



## Considerations for Landslide and Debris Flow Monitoring

### **Problem Description**

Landslides on highways are common geologic hazards affecting transportation routes within the steep hillsides and thick soil cover of the Cumberland Plateau, Ridge and Valley, and Appalachian Mountains regions of Tennessee. In recent years, the area has been overwhelmed by extreme weather events of high-intensity or prolonged rainfall, with the highest amounts occurring in late winter and early spring, triggering significant landslides. These unexpected events disturb state routes and demand immediate attention, superseding other scheduled projects; the repair cost creates tremendous strain on available resources. An understanding of currently available techniques is necessary to select high-risk slopes and deploy an appropriate system to provide real-time movement data that can lead to an early warning for future landslides.

### **Research Objectives**

This project will focus on six step-by-step objectives using selected sites applying the critical elements of an Unstable Slope Management Program (USMP). The methodology developed from this study can then be extended to other unstable slopes on state routes.

- Catalog existing landslides on high priority state routes, and review the literature to establish landslide risk parameters and a rating system for TN.
- Identify landslide mechanisms, perform risk rating at twenty (20) landslide locations, and build a GIS Hub site where all data, maps, apps, and Survey123 forms can be viewed and accessed.
- Select eight to ten (8-10) high-risk sites and employ remote sensing monitoring, model failure surfaces of all selected high-risk sites and choose three (3) candidate sites for ground-based monitoring.
- Install a cost-effective composite ground-based Time Domain Reflectometry (TDR) system (with piezometer, soil moisture sensor, and rain gauge) at all three (3) candidate sites.
- Analyze real-time data from the TDR system at each site to develop an early warning system and methods for extension to other slopes.

### **Potential Implementation and Expected Benefits**

This study will produce a cost-effective, high-impact monitoring system that will provide long-term, real-time monitoring for transportation improvement programs and maintenance projects. Transferable tools can be adopted readily by TDOT GES and the TDOT research program. The project's success will position TDOT near the top among its nationwide DOT peers, many of which are currently applying advanced monitoring techniques on landslide sites. TDOT will be able to optimize proactive decisions and justify timely monitoring, maintenance, and strategic design based on potential risk. The resulting monitoring system may offer benefits and uses to local or sister state agencies or federal partners.

### **PROJECT NUMBER:**

RES2023-12

### **PRINCIPAL INVESTIGATOR:**

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### **TDOT LEAD STAFF:**

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Materials & Tests

### **PROJECT SCHEDULE:**

August 2022 to January 2025