18th Annual Technical Forum
Geohazards Impacting Transportation in Appalachia

Working Against Gravity: Mitigating Rock Slopes and Landslides in Westernport, MD

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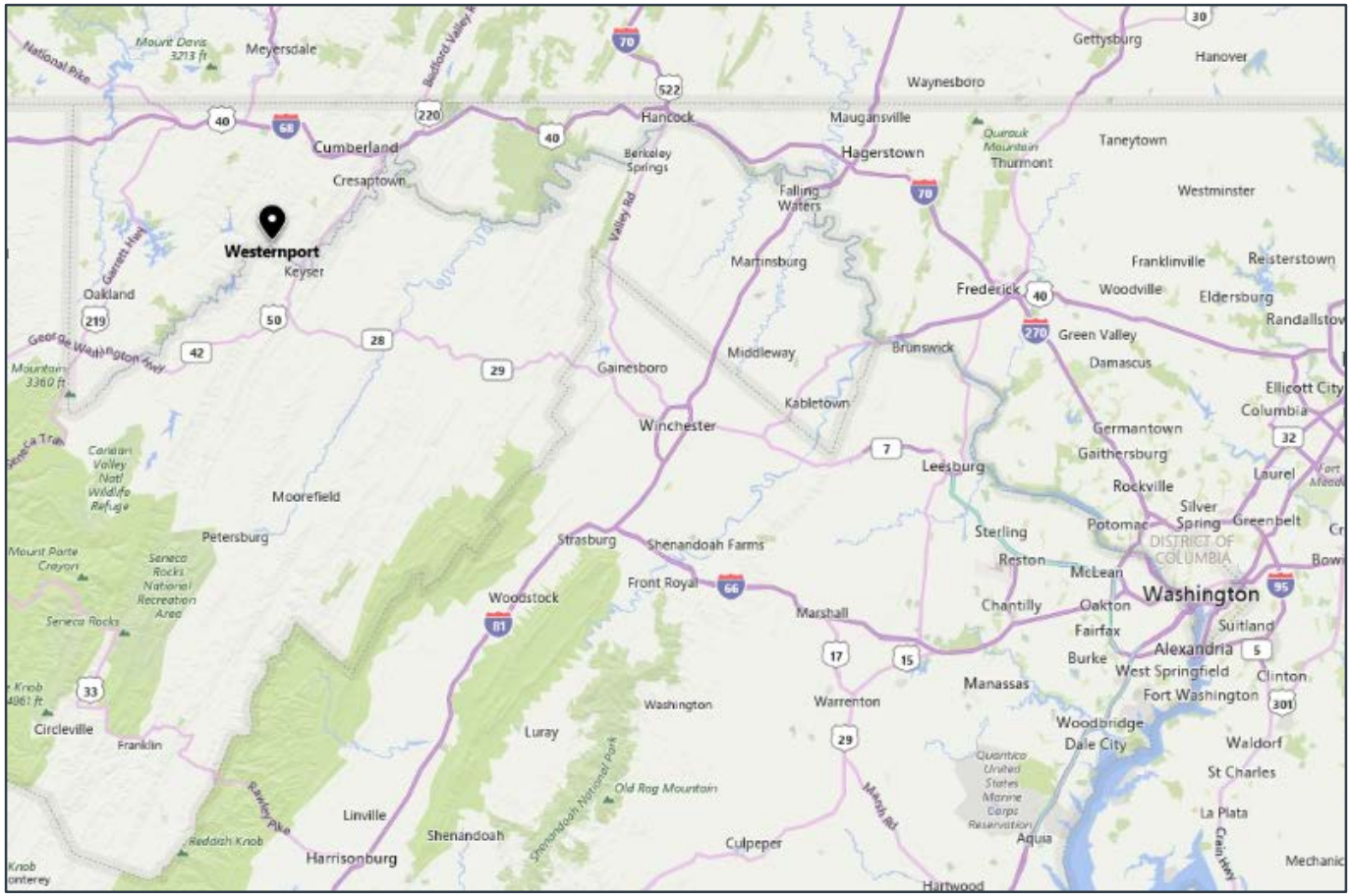
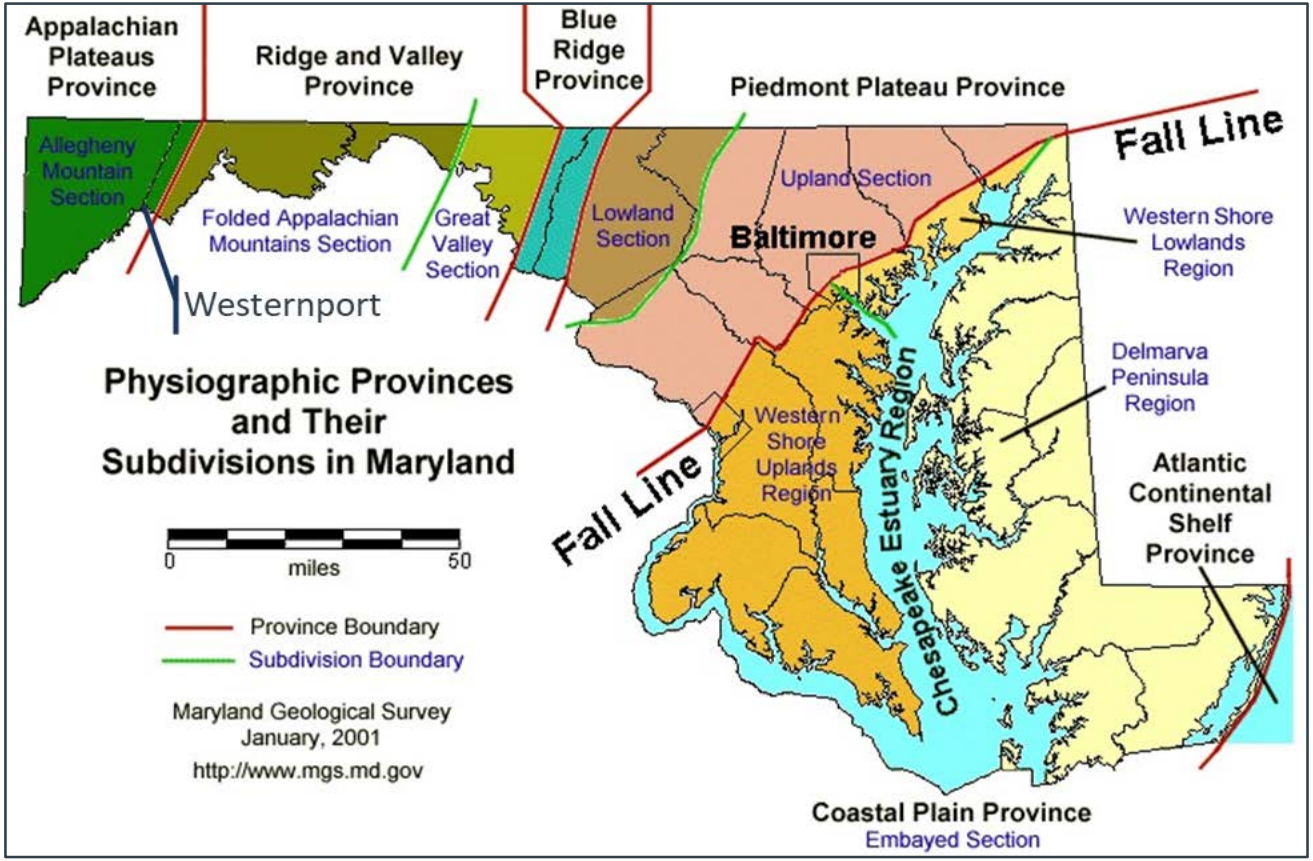
Presentation Overview

- Introduction to Geologic Setting
- Introduction to Geohazards Impacting Route 135
- Recommended Mitigative Treatments
- Design Overview
- Conclusion

Project Location

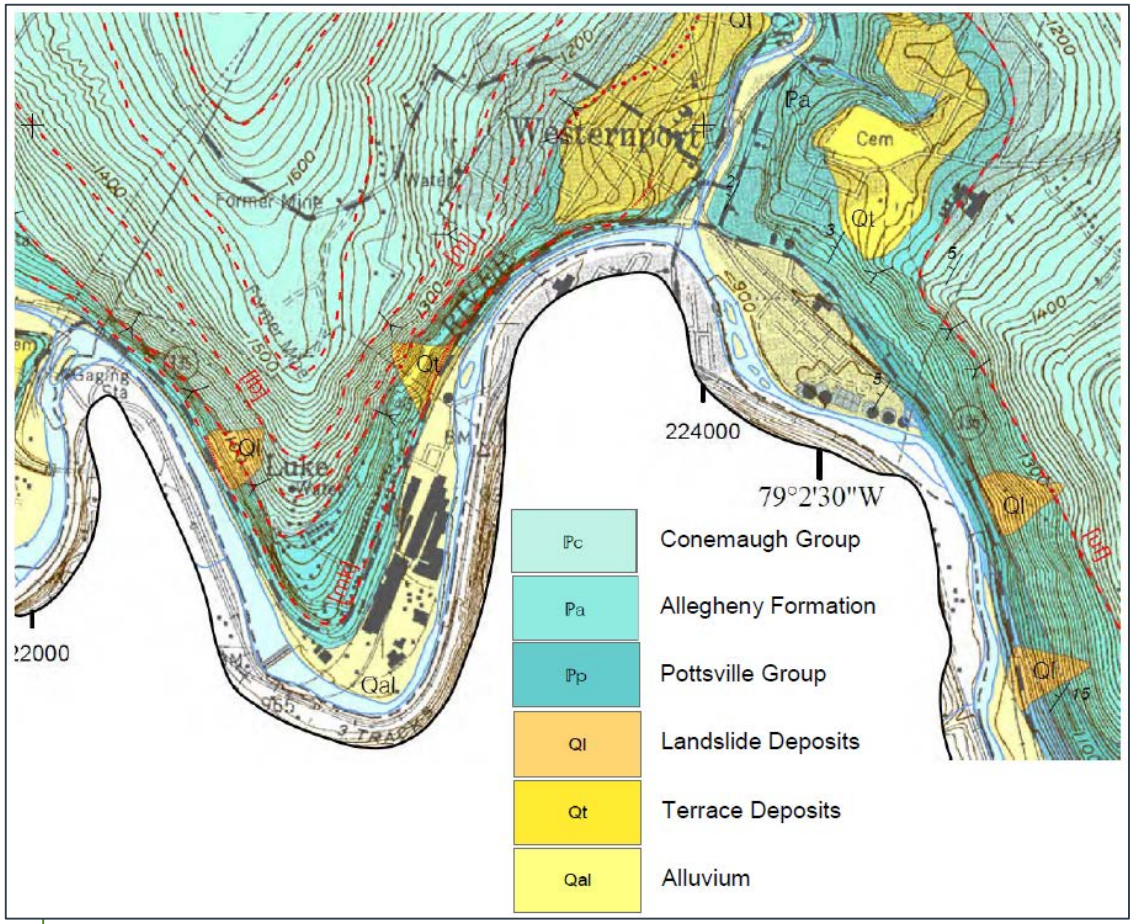


Physiographic Map of MD



- Allegheny Mountain Section
  - Characterized By Wide ridges separated by broad valleys; plunge direction on broad folds produces topographic basins

Geologic Map of MD



- Conemaugh Group, Allegheny Formation, & Pottsville Group
  - Pennsylvanian Age
  - Cyclothemic Sequences of Interbedded Sandstone, Shale, Claystone, and Coal
  - Near the Hingeline of the SW-NE George's Creek Syncline
  - Coal Mining Adits into the Kittanning, Mahoning, & Bakerstown Coal Sequences

Site Development History

- Roadway Construction
  - Constructed in Stages in Early 1900's
  - Roadway Improved From 1929 Through 1940
  - Additional Rock Slope Cut in 1950's
- Historic Slope Instability
  - Large Slide in 1939 resulting in 60,000 CY of Debris
  - Large Slide in 1996
  - Activation of Historic Slide (450' Long; Extends 160' Upslope)
  - Multiple Rockfalls and Landslides Each Generating Hundreds of Yards of Debris Occurred Over Past 15 Years
  - Large Rockfall Event in January of 2016 Prompted Emergency Stabilization at Western End of Project Limits

Previous Investigation Activities

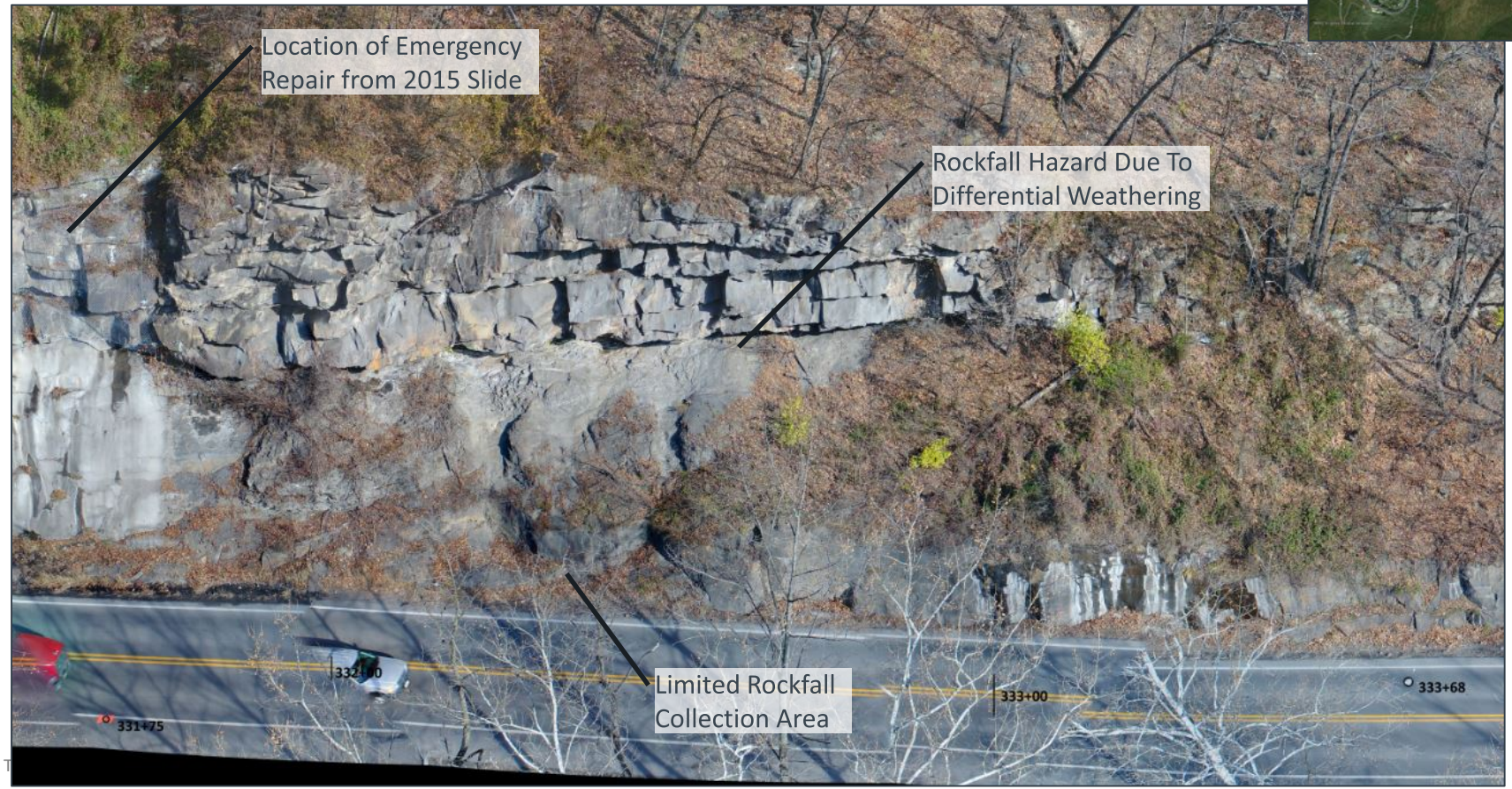
- 2017 Geologic Assessment Report
  - Completed By EA Engineering/Schnabel Engineering Joint Venture
  - Provided Geologic Overview and History of Site and Slope Instability
  - Developed a Topographic Site Plan Using LiDAR
  - Conducted Field Mapping to Identify Current and Past Hazards
  - Conducted a Geophysical Investigation of Select Sections
  - Slope Stability Assessment
- Resulted in the Identification of 20 Discrete Slope Sections for Risk Assessment
- Identified Two Sections as High Risk and 5 Sections as Medium-High Risk
- Developed Mitigation Concepts for Each of the 7 Sections

Current Design Activities

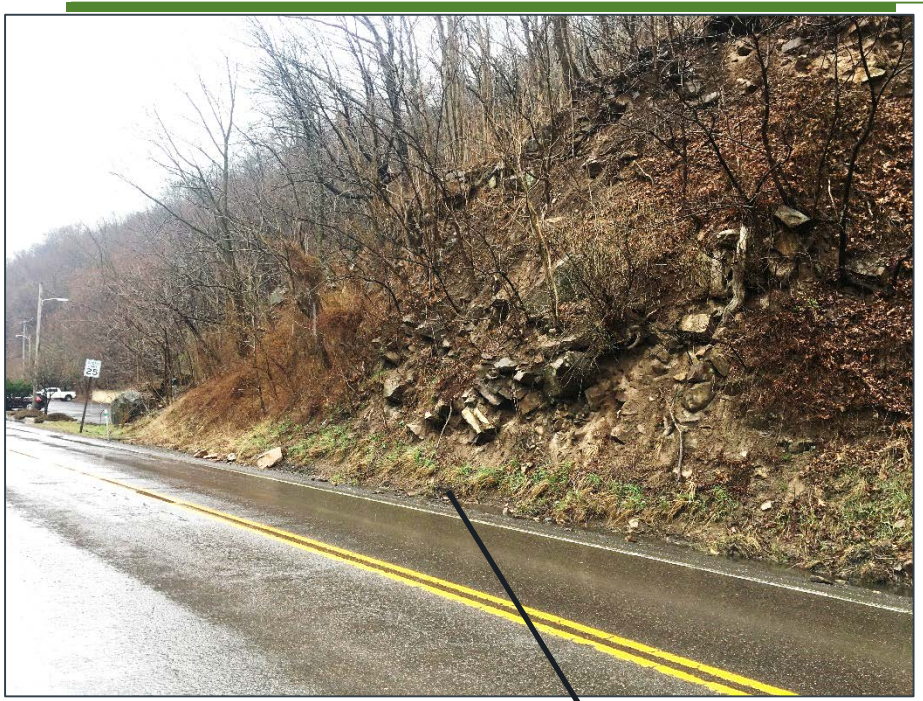
- Review of 2017 Geologic Assessment Report
- Conduct Field Reconnaissance
- Verify Conditions of Assessment Report
- Select Final Mitigation Scheme for 6 Slope Sections; One Section Was Not Included in Current Scope
- Drone Survey of Slope Sections
  - Produced Digital Surface Model; Orthoimages, 3D Photorealistic Model; Oblique Photos For Use in Design and Plan Presentation
- Prepare Final Design and Plans, Specifications, and Estimates for Each Section

Slope Section Map

Slope Section 2



Slope Section 7

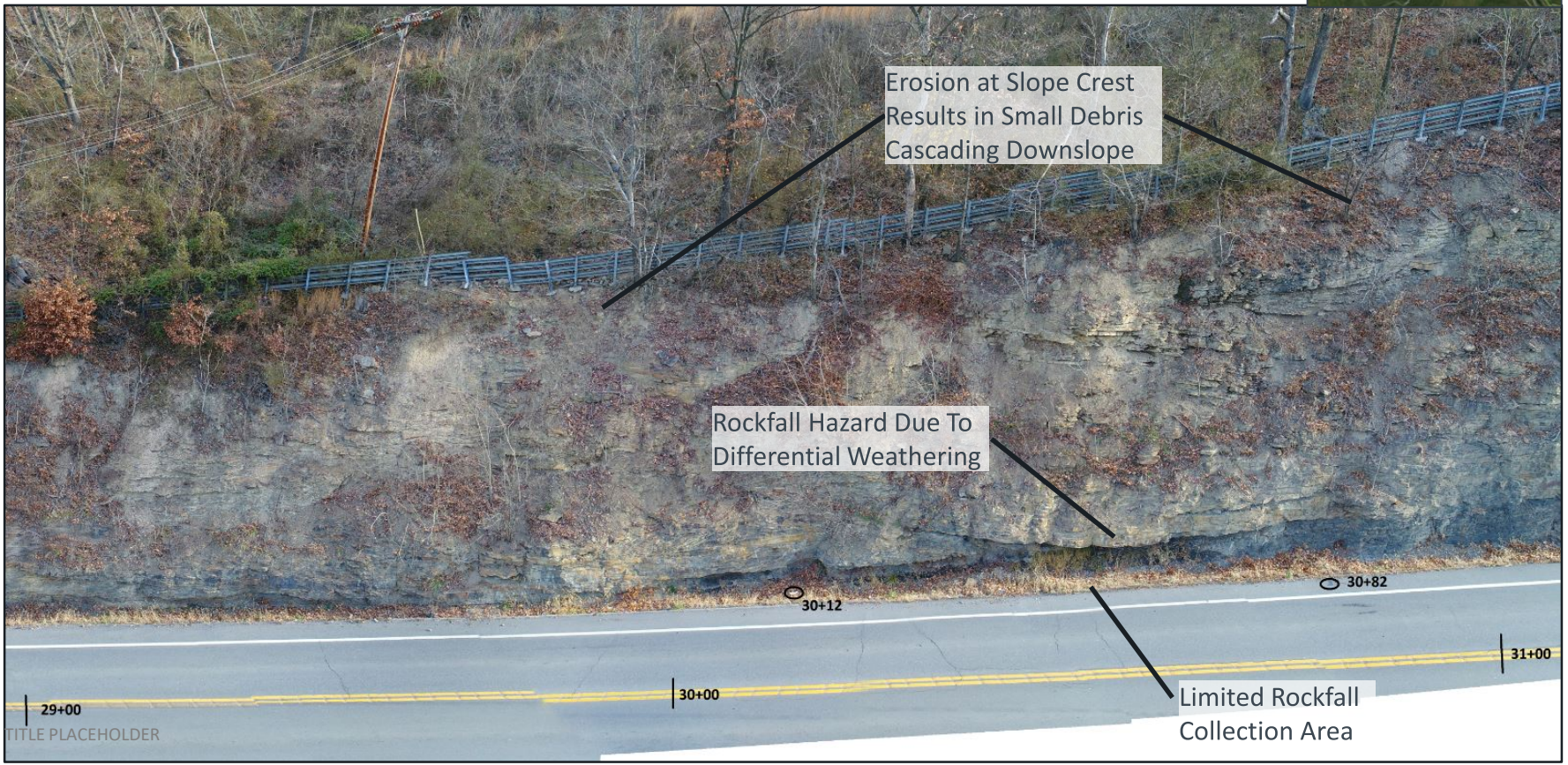


Limited Rockfall Collection Area

Rockfall Hazards Due To Erosion of Fines Allowing Boulders to Roll Out of Slope

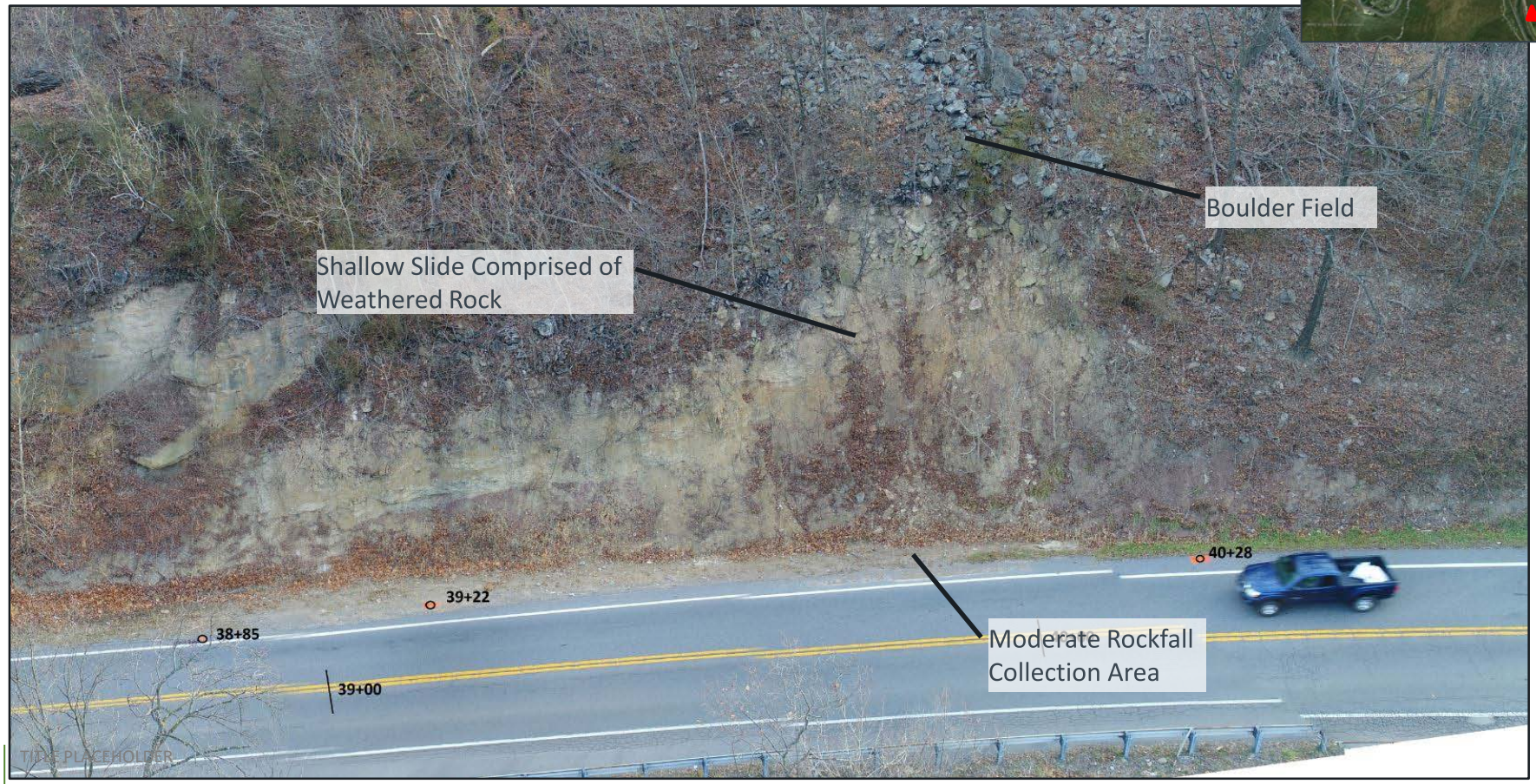
Slope Section 9

Slope Section 14

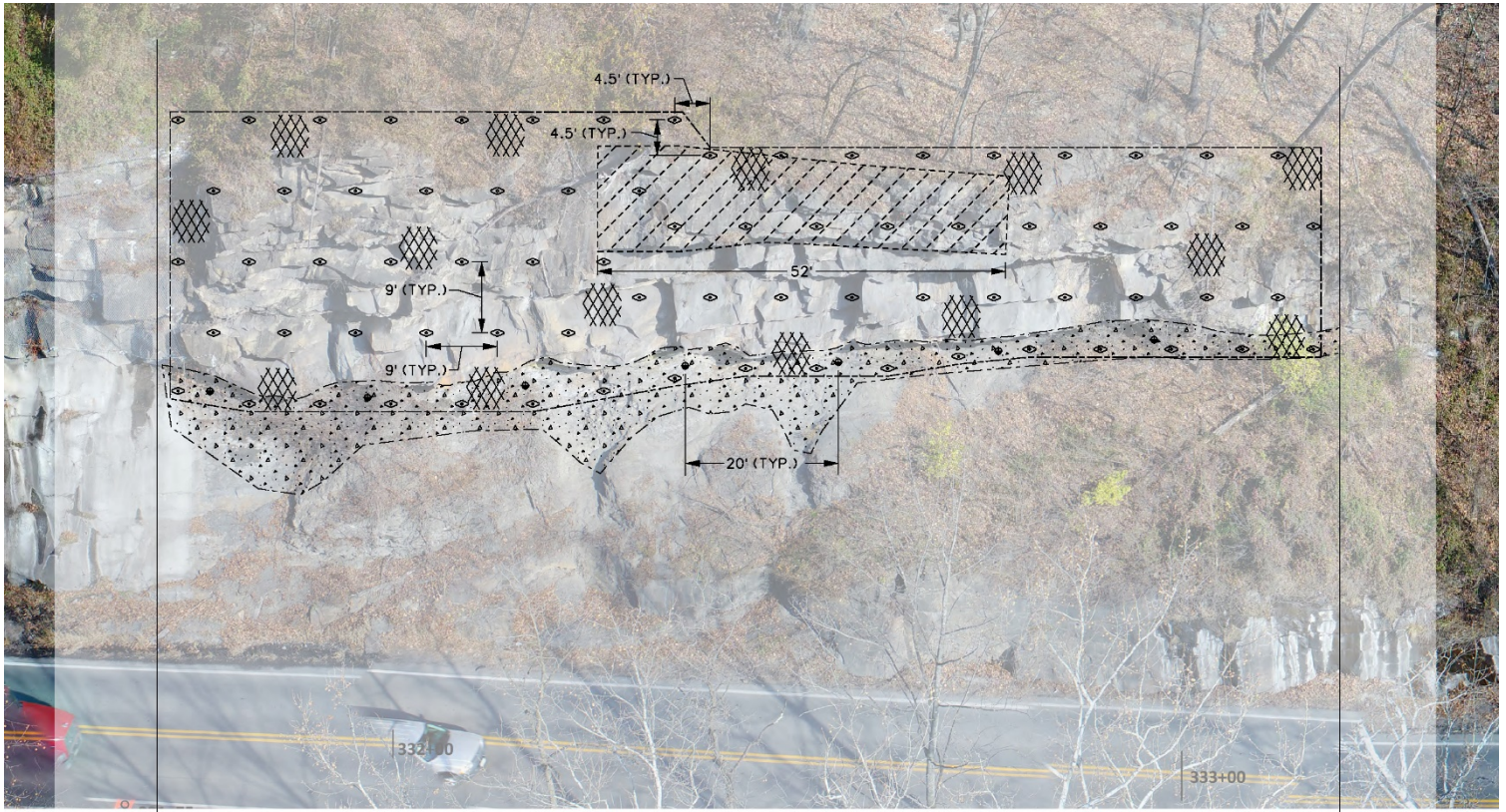


Slope Section 16

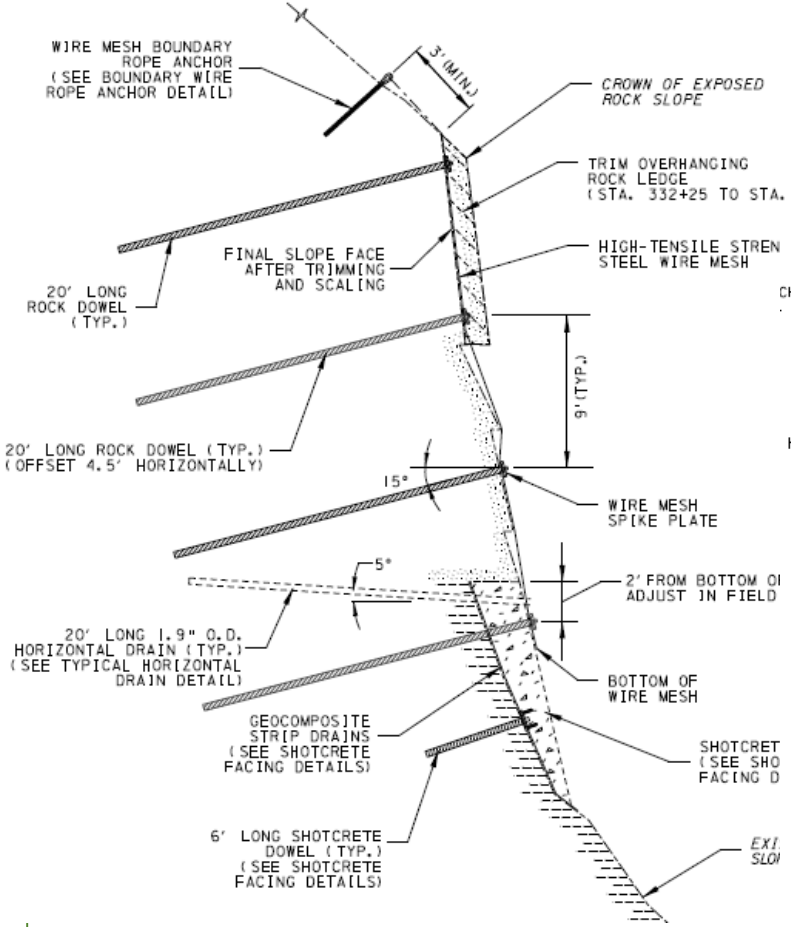
Slope Section 18

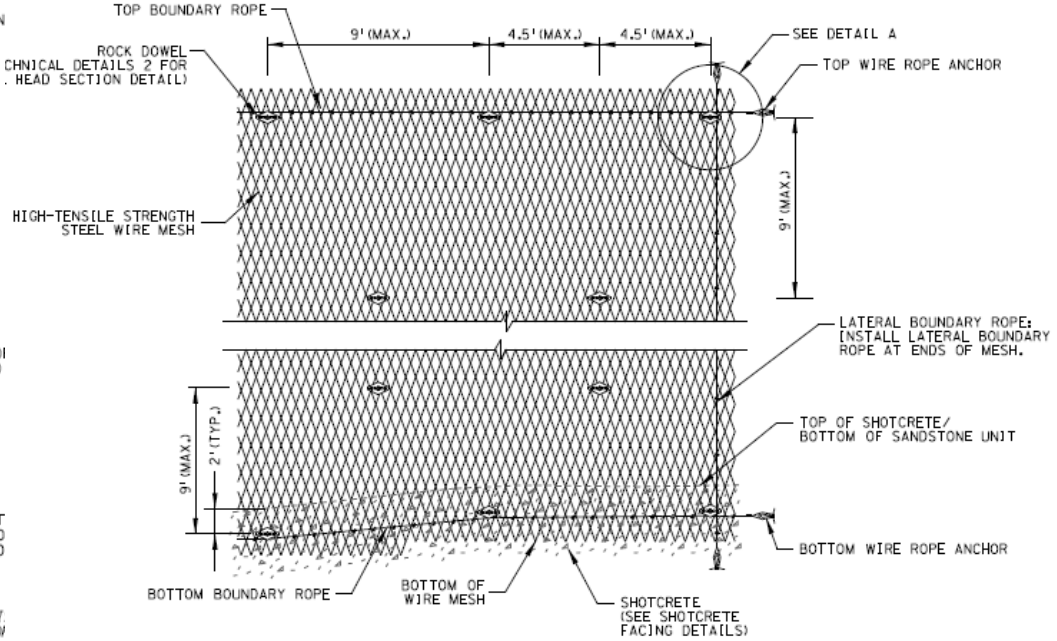


Section 2 Photomosaic Design Layout

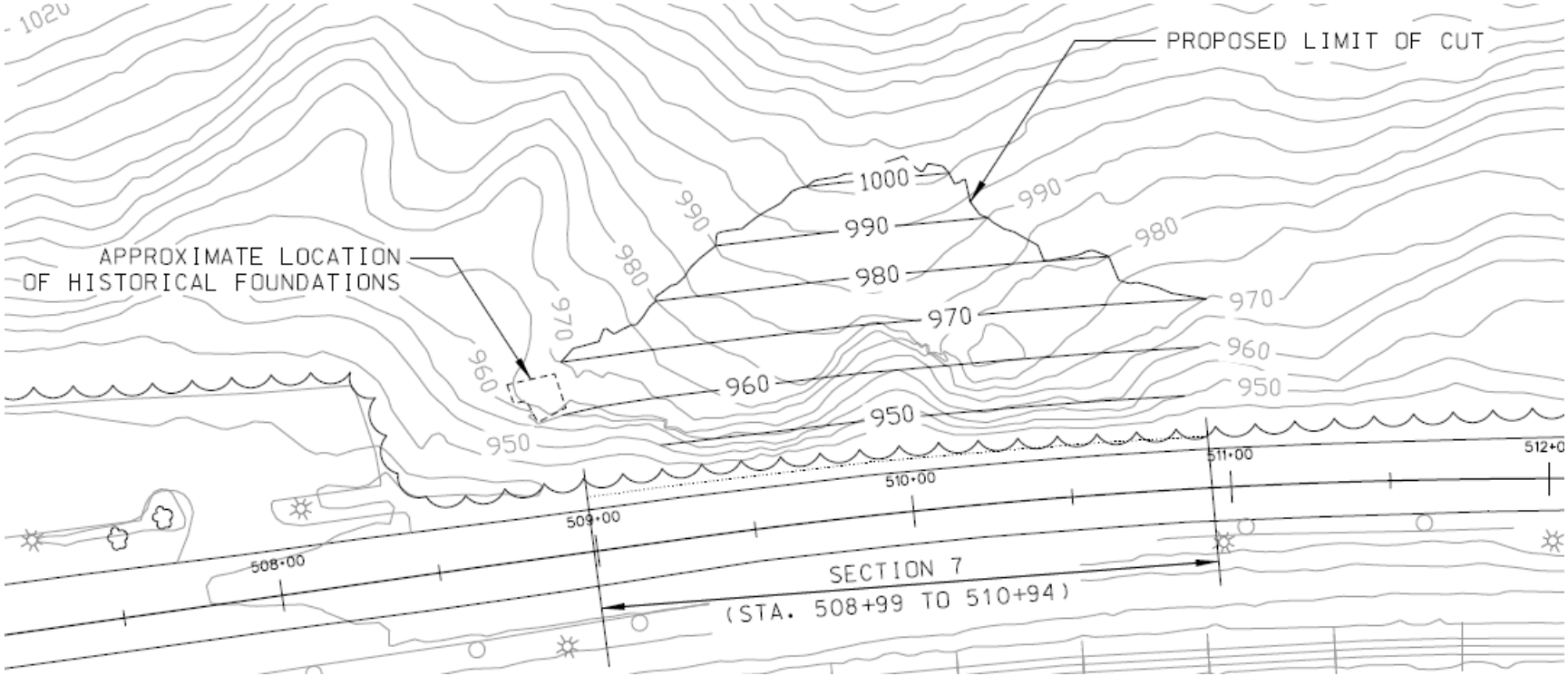


Section 2 Design Details

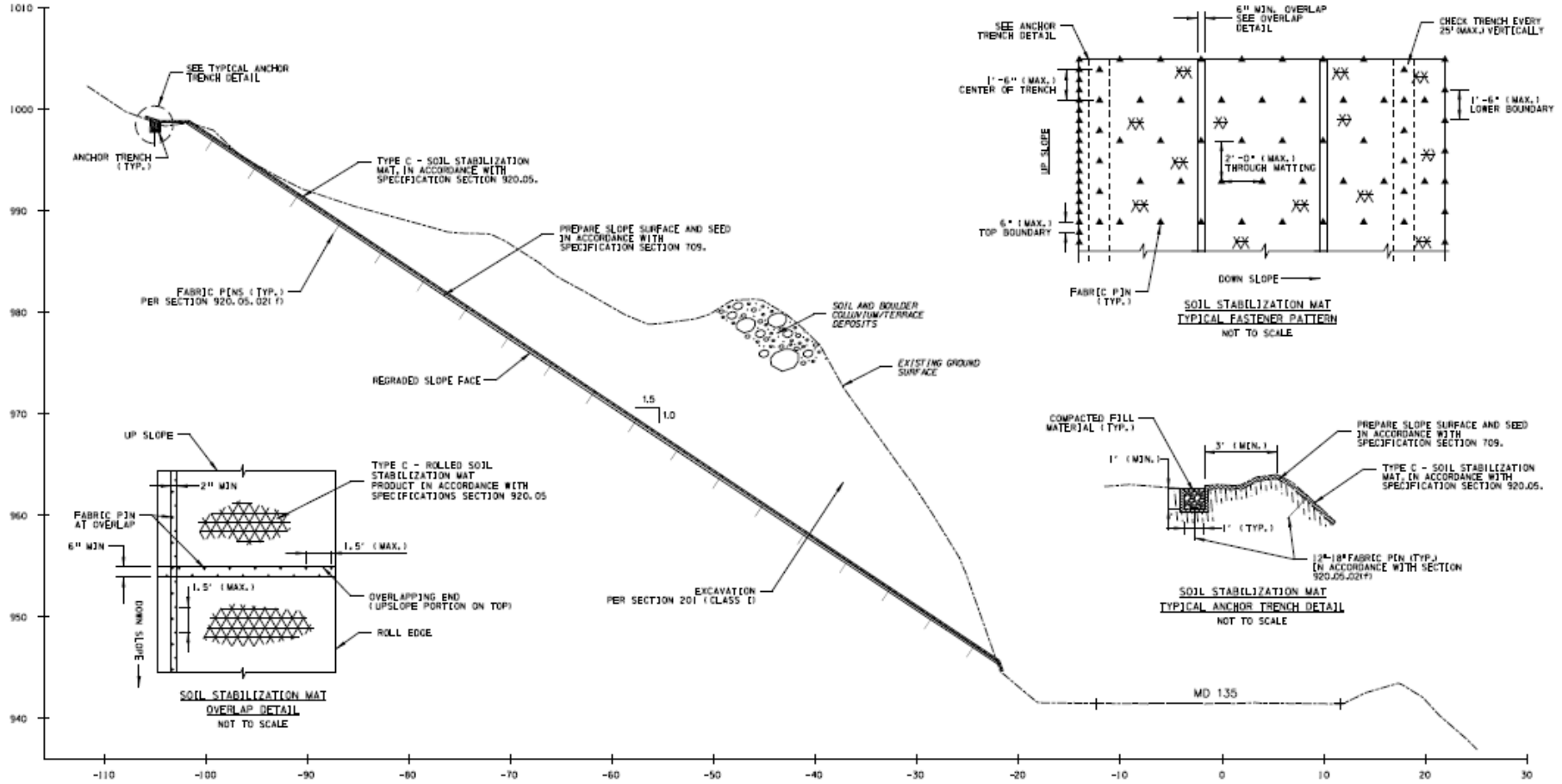




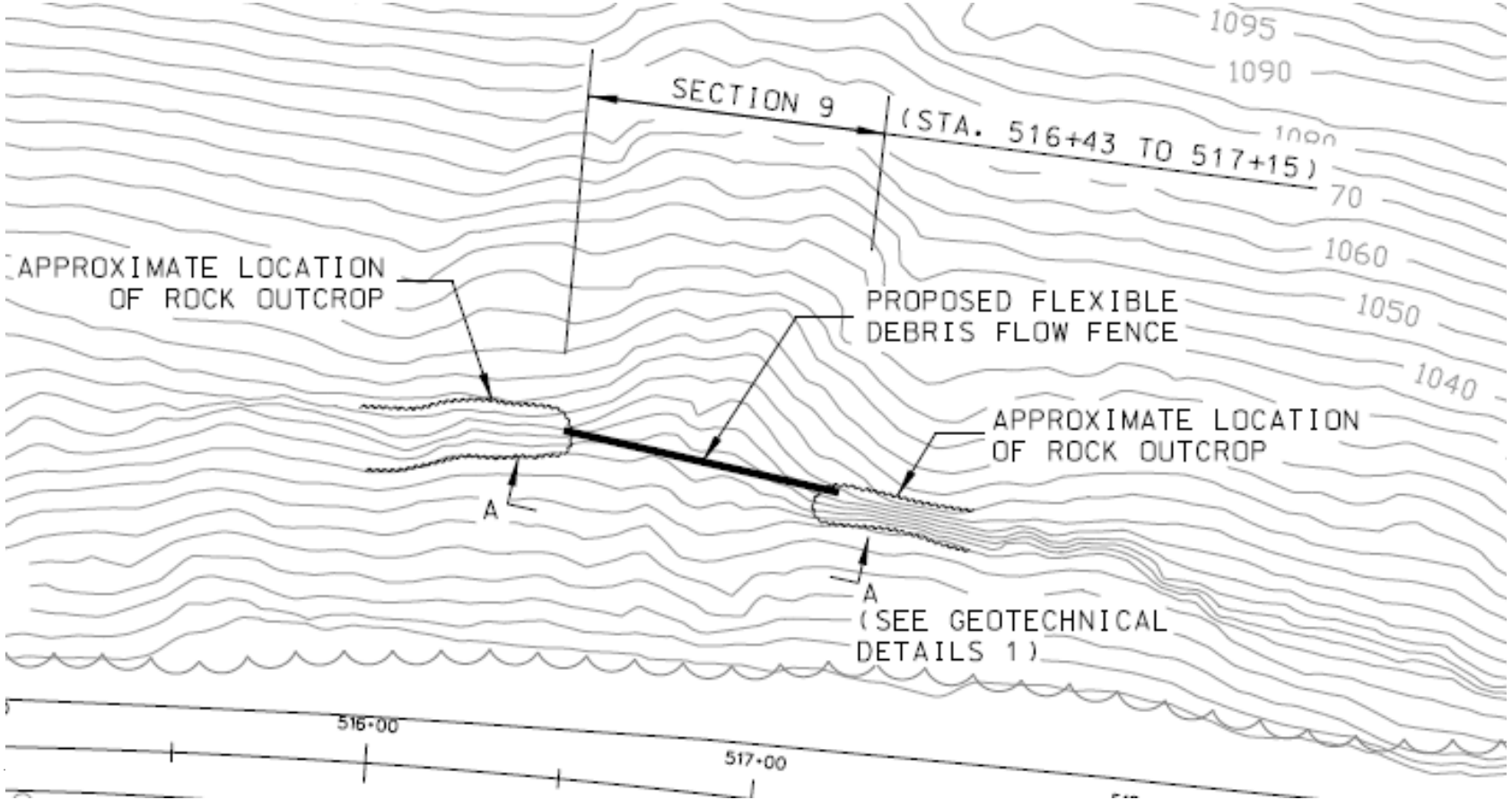
Section 7 Plan View



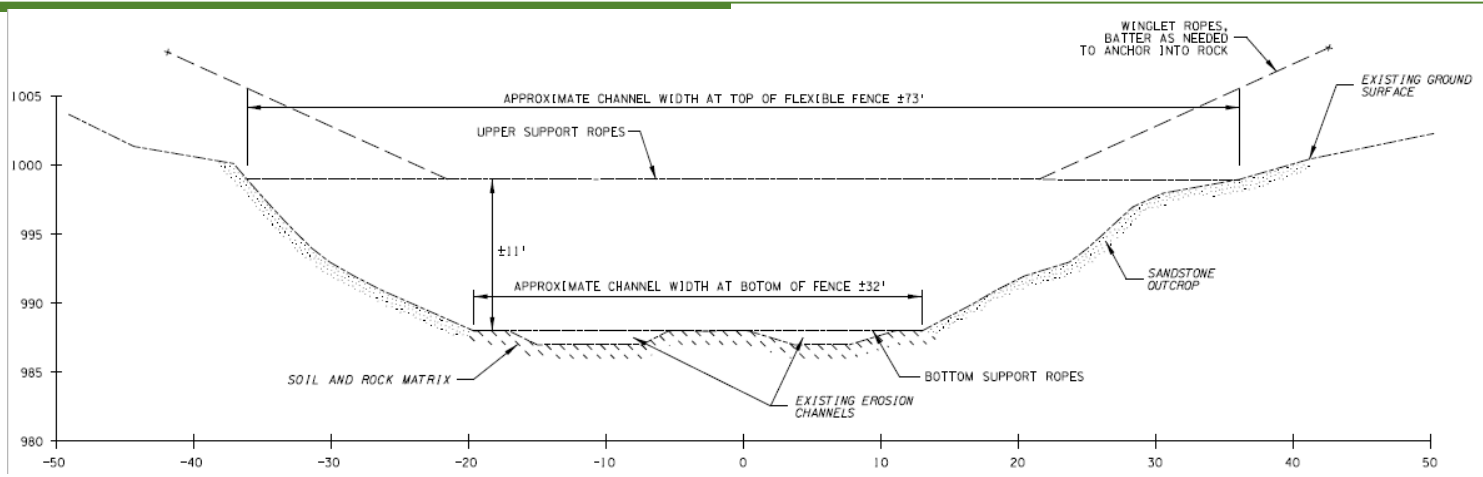
Section 7 Typical Cut Section

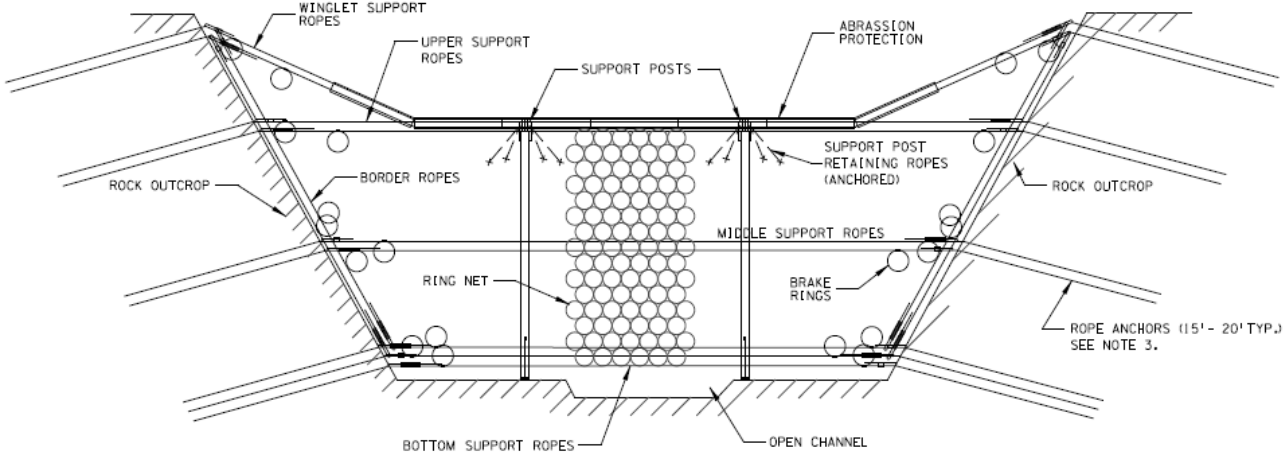


Section 9 Plan View



Section 9 Design Details

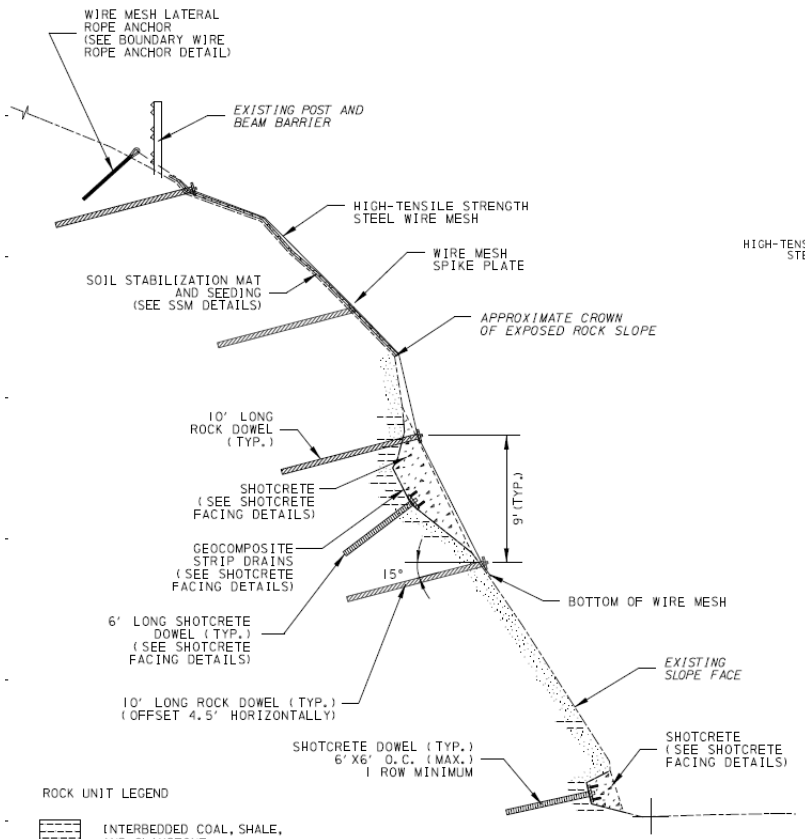


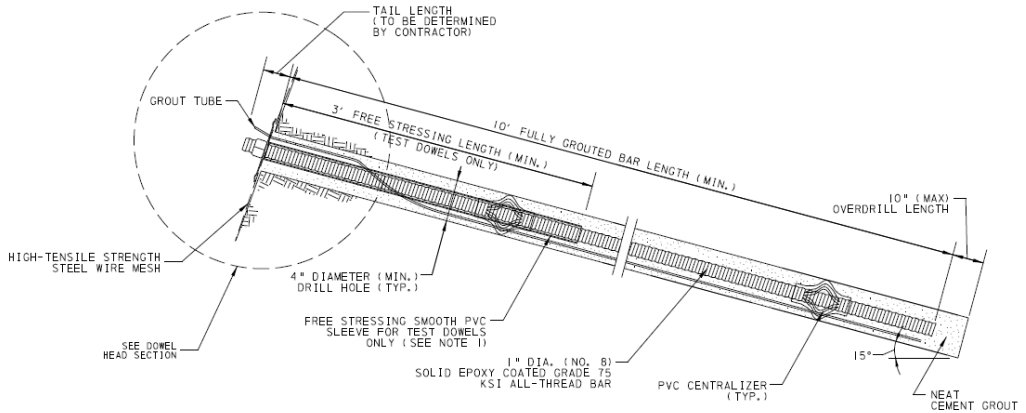


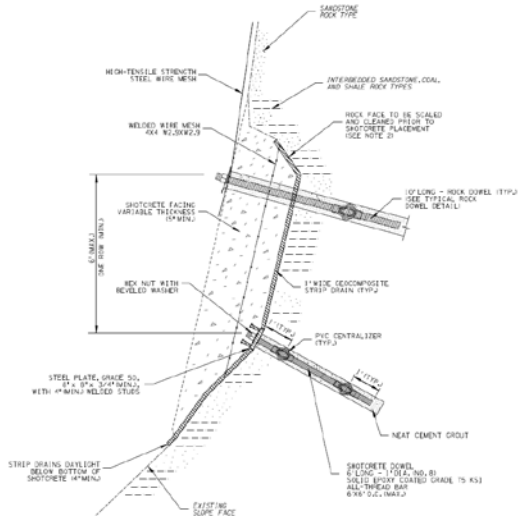
Section 14 Photomosaic Design Layout

TITLE

Section 14 Design Details







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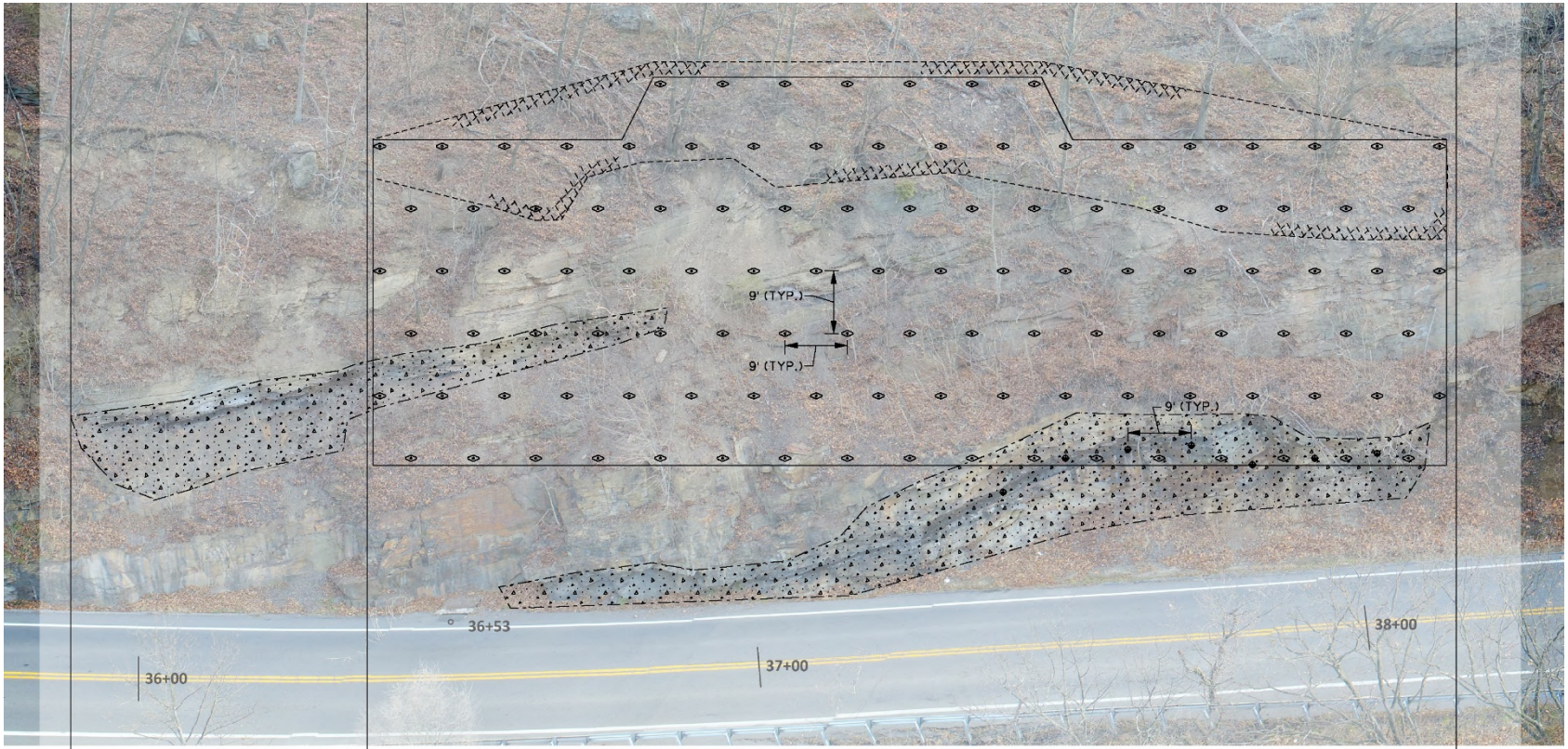

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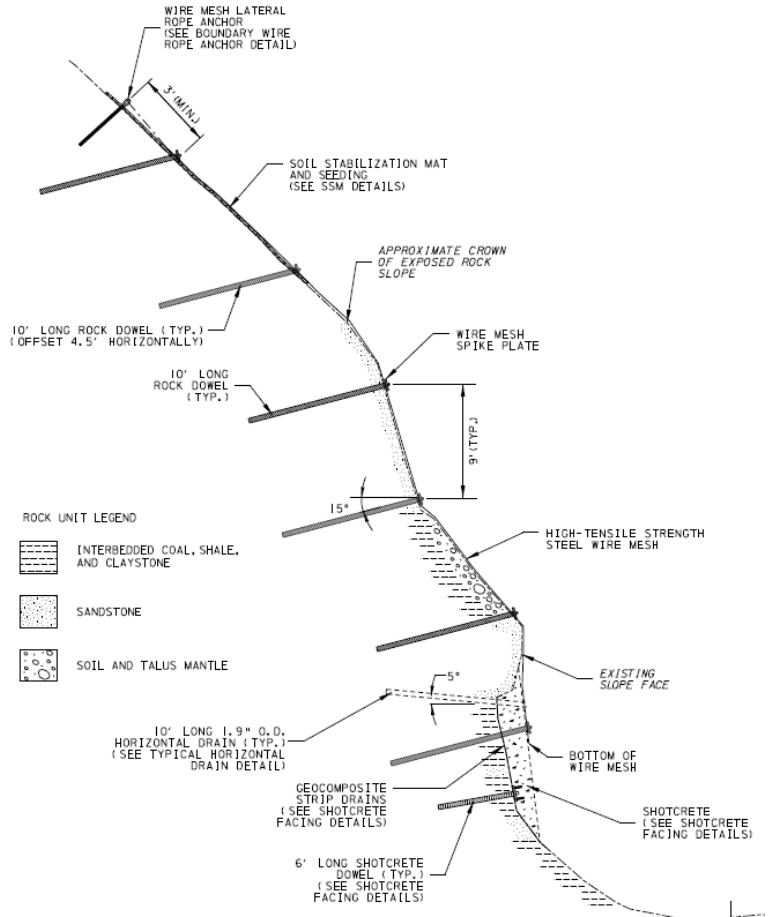

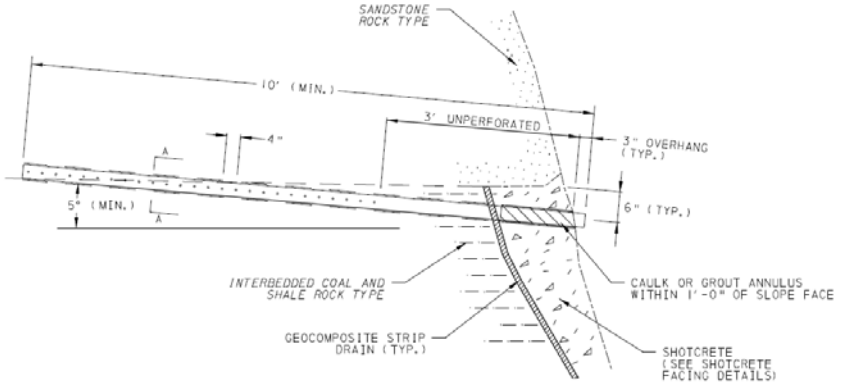

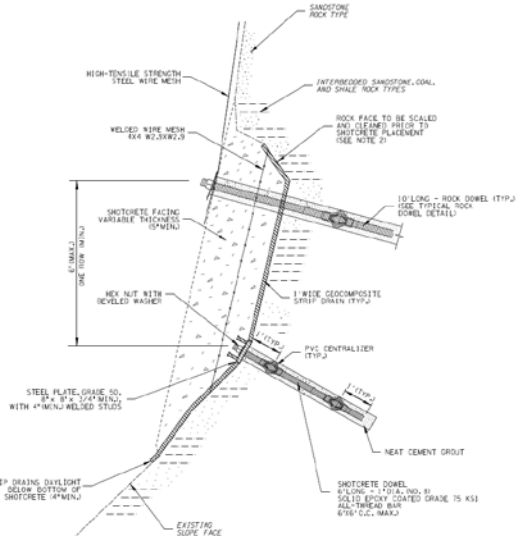

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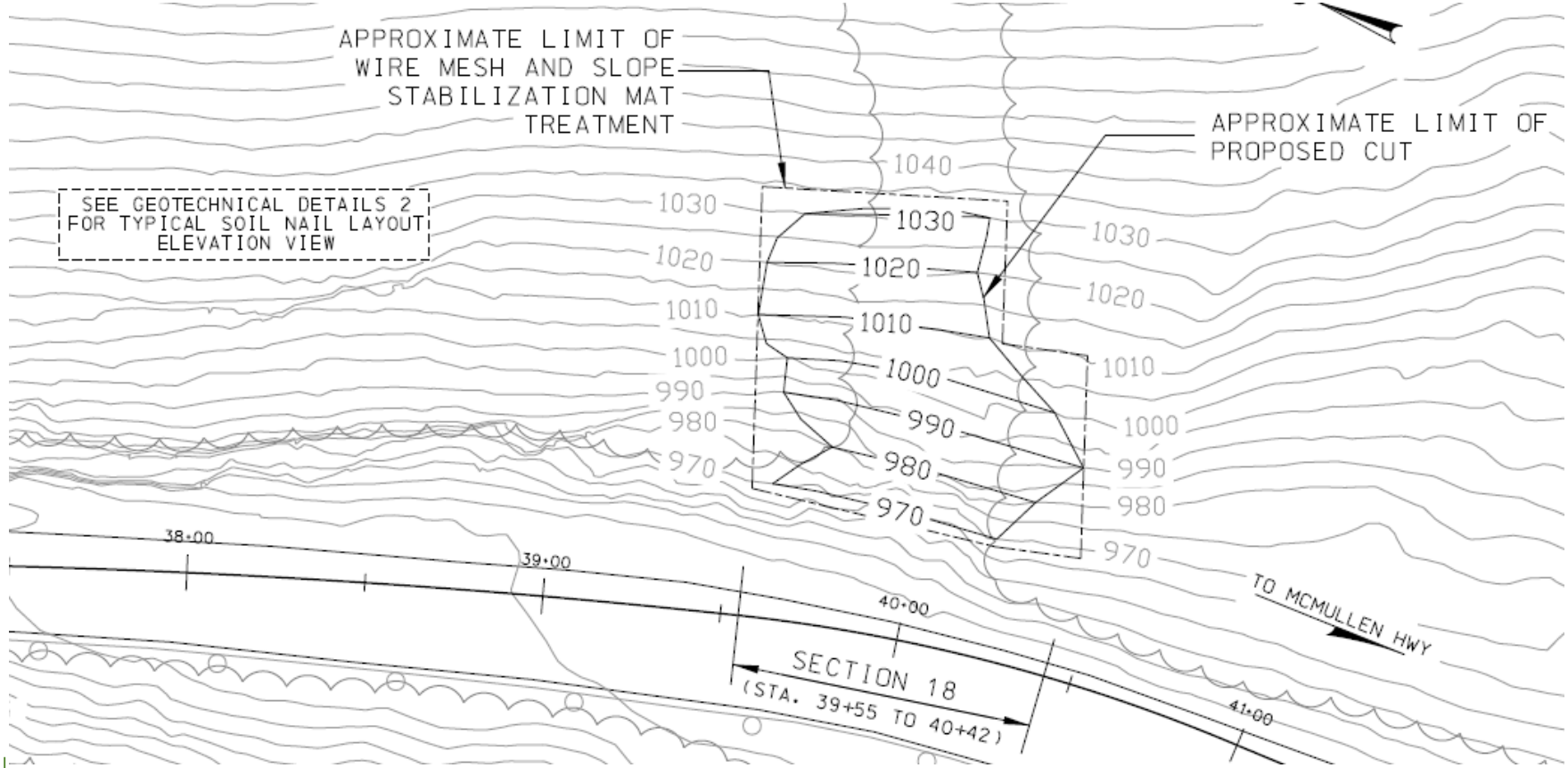

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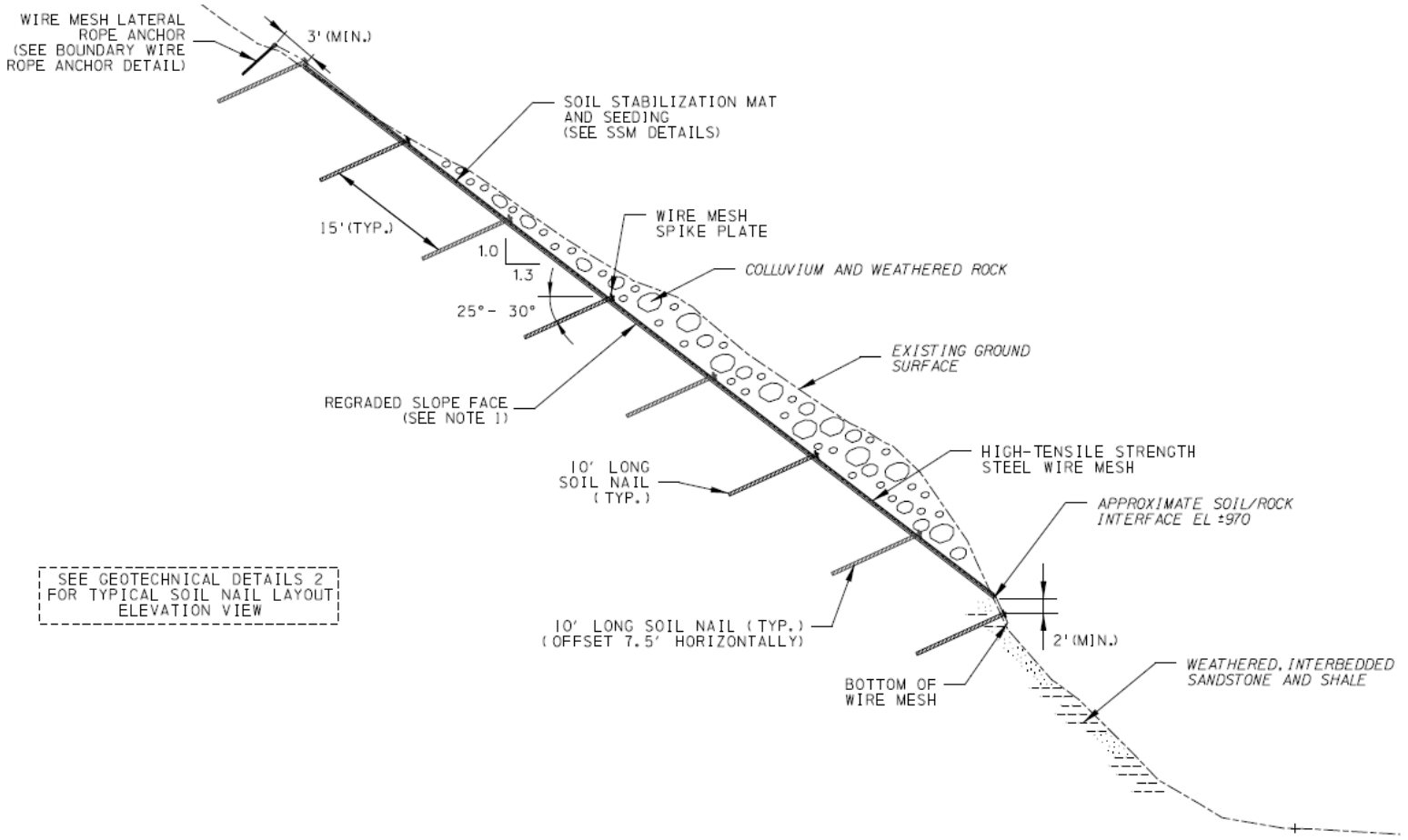

Mitigation Summary

Major Mitigation Items	Slope Section						
	2	7	9	14	16	18	Total
Rock Dowels (Each)	74		26	52	112	48	312
Wire Mesh (Square Yards)	600			400	1,100	840	2,940
Shotcrete (Cubic Yards)	74			46	100		220
Excavation (Cubic Yards)	149	3,700		74	192	650	4,765
Scaling (Hours)	32			32	32		96
Turf Reinforcement Mat (Square Yards)		489		200	315	840	1,844
Flexible Debris Flow Barrier (Square Feet)		489	600	200	315	840	2,444

Conclusions

- The Topography, Geology, and Urban Development of the Appalachian Region Creates Numerous Geohazards Impacting Transportation Corridors
- Traditional Methods of Rock and Soil Slope Stabilization, such as Flattening Slopes, Often Resulted in Significant Environmental and Property Impacts
- New Technology Such as LiDAR and Unmanned Aerial Vehicles Allow Designers to Collect and Quickly Assess Data and Design “Right-Sized” Mitigative Solutions
- New Construction Techniques and Materials Often Allow for In-Situ Stabilization, Reducing Property and Environmental Impacts

Acknowledgements:

Maryland Department of Transportation
Eric Dougherty
Karen Kalbaugh
EA Engineering/Schnabel Engineering

Thank you!