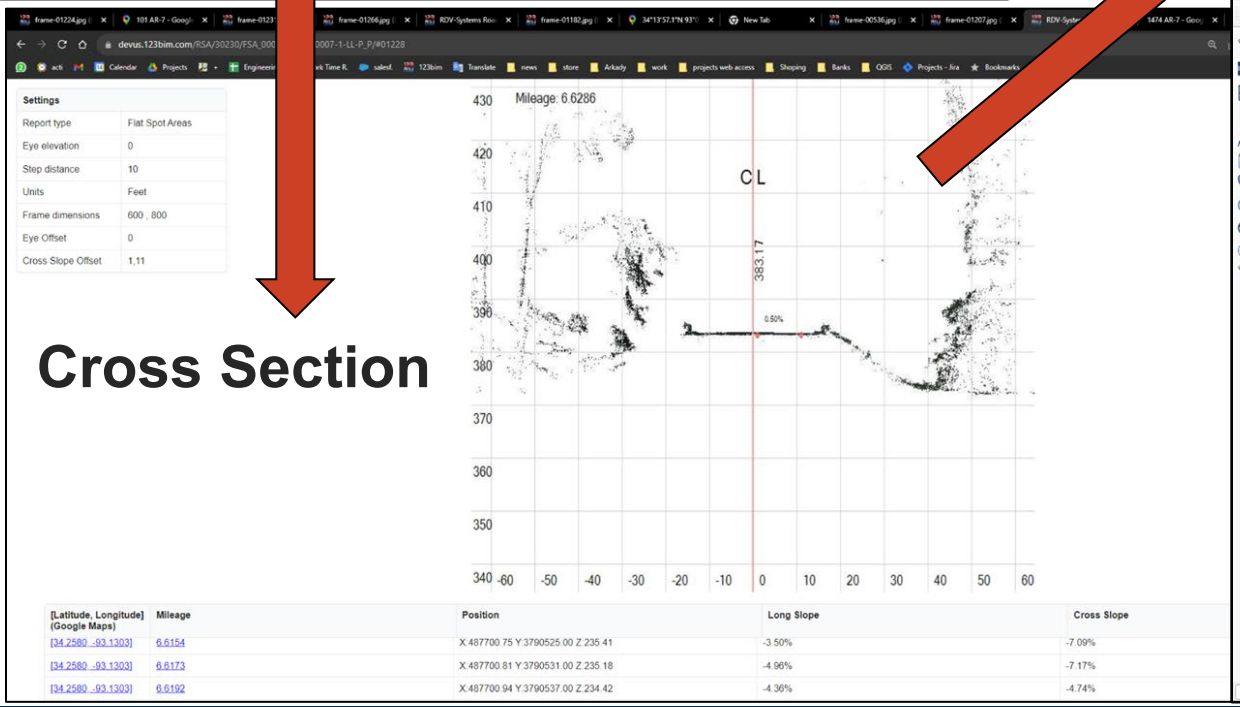
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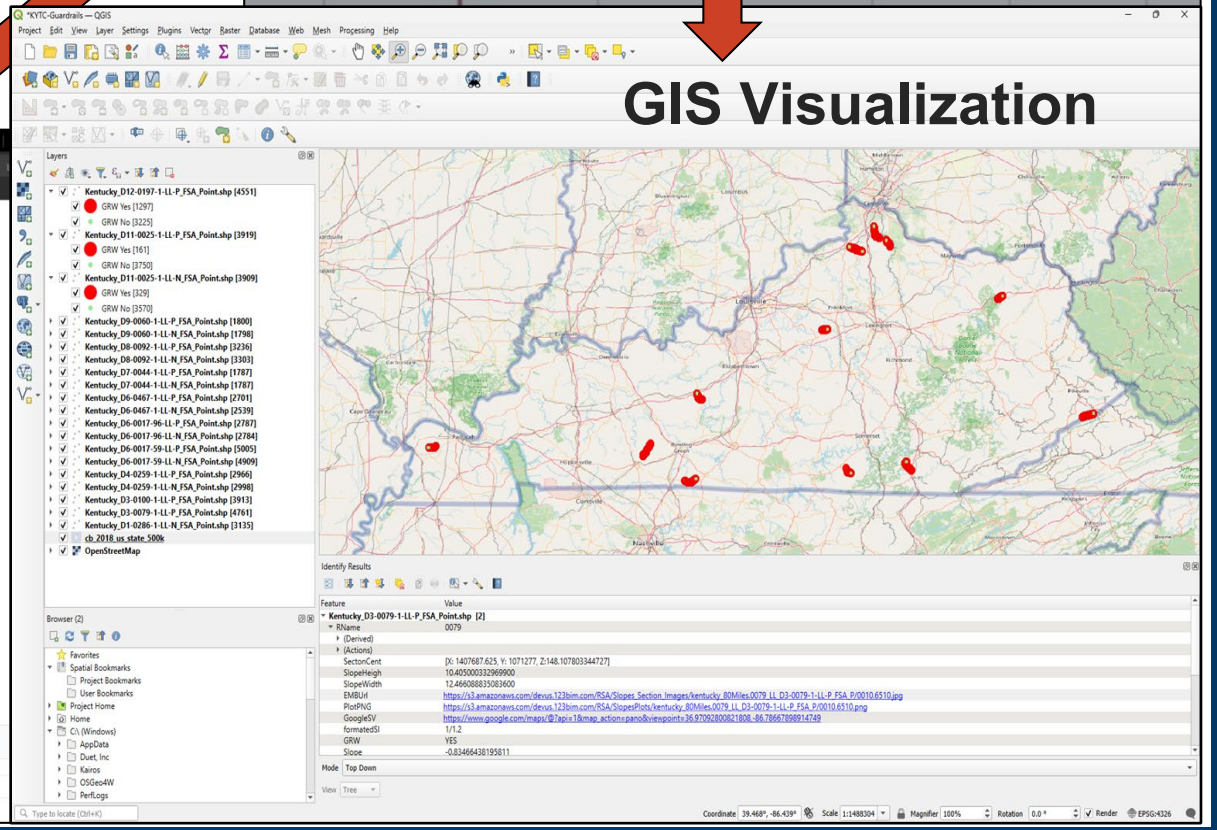

GIS Visualization

Embankment Study Pilot Project

- **Project Timeline:**
  - May 2024
    - Agreement executed and project kickoff
  - August 2024
    - Beta release of AI algorithm and initial analysis results
    - RDV adjusts AI algorithm based on KYTC feedback
  - September 2024
    - Final analysis results delivered and knowledge transfer
  - November-December 2024
    - Project recap / overview meetings with broader KYTC team

Embankment Study Pilot Project

- **Summary:**
  - Duration: 6 months
    - AI algorithm development
  - Identification of segments warranting guardrail
    - Analyzed 122.7 miles of roadway
    - 389 individual segments detected
    - 8.98 miles of warranted guardrail identified
  - Automation benefits
    - Efficient, large-scale evaluation, with consistent, objective analysis
  - Safe impact
    - Identification of warranted guardrail locations quickly allowing for better prioritization of available funds

Route	Miles	Warranted Guardrail Segments	Warranted Guardrail Miles
KY 197	8.6	73	2.132
US 25W	14.8	32	0.729
US 60	6.8	23	0.547
KY 92	12.5	18	0.300
KY 44	6.7	18	1.269
KY 467	9.9	47	0.575
KY 1796	10.6	29	0.893
KY 1759	18.8	60	0.916
KY 259	11.4	37	0.835
KY 100	7.4	22	0.367
KY 79	9.0	19	0.276
KY 286	5.9	11	0.149
Totals	**122.7**	**389**	**8.984**

Embankment Study Pilot Project

- **Project Deliverables:**
  - Findings Summary Report (comprehensive written report outlining analysis results)

RSA-3D Findings Summary Report

KYTC 0017 from 5.9 to 0.6 mile Road Safety

Date: 2024-10-07

Job Number:2023164 **Corridor: 0017**

Project Introduction:

RSA-3D Simulation Overview

RDV's RSA-3D solution provides real-world simulations through the 3D environment to test for potential roadway safety deficiencies related to sight distance and to evaluate for roadway geometrics.

The area of interest for the simulations:

The image below illustrates the corridor, color coded according to embankment requirements:

Summary of RSA-3D Findings

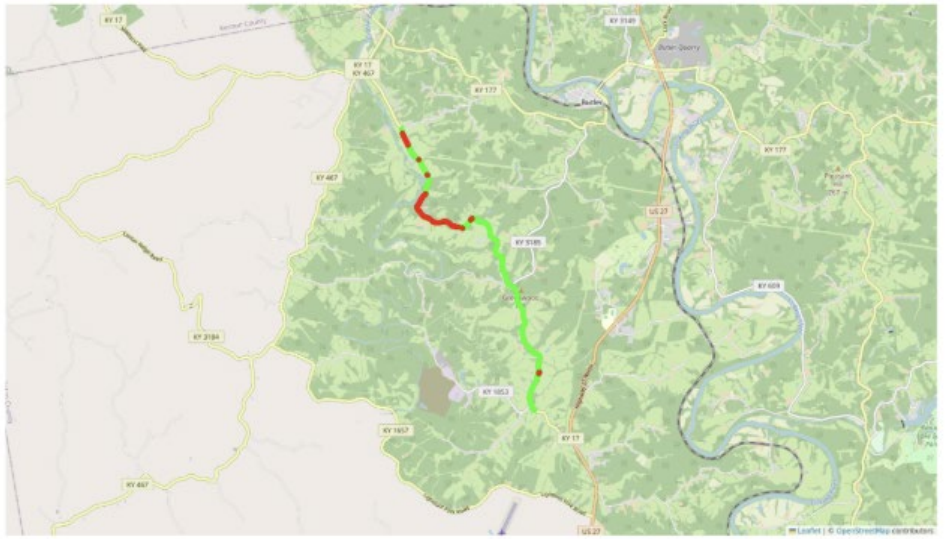
RSA-3D Existing Analysis

RDV performed several 3D simulations for the existing roadway conditions to determi
there were any safety concerns. The following section provides an overview of the fin
from each simulation.

Below are the segments identified by the RSA-3D simulations with potential Embankn
Slope/Height issues. The table identifies the location for the segment along the corrid

Length (feet)	Directio	From Mile	To Mile	First Slope	Report
90 FEET	N	5.9088	5.8918	1/1.8	Link
40 FEET	N	5.8558	5.8482	1/1.7	Link
430 FEET	N	5.8179	5.7365	1/2.4	Link
30 FEET	N	4.9732	4.9676	1/1.7	Link
350 FEET	N	4.9373	4.8710	1/2.1	Link
30 FEET	N	4.8691	4.8634	1/1.4	Link
280 FEET	N	4.8615	4.8085	1/1.4	Link
190 FEET	N	4.8009	4.7649	1/1.5	Link
30 FEET	N	4.7384	4.7327	1/2.3	Link
150 FEET	N	4.7251	4.6967	1/2.3	Link
870 FEET	N	4.6948	4.5301	1/2.0	

Below is an image showing the corridor colored by guardrail warrant requirements



NO
YES

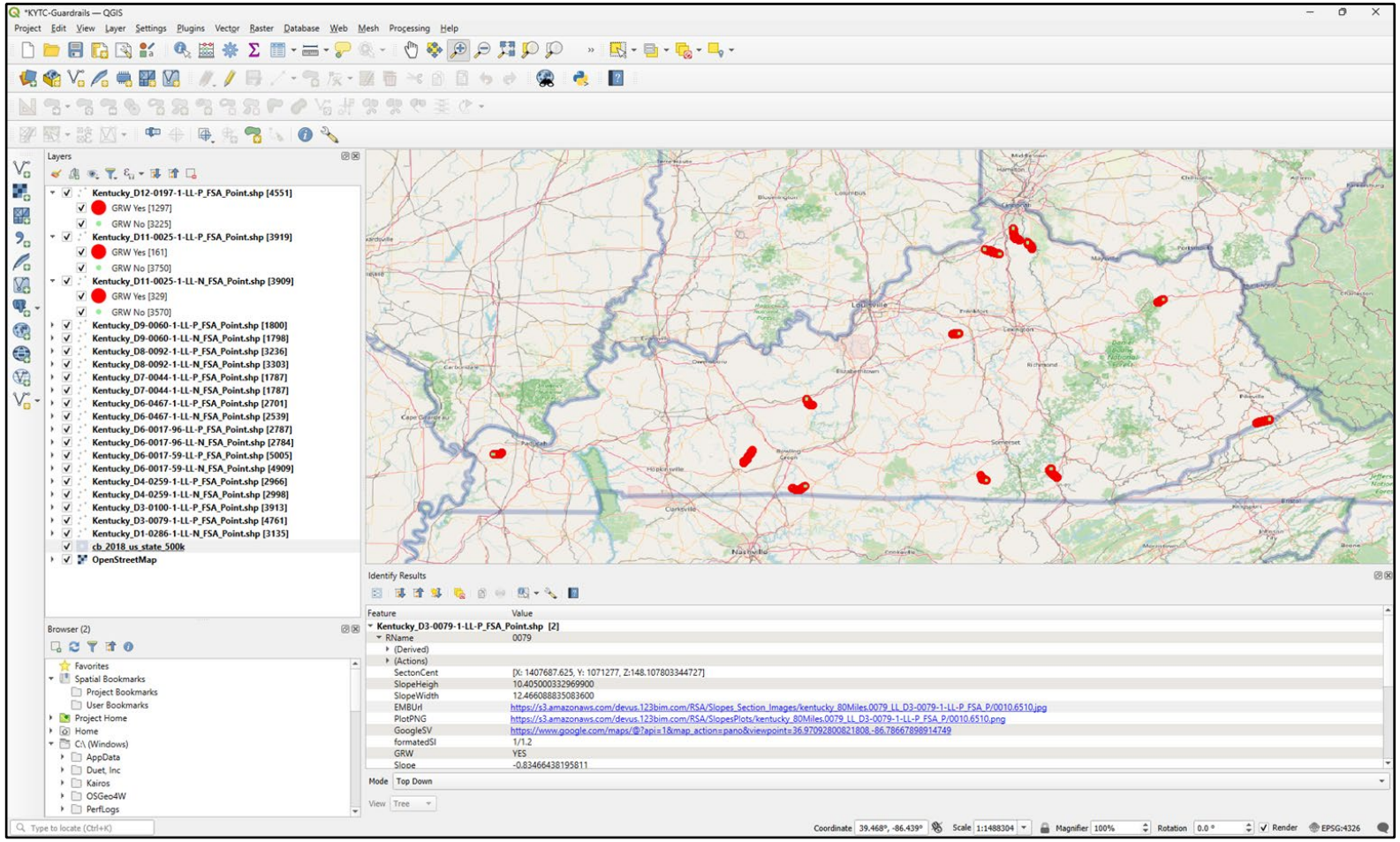
*Note:

No (green point) - no guardrail warrant

Yes (red point) - guardrail warrant

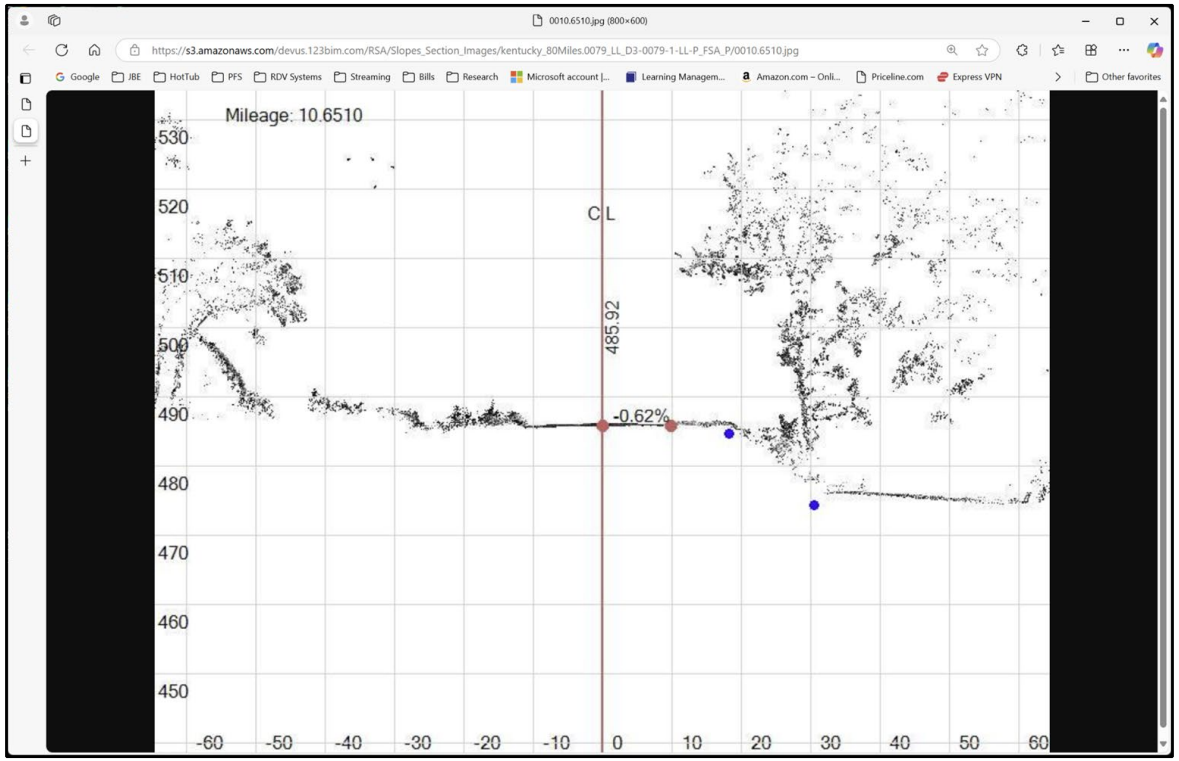
Embankment Study Pilot Project

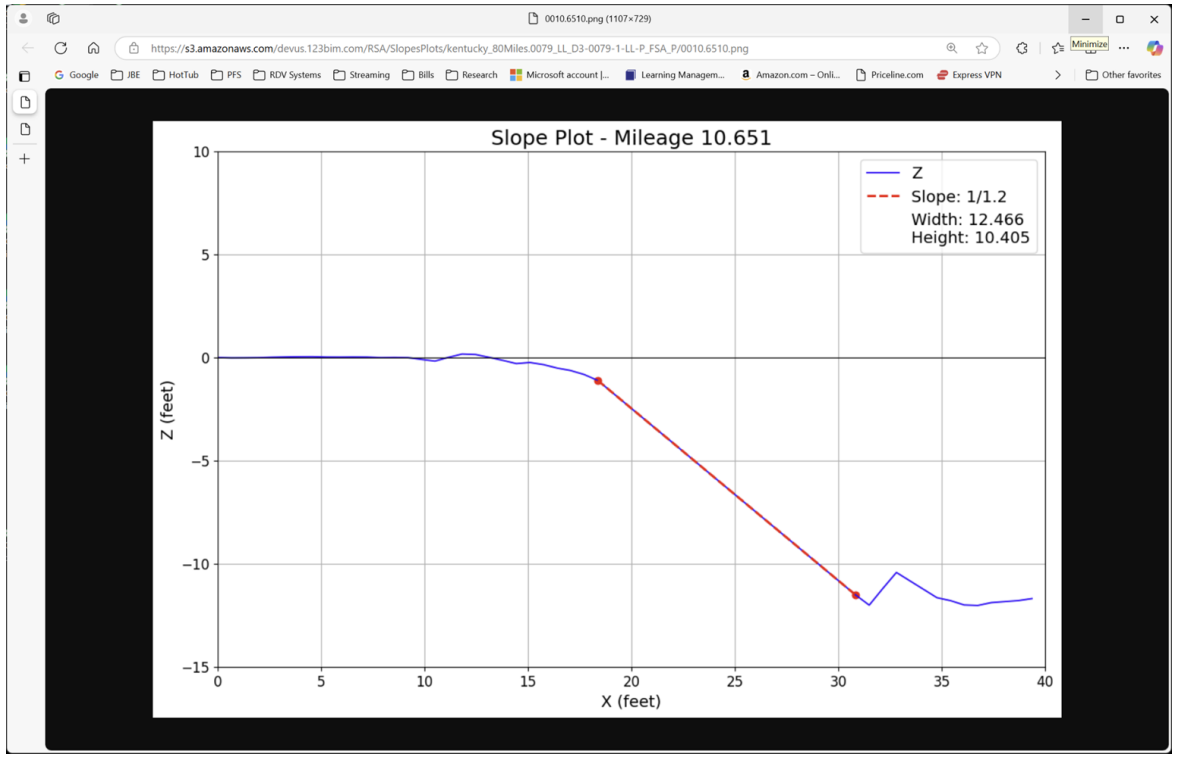
- **Project Deliverables:**
  - GIS data provided as a Shapefile (.shp)



Embankment Study Pilot Project

- **Project Deliverables:**
  - Browser-based cross-sectional view of each evaluated location (including embankment measurement details)





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Questions?

Kentucky Transportation Cabinet

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