

Dismantling the Tallest Reinforced Fill in North America - The Observational Method Applied at the Yeager Airport



Allen Cadden, PE, DGE
October 12, 2016
Geo-Virginia 2016



Legal Disclaimer

Due to ongoing legal proceedings regarding the Runway 5 Slope Failure at the Yeager Airport, we will not and cannot discuss the design, construction or any opinions regarding the causes of the issue.



History of Yeager Airport

- Yeager Airport was constructed in 1947
- Typical of most West Virginia construction, work involved cutting the tops off of three mountains and filling in the two valleys
- Original construction included two runways
 - RW 5-23 – 6,300' x 150'
 - RW 15-33 – 4,300' x 100'
- Runway 15-33 was closed in 2008 and converted to a taxiway to serve the General Aviation Area



Yeager Airport Pre-2008





History of Yeager Airport

- Runway Safety Area requirements caused a need for a fill at the end of Runway 5
- Reinforced fill was selected with an Engineered Materials Arresting System (EMAS)
- An additional 500' of runway length was added to RW 23 to extend the total runway length to 6,801'
- Project completed in 2008
- Project was touted as the largest reinforced fill in North America



EMAS Reinforced Fill Construction



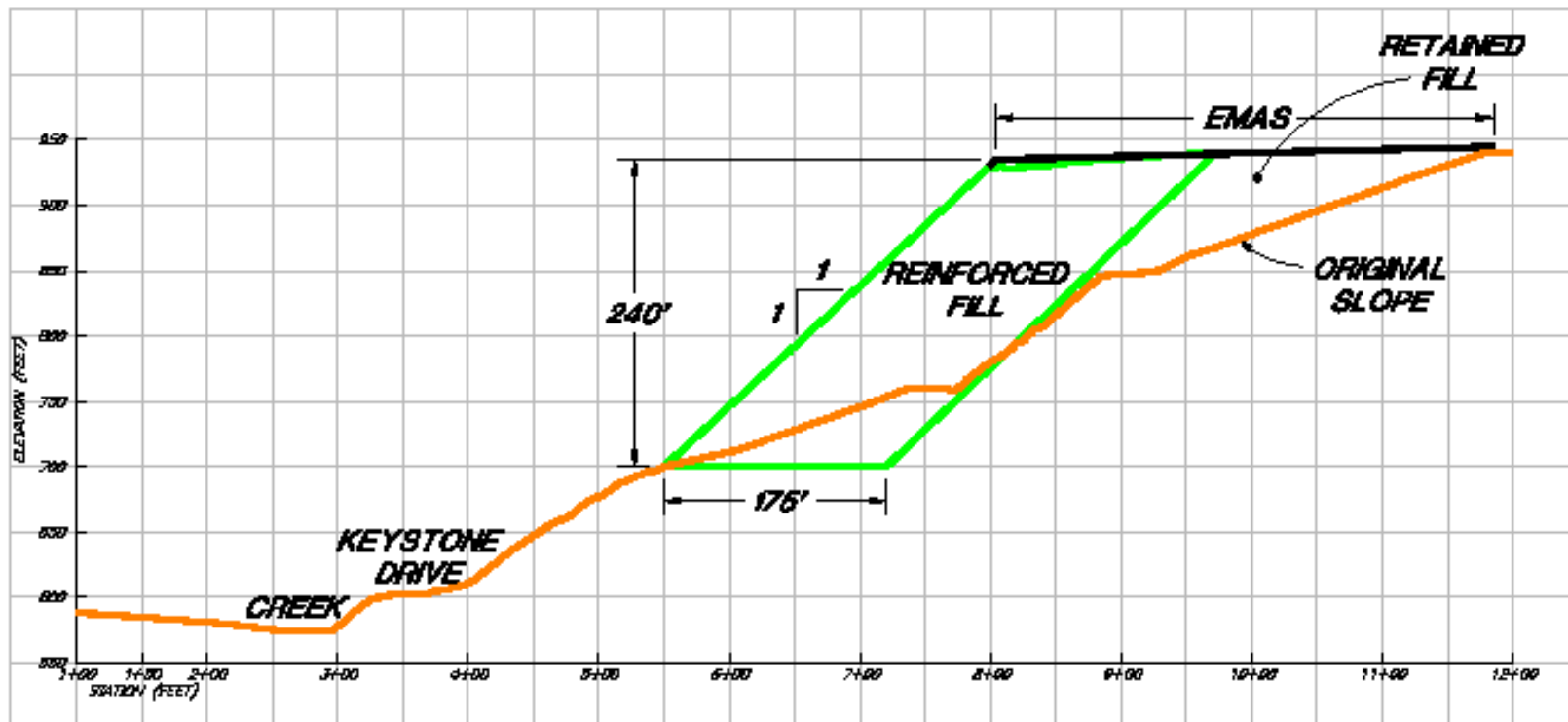


Statistics

- Height of 240 feet
- 1H:1V outslopes with Geogrid every 3 feet vertical
- Lengths of as much as 175 feet
- Volume of >1,000,000 cy

Completed EMAS Installation





SECTION A-A







Problems Develop

- Crack noticed in 2013
- Southwest corner drops a few feet
- Drops a couple of feet each day in early March 2015





Problems Develop



2015/03/12 07:55

Emergency Planning

- The day before the failure Airport officials convened a meeting with local emergency responders
 - Discussed worst case scenarios, flooding, evacuations, emergency public information, reverse 911
- The morning of the failure (March 12th) Airport officials again met with local emergency responders
- Given the amount of movement emergency management officials took the threat of a collapse very seriously

Emergency Planning



Day of the Failure – March 12th

- An Airport employee was stationed at the base of the fill in parking lot of the Keystone Apostolic Church to watch for movements
- At approximately 12:15 PM the employee noticed significant movement and notified Airport management
- The Airport immediately responded and closed Keystone Drive

Day of Slope Failure











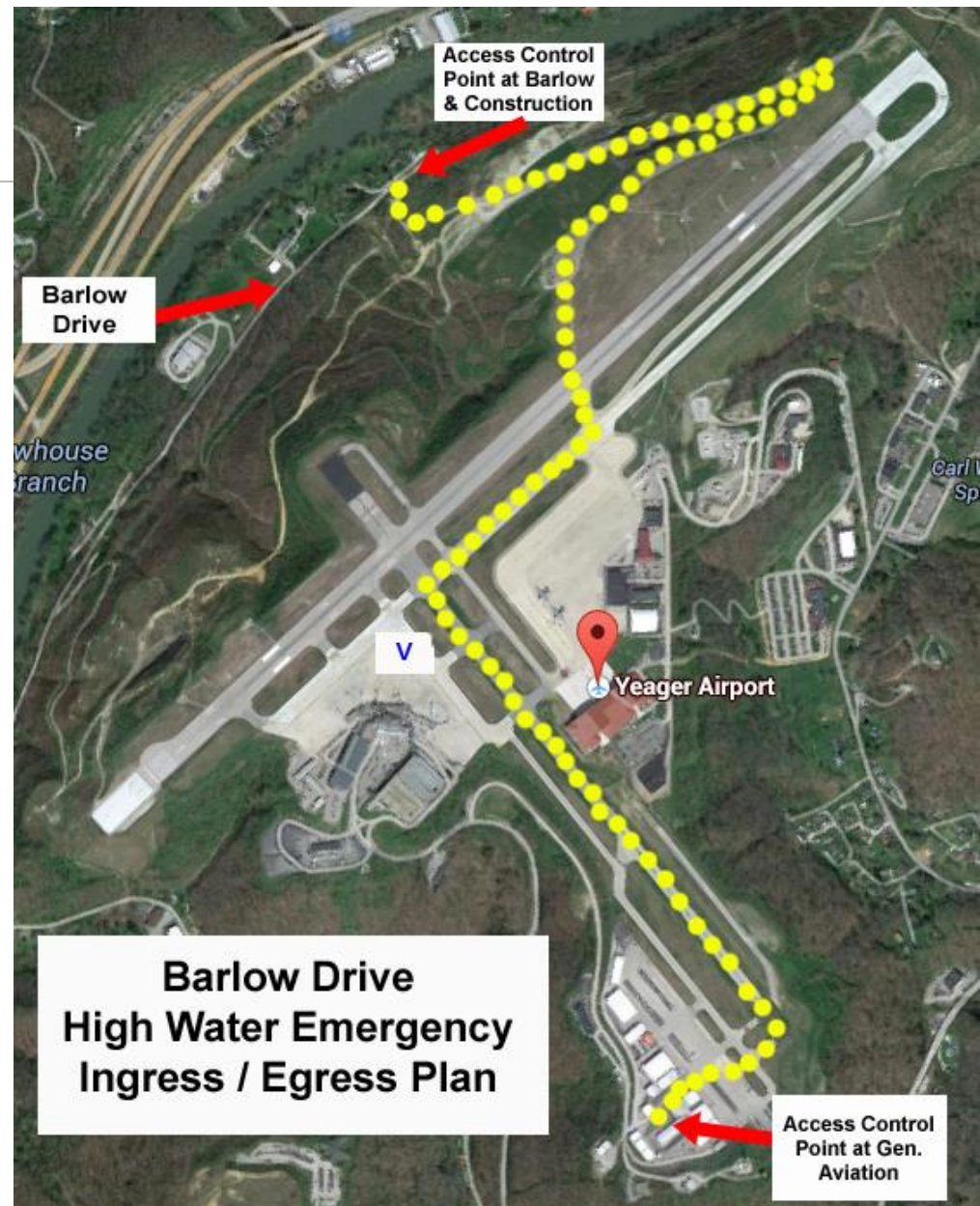
Risk

Slide Impact

- 132 lives affected/approx 60 households
- 38 folks were able to return home within a couple of days
- 56 able to go home within a week

Elk River Flooding:

- 30 houses
- 62 residents
- 12 businesses
- 60+ employees







CHALLENGES

Schedule

- Mitigation plan
- Bid package
- Contractor selection



CHALLENGES

Available data limitations, unknowns

- Materials used
- In-place density and strength
- Water
- Grid limits
- Failure mechanism



CHALLENGES

Safety

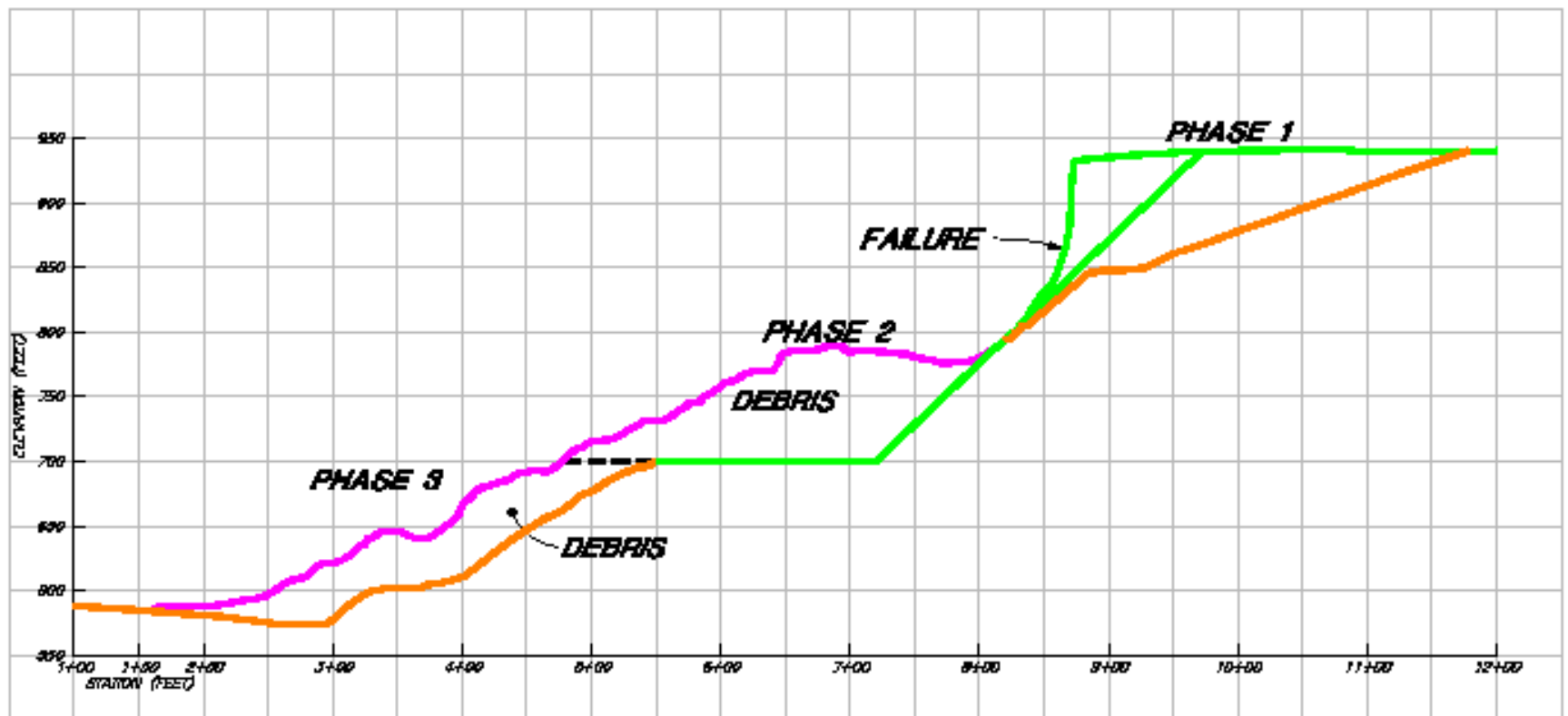
- No one gets hurt
- 140 feet high vertical face below runway
- Massive, creeping debris field below vertical face



Phase 1

Phase 2

Phase 3



SECTION A-A



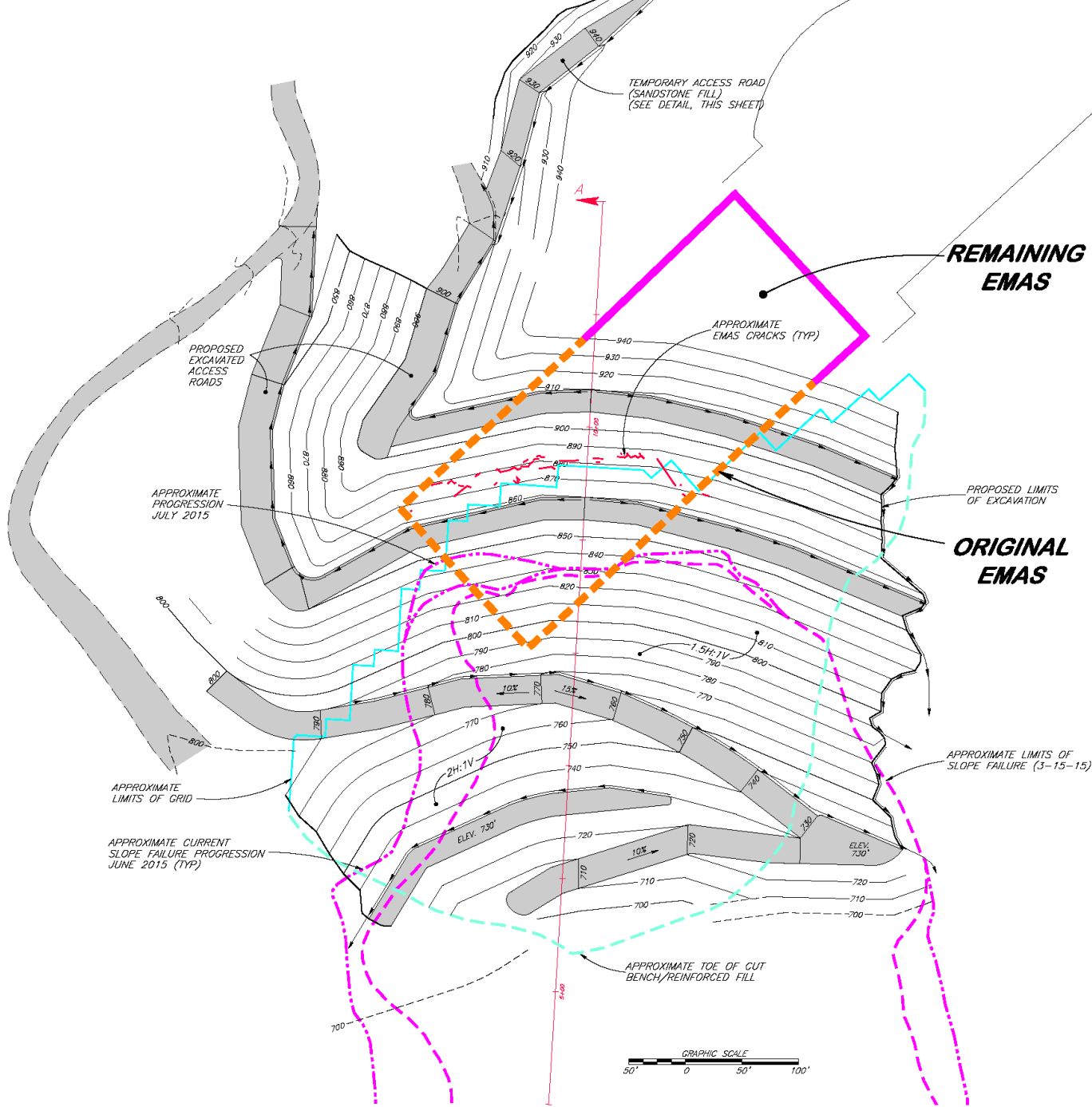
DESIGN

- Temporary cut slopes to be left in place
- Removal of hanging wedge/vertical face



TEMPORARY CUT SLOPES

- Balance safety factor with minimizing removal of remaining fill
- Based on perceived nature of material, used cut slopes of 1.5H:1.0V with benches approximately 50 feet vertical



REMOVAL OF HANGING WEDGE/VERTICAL FACE

- Not easily explained
- Remaining sheared grid was a benefit
- Concerns about equipment/personnel safety
- Practical limitations of equipment reach vs. boomph





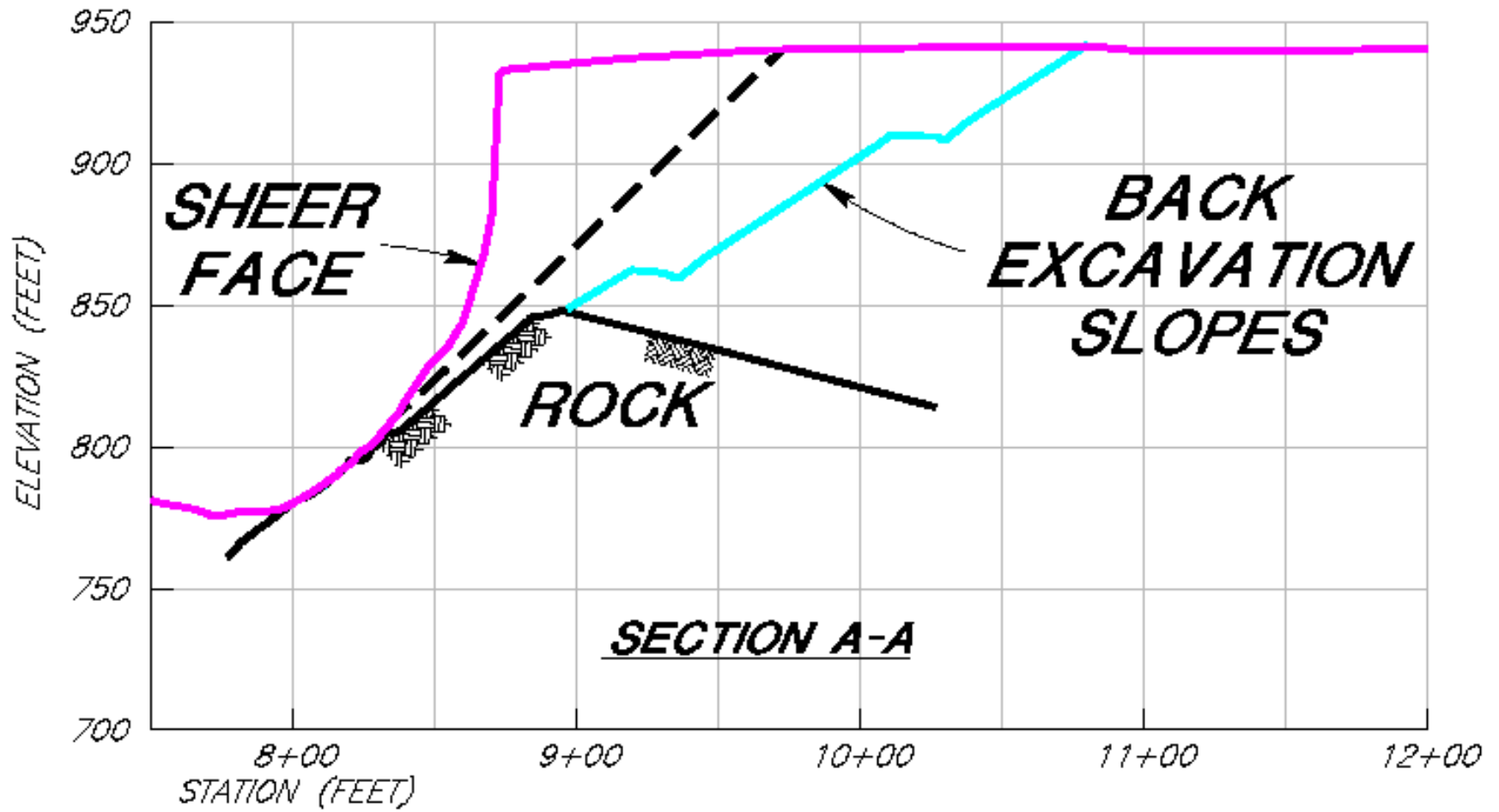
OBSERVATIONAL APPROACH

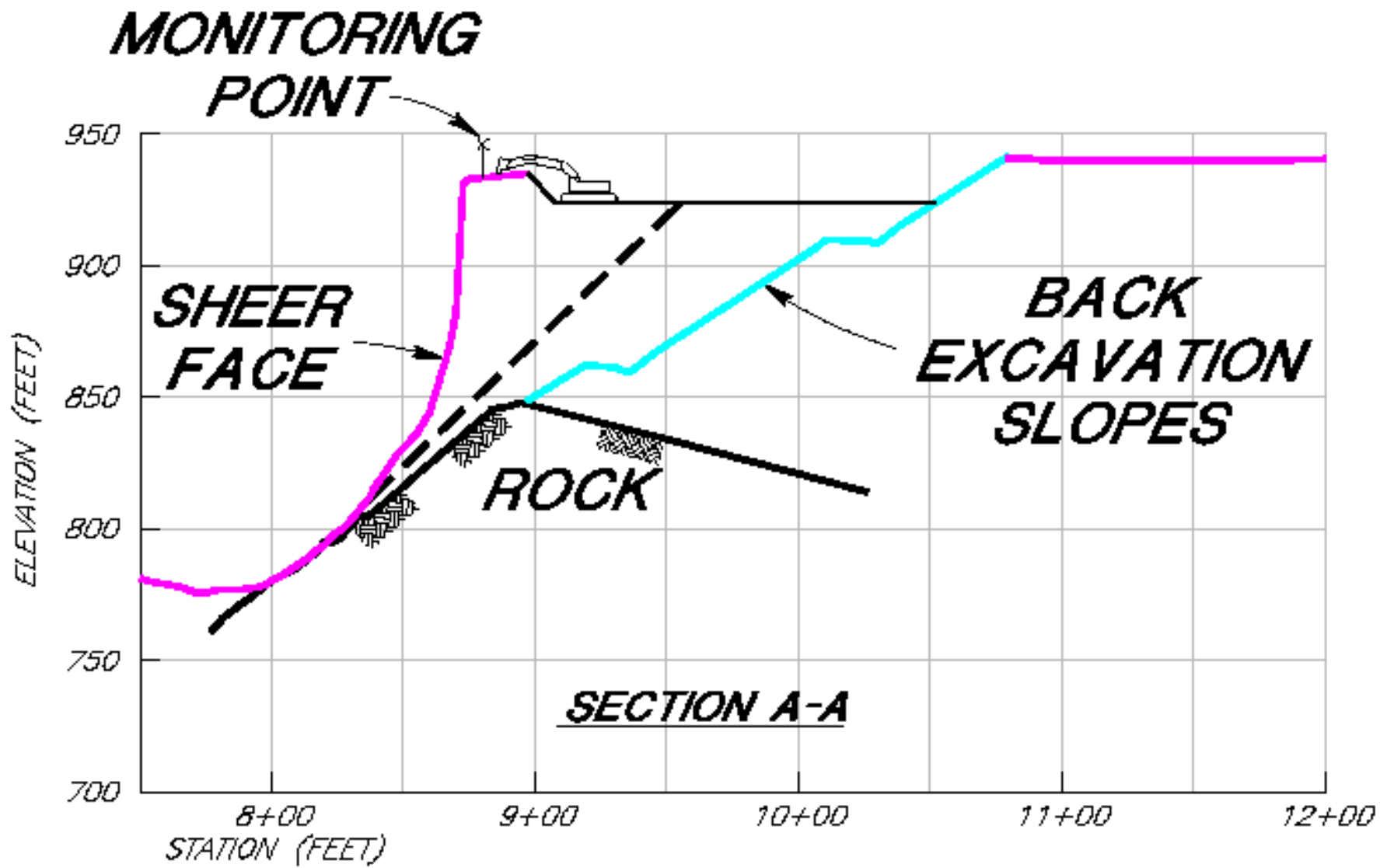
- Excavate enough material to balance weight of equipment
- Monitor/restrict access in front of known cracks in remnant fill

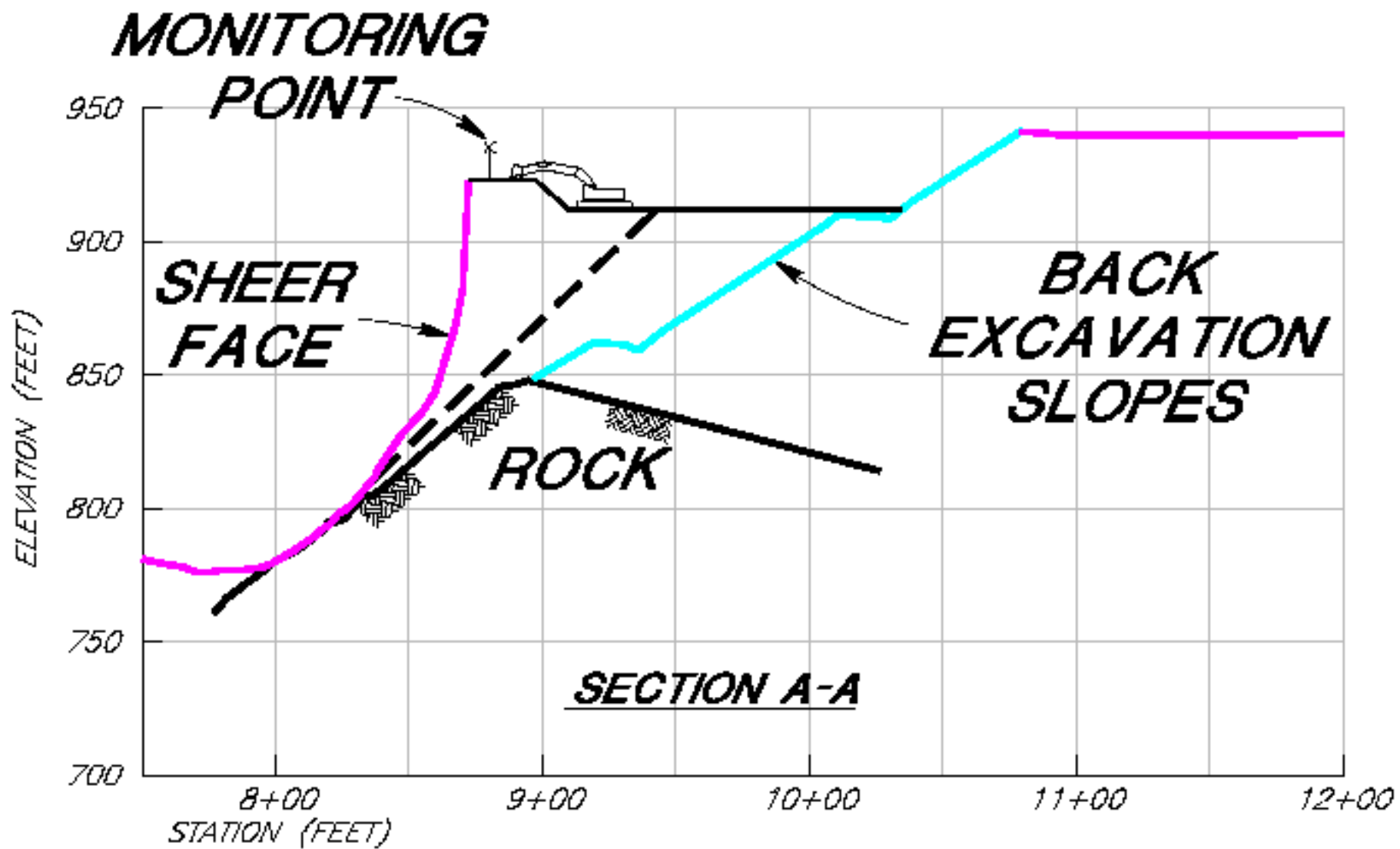


OBSERVATIONAL APPROACH

- Survey points on outer edge of face with continuous monitoring
- Visual observations





















Waste Storage Fill

Active Runway 5

Slope Mitigation Area

Keystone Dr

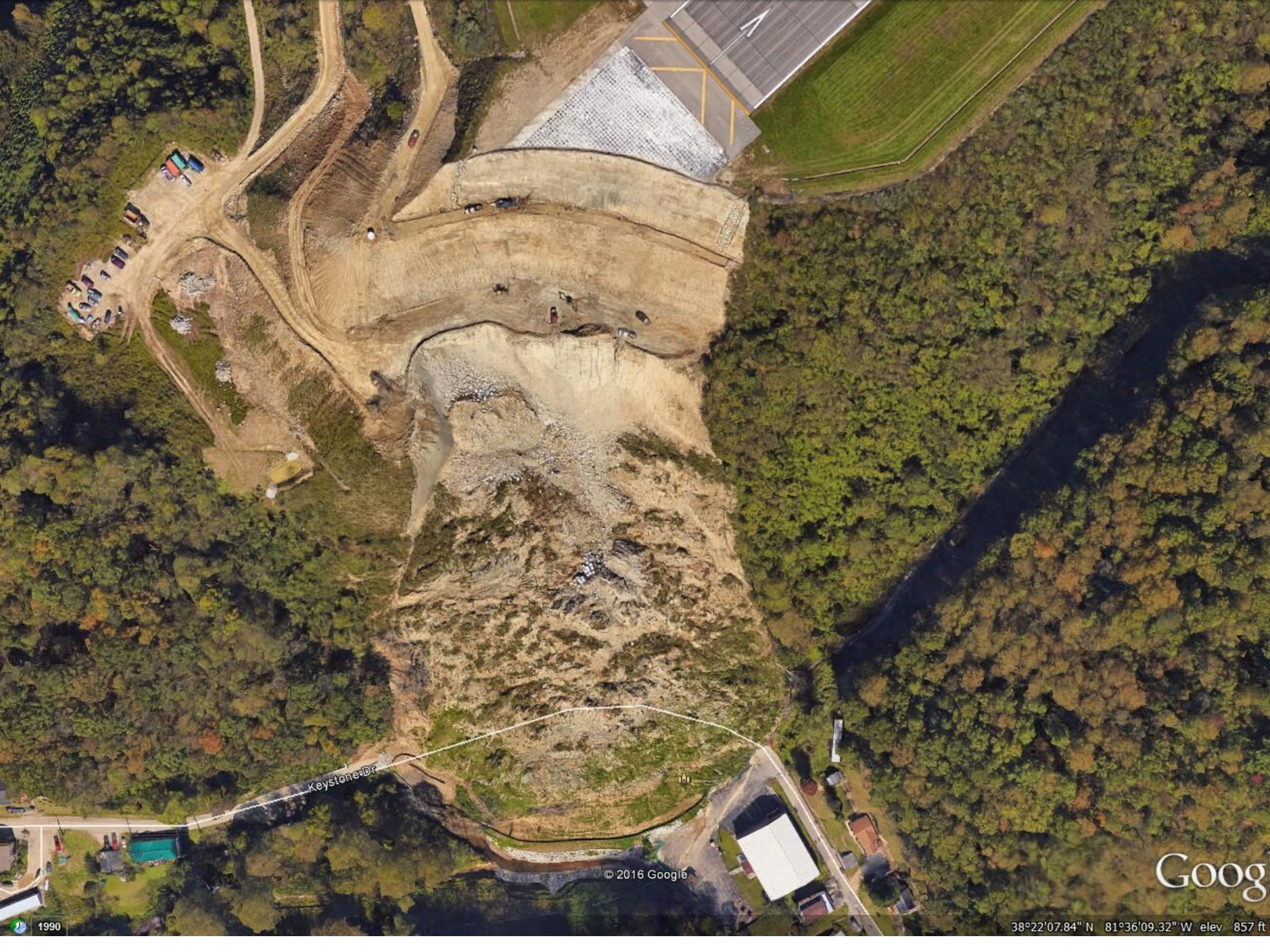
Airport Rd

© 2016 Google

Google

38°22'11.73" N 81°35'46.58" W elev 948 ft eye

1990



Keystone Dr

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Google

38°22'07.84" N 81°36'09.32" W elev 857 ft

1990









Phase 3



Phase 3





Emergency Public Information

- No substitute for being on-site
- No Controlling Social Media.
- Disseminating Information to the Press via Media Releases.
- The Press Abhors a Vacuum.

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