



Large Landslide Repair in an Area of Limited Data I-64, MP 45.65 Slope Repair – Horizontal Drains

August 17, 2017

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Staunton District Materials

Timeline

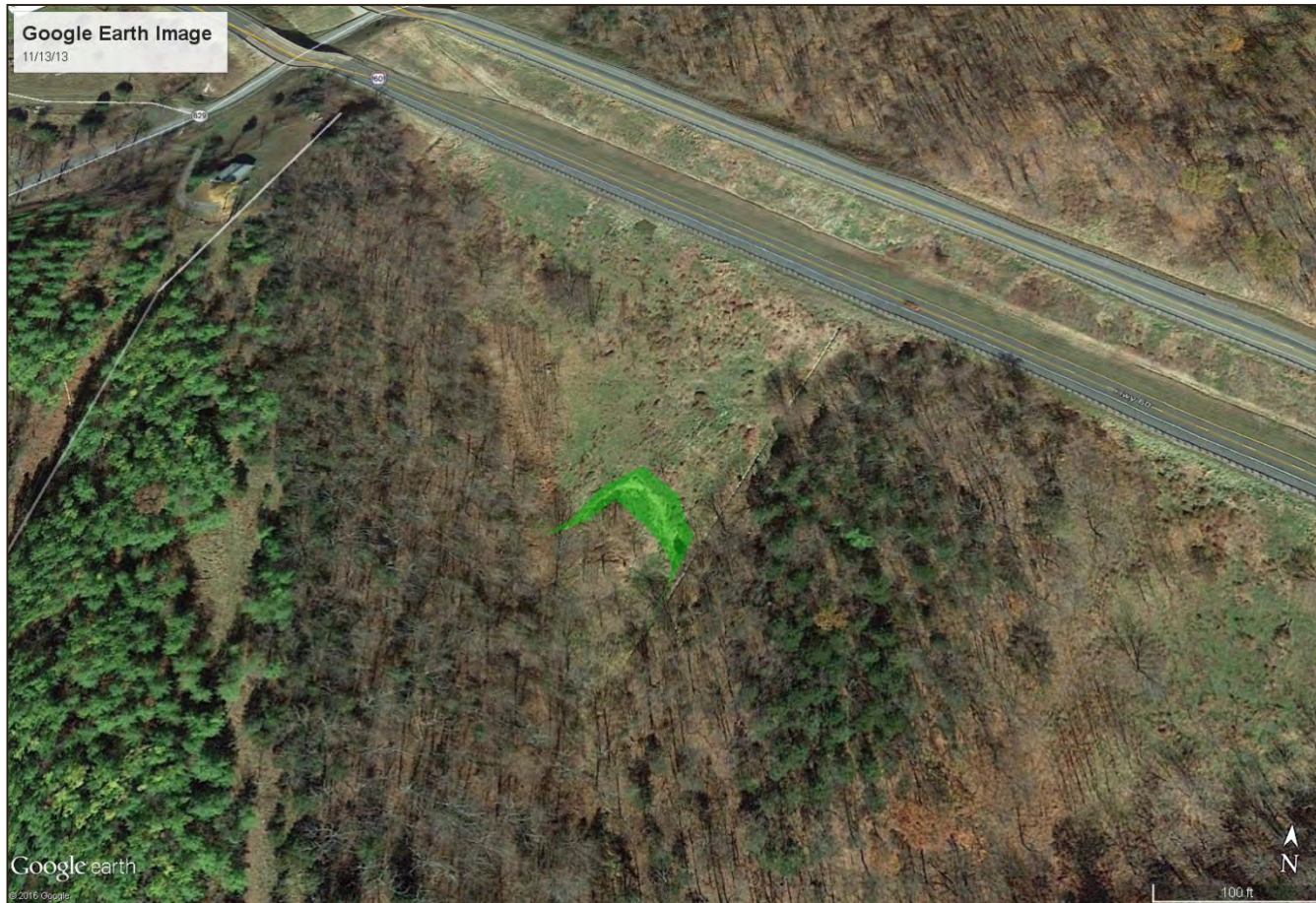
Timeline

- **November 13, 2013 – Google Earth Image**
- **January, 2014 – Local Resident reports Slope Failure**
- **July, 2014 – Geotechnical Drilling**
- **July, 2014 to Present – Slope Inclinator Monitoring**
- **February, 2015 – Cleaning and Survey of Drainage Pipe**
- **November, 2015 – Construction begins**
- **Late-December, 2015 to February, 2016 – Horizontal Drains**
- **April, 2016 – Project Complete**

Project Site



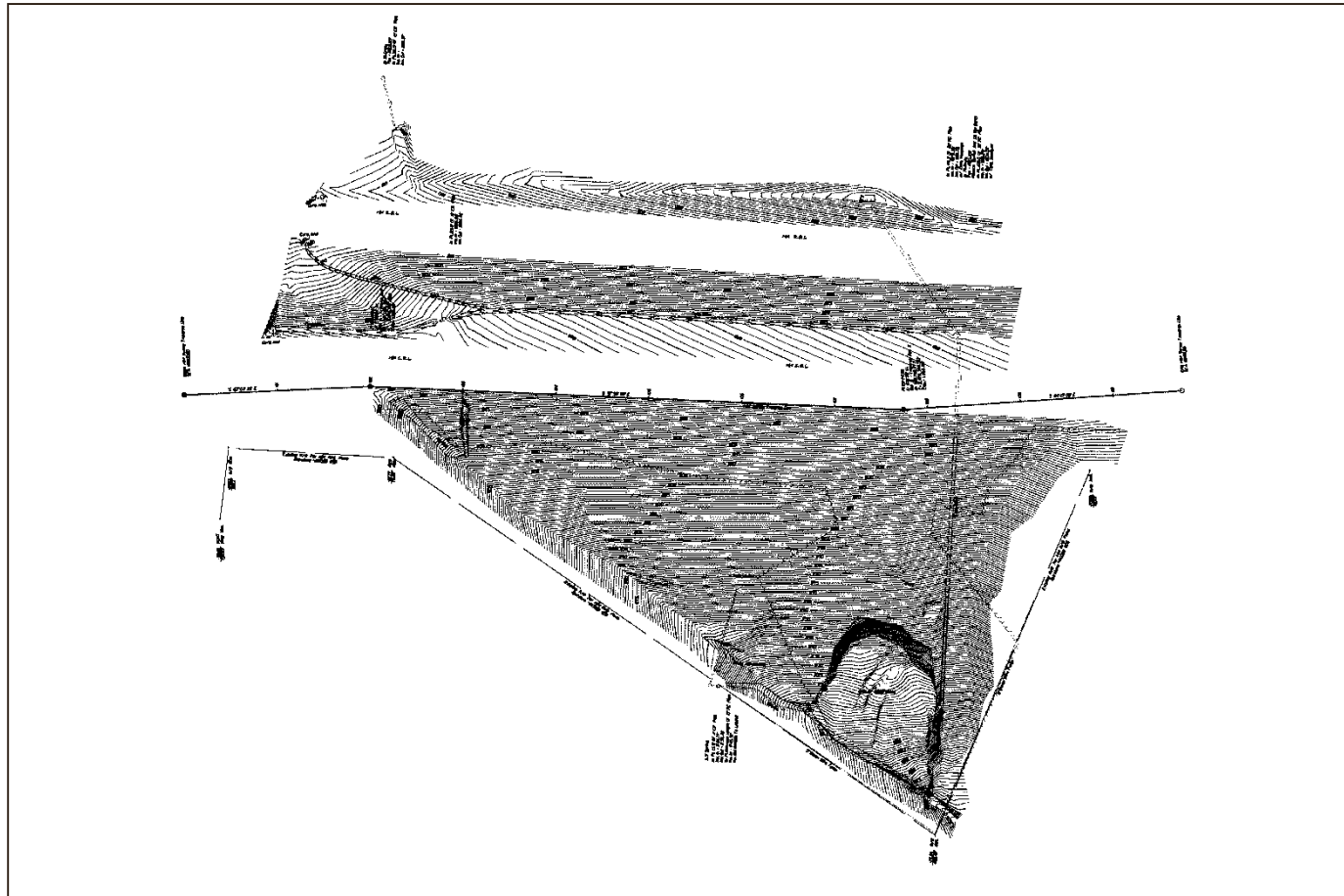
Scarp



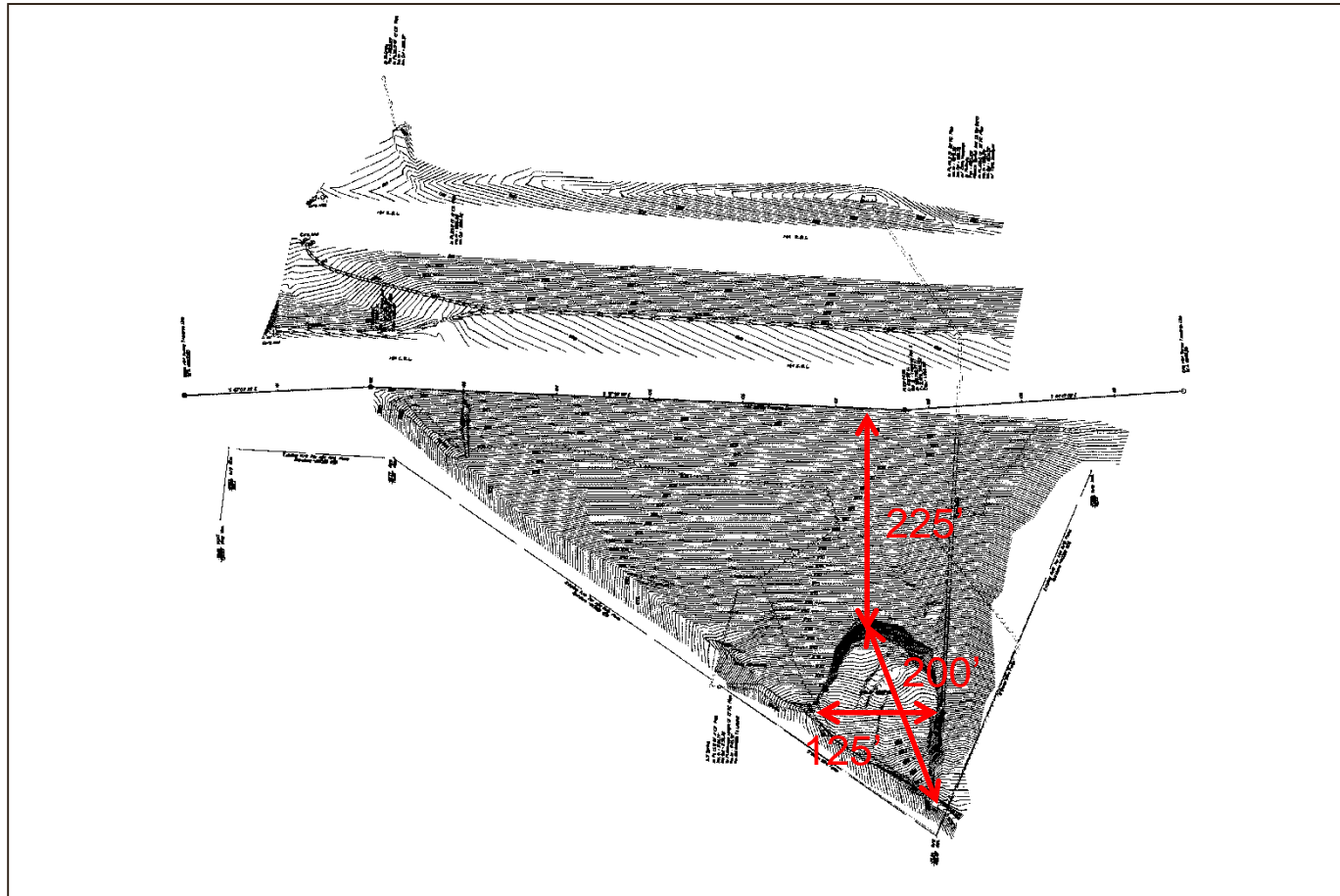
Scarp



Survey



Slide Dimensions



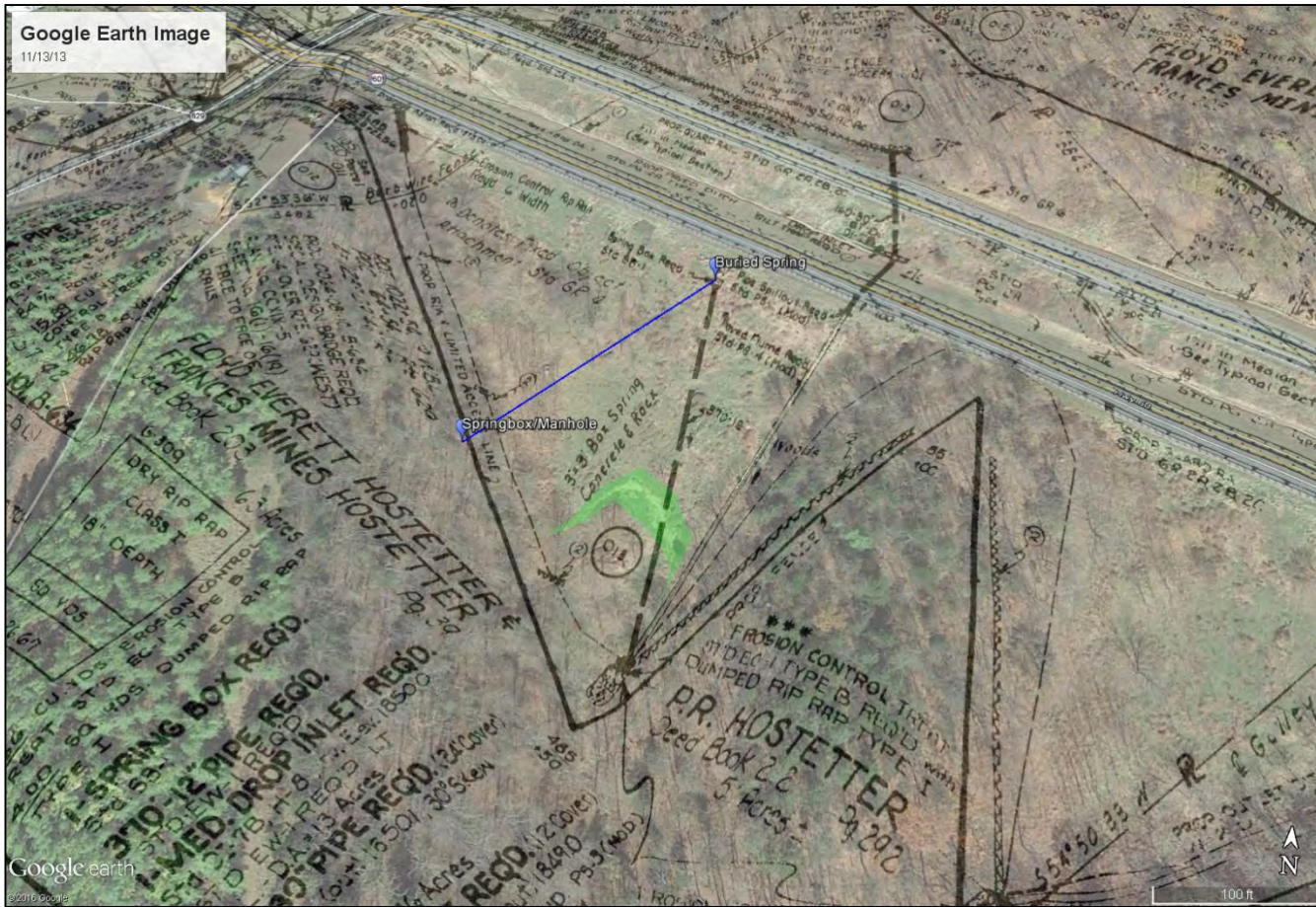
J'ed Trees on the Slope



Scarp



Springbox



Drainage out of Slope



Drainage into Cistern



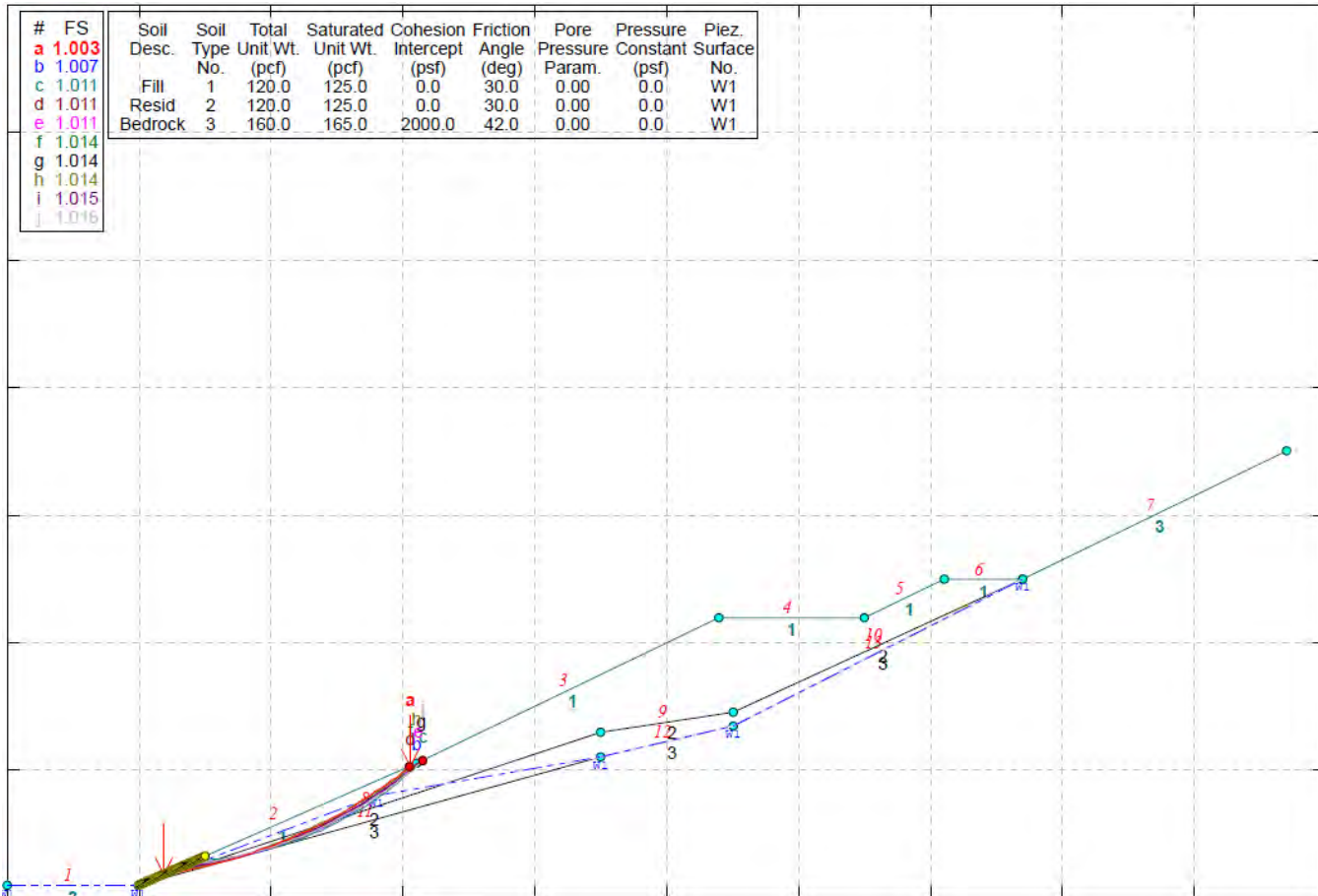
Sag in Drainage Pipe



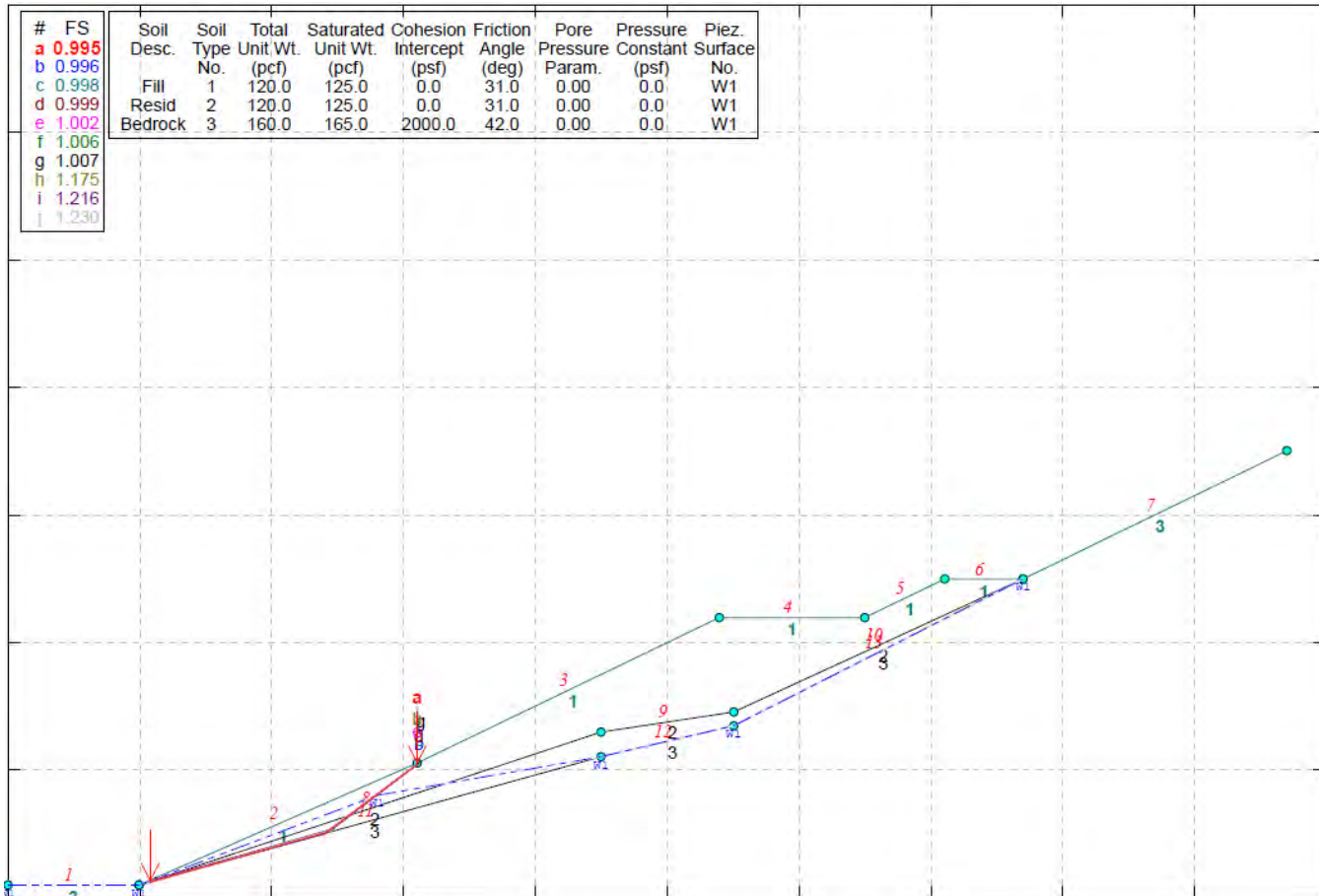
Frogs



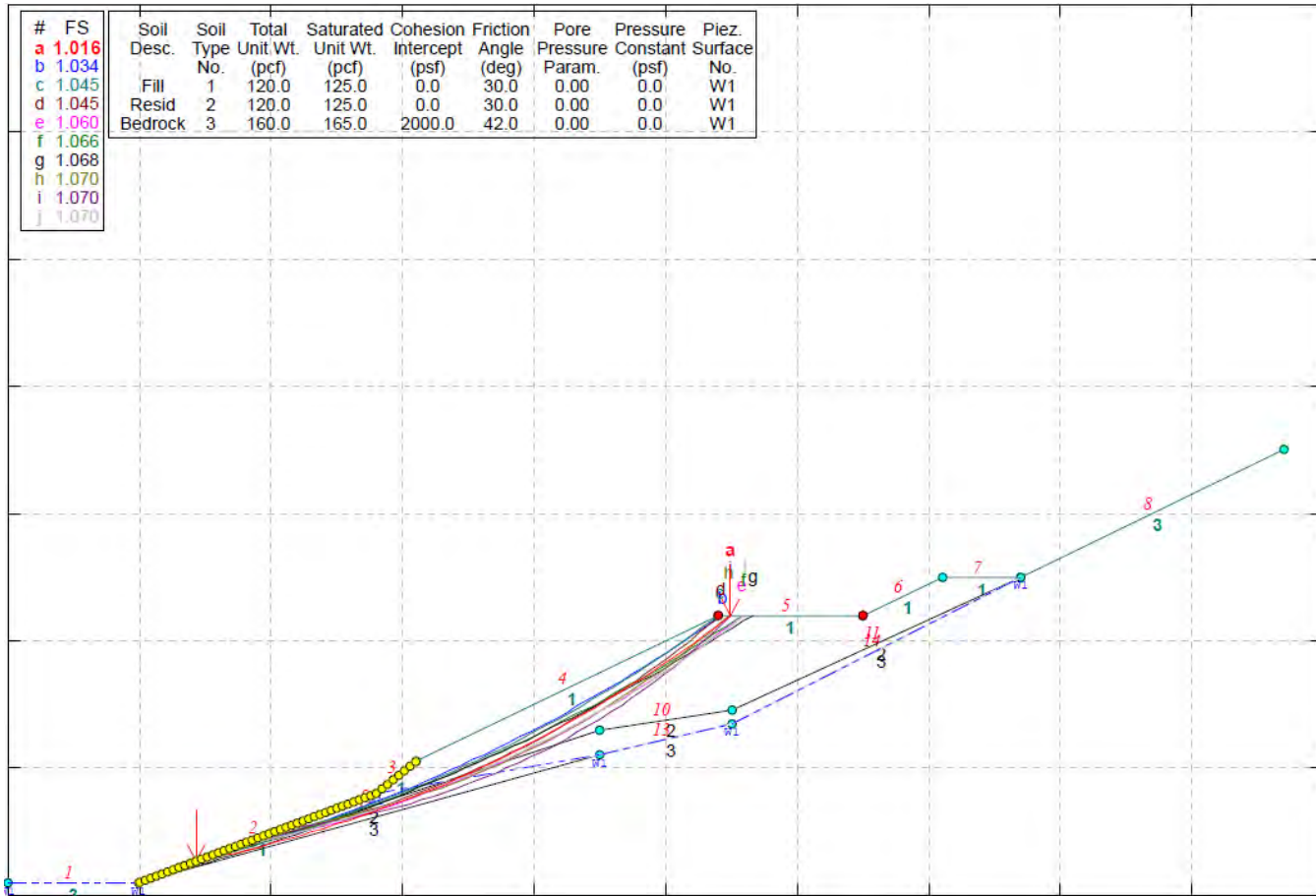
Back-Calculation - Circular



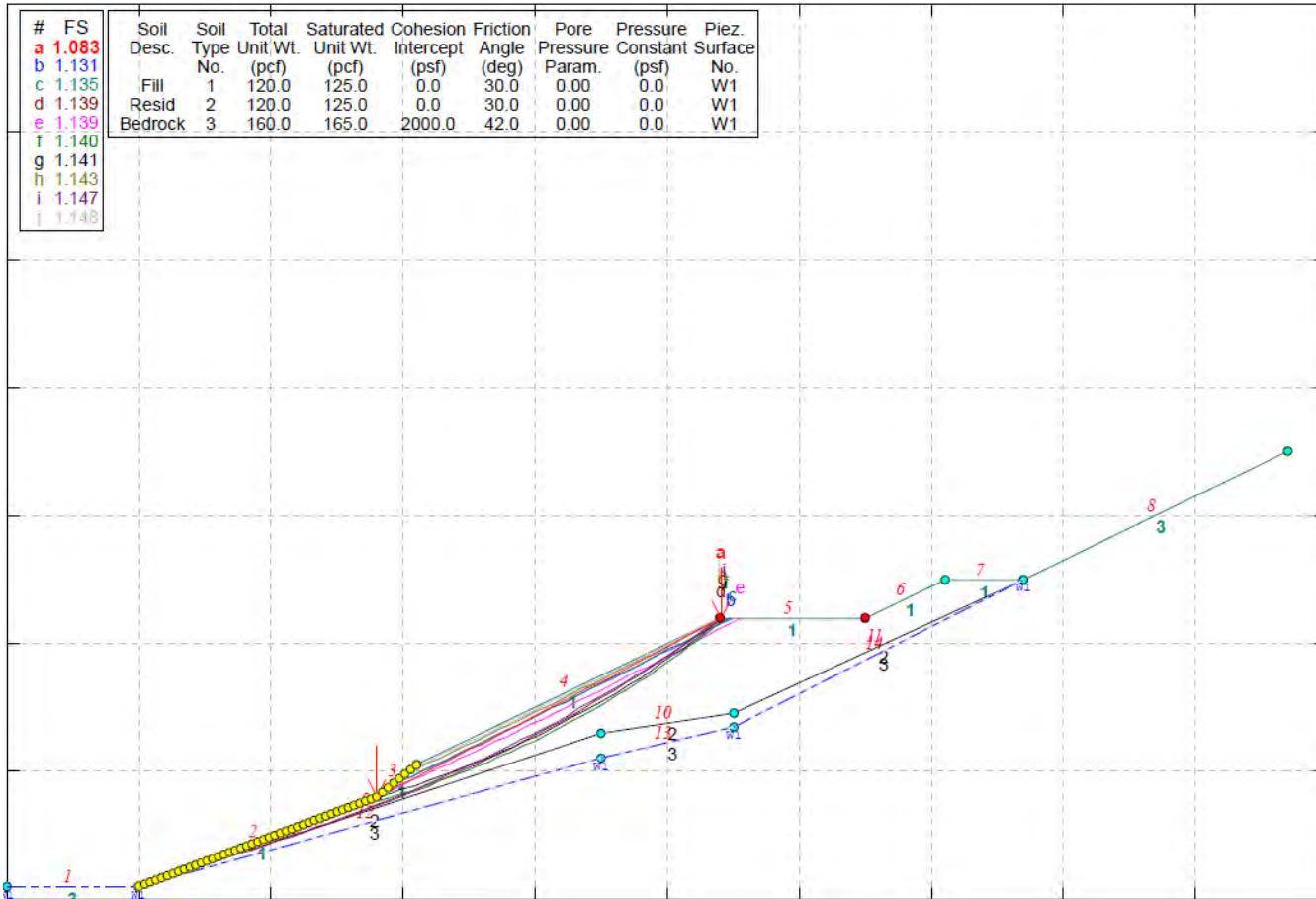
Back-Calculation - Wedge



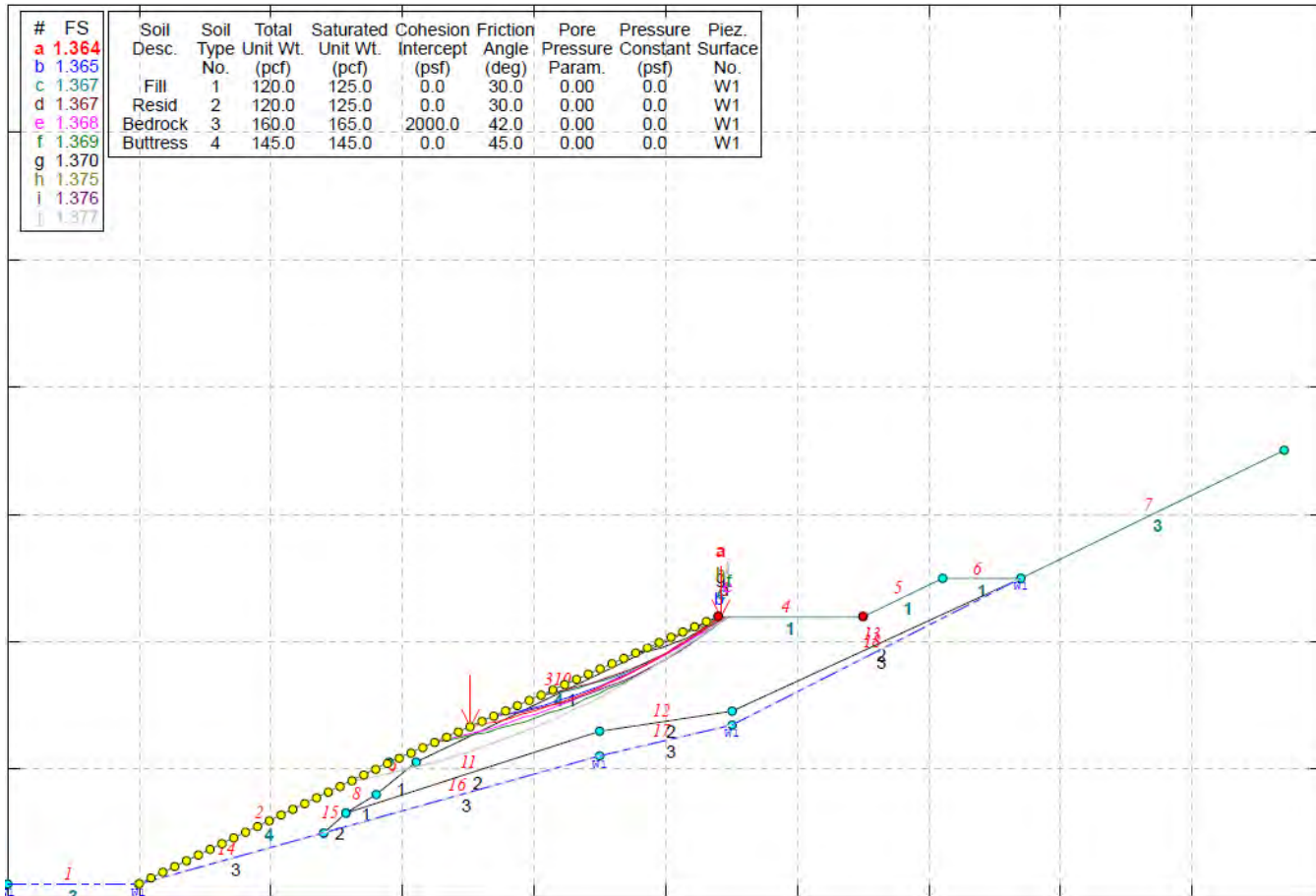
Global - Existing



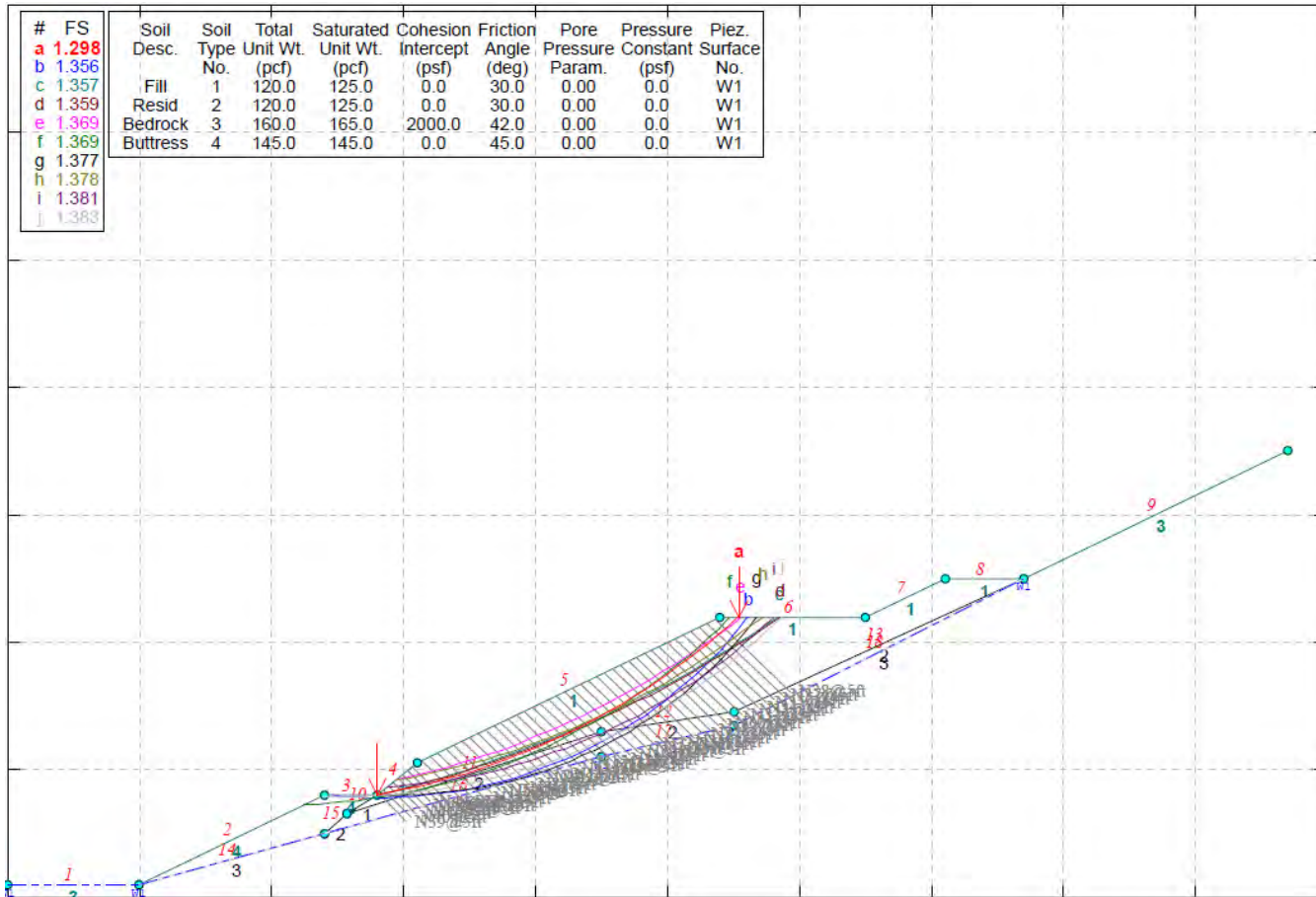
Improved Drainage



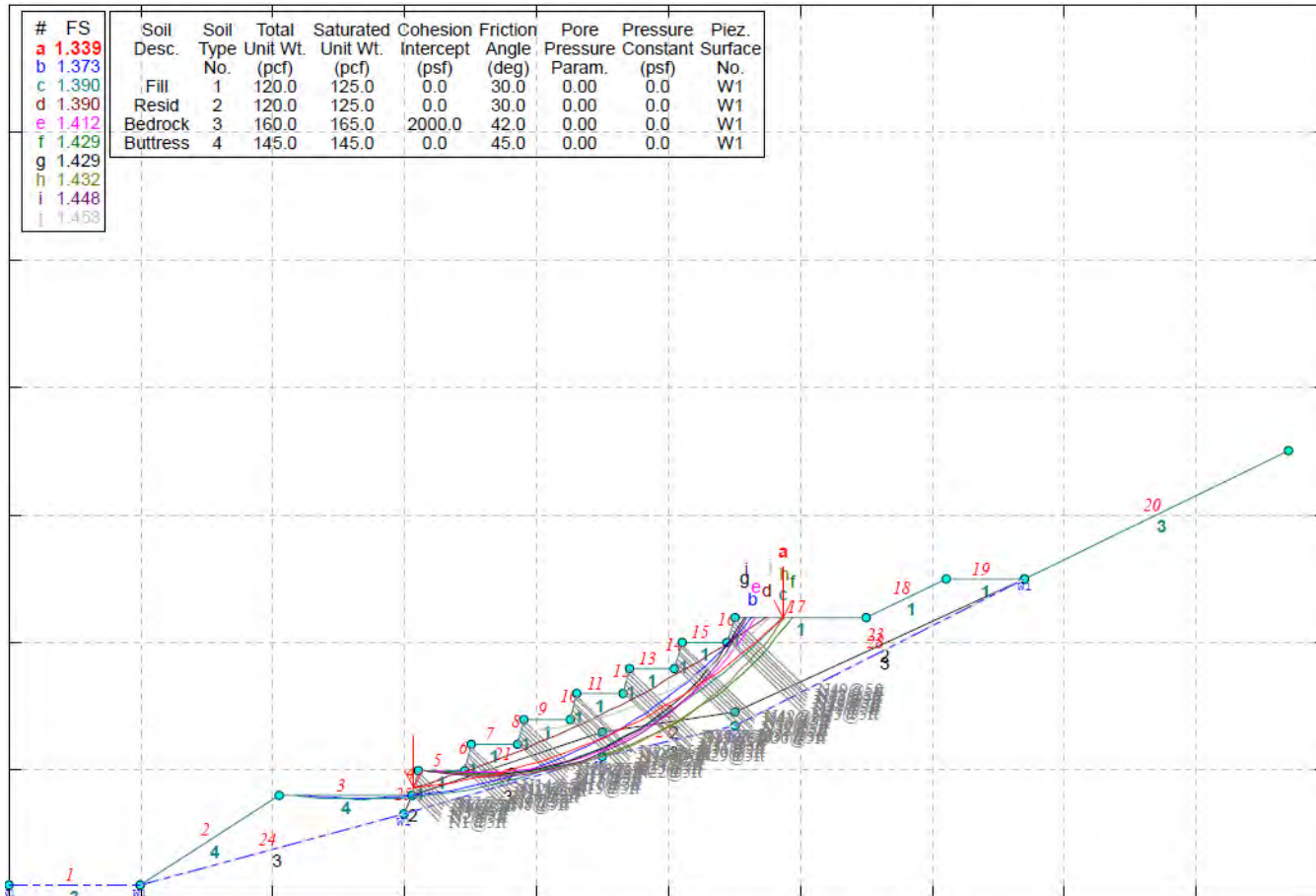
Full Buttruss



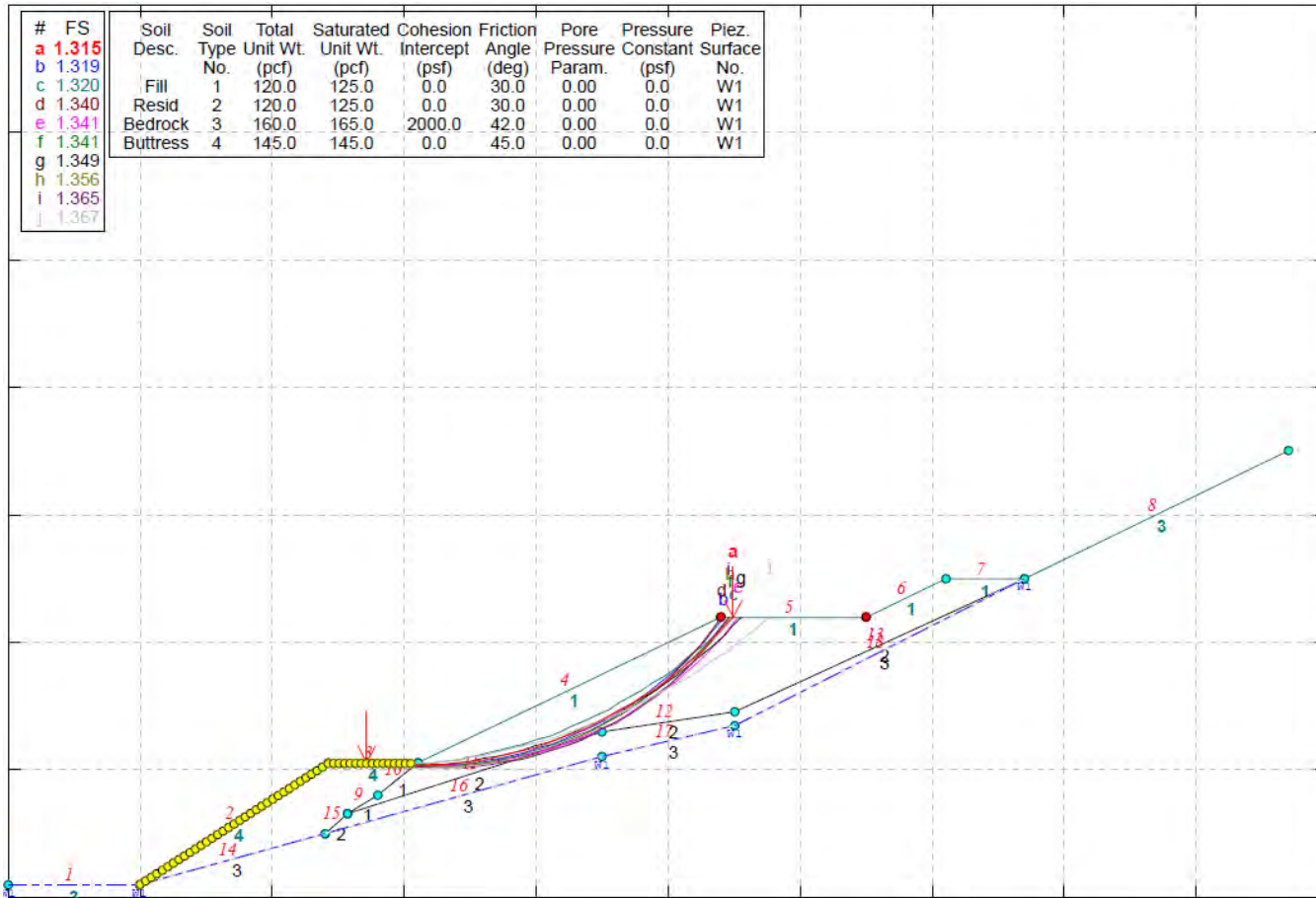
Soil Nails along Slope



Soil Nail Walls



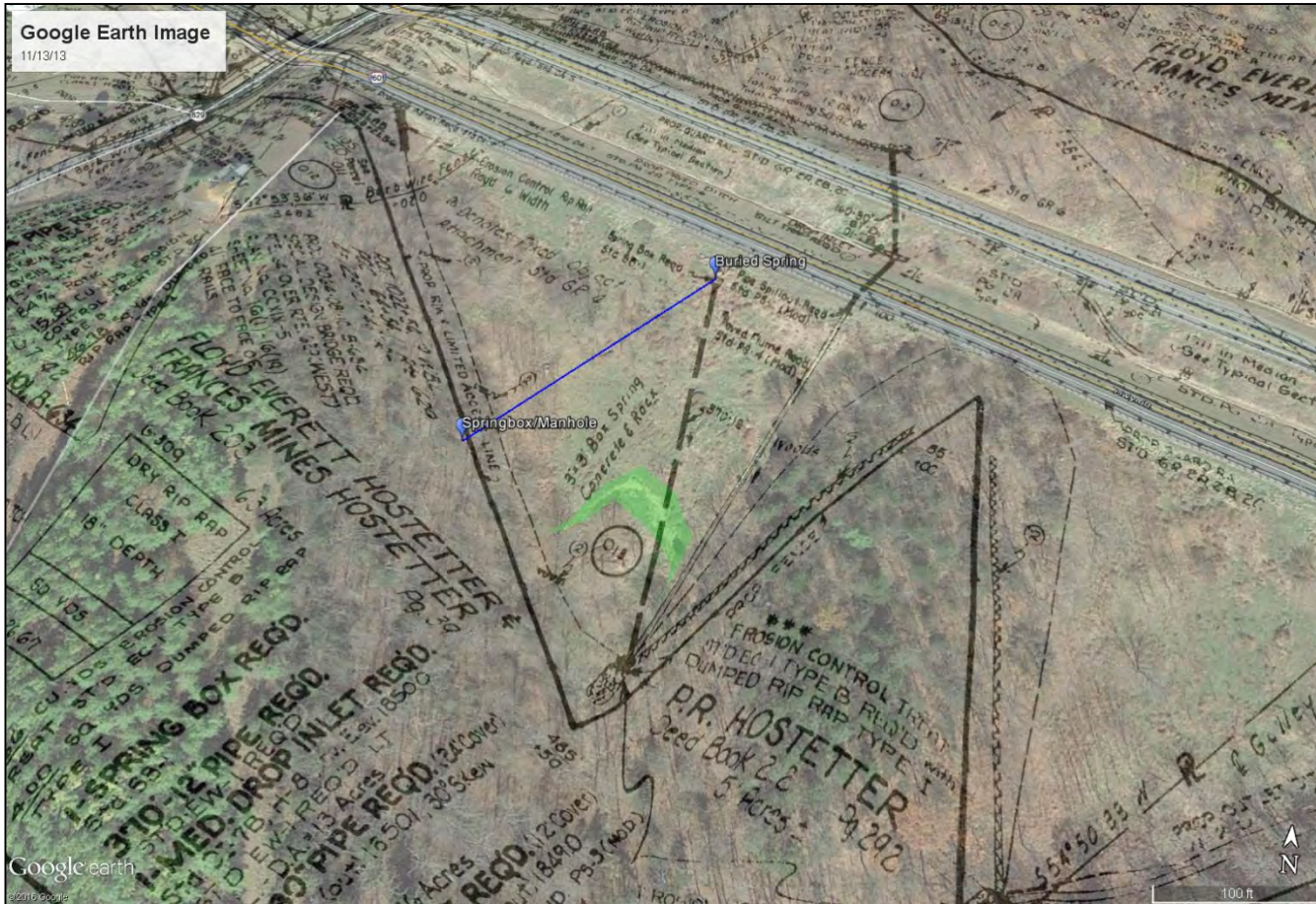
Lower Buttress



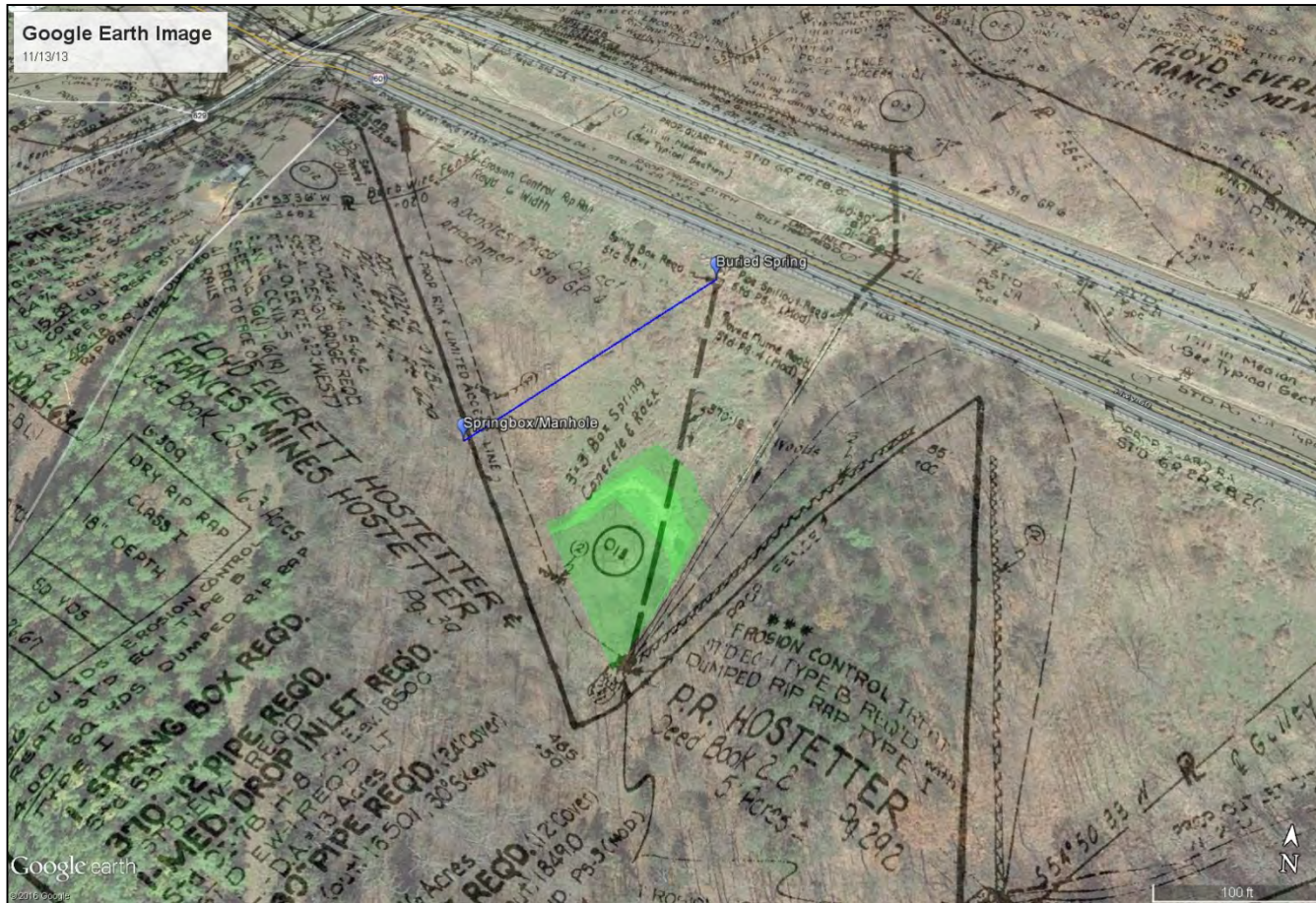
Slope Stability Results

Concept	Back-Calculated Shear Strength ($\phi' = 30^\circ$)	
	Factor of Safety	Rough Cost
Existing Slope	1.02	NA
Improved Drainage	1.08	NA
Full Buttress *	1.36	\$3,000,000±
Soil Nails on Existing Slope, with Lower Buttress **	1.30	\$16,000,000±
Soil Nails on Benched Slope, with Lower Buttress **	1.34	\$5,500,000±
Lower Buttress Only	1.15 (1.32)	\$2,000,000±
Soil Nails in Scarp Only (3 ft. spacing)	1.15 (1.18)	\$600,000±
* – 1.5:1 Buttress for stratified cross-section. 2:1 Buttress for $f' = 30^\circ$.		
** – 3 ft. spacing for stratified cross-section. 5 ft. spacing for $f' = 30^\circ$.		
() – Global Factor of Safety.		

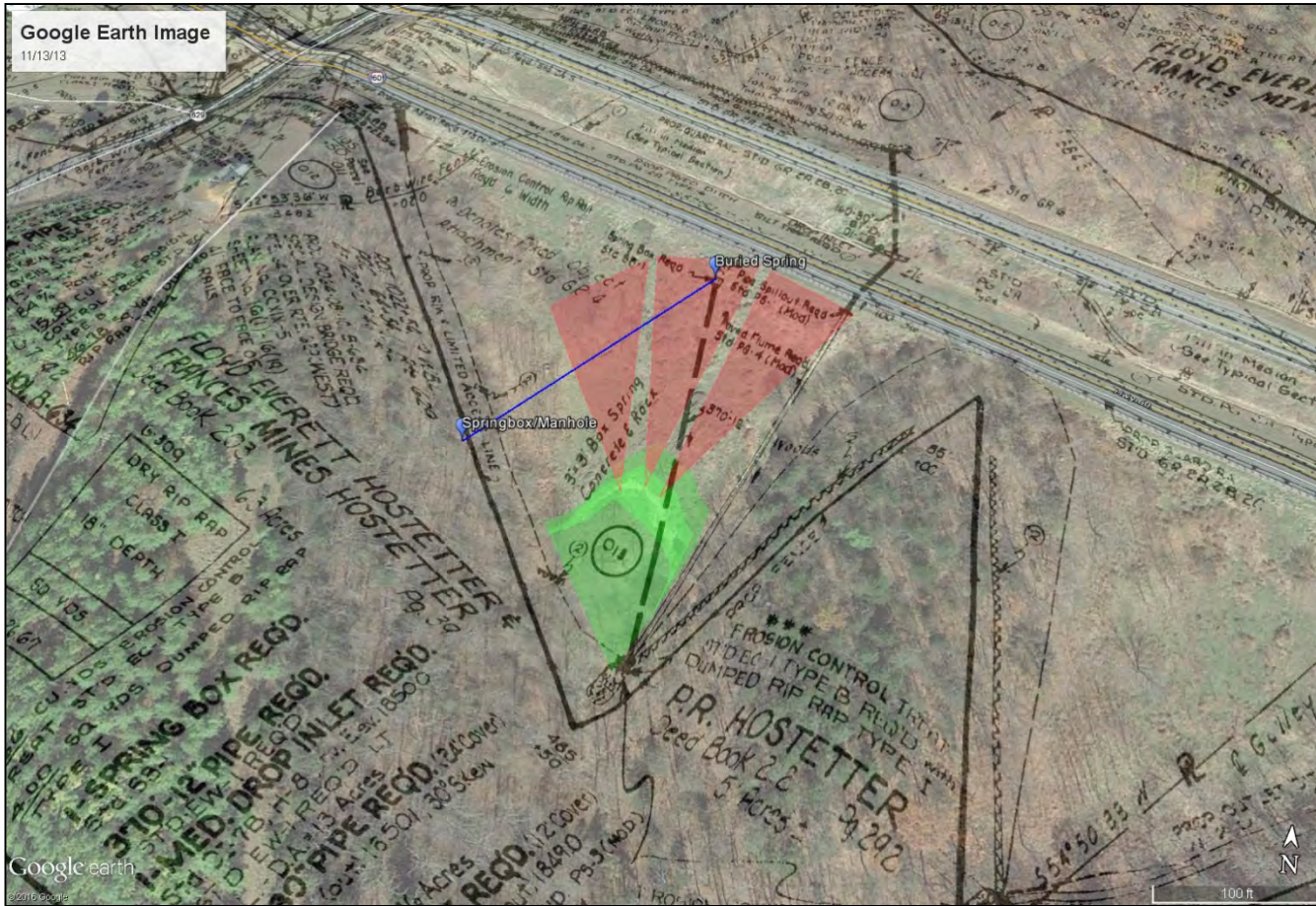
Scarp



Buttress



Horizontal Drains



Buttress Construction



Buttress Construction



Buttress Construction



Horizontal Drains



Horizontal Drains



Horizontal Drains



Horizontal Drains



Horizontal Drains



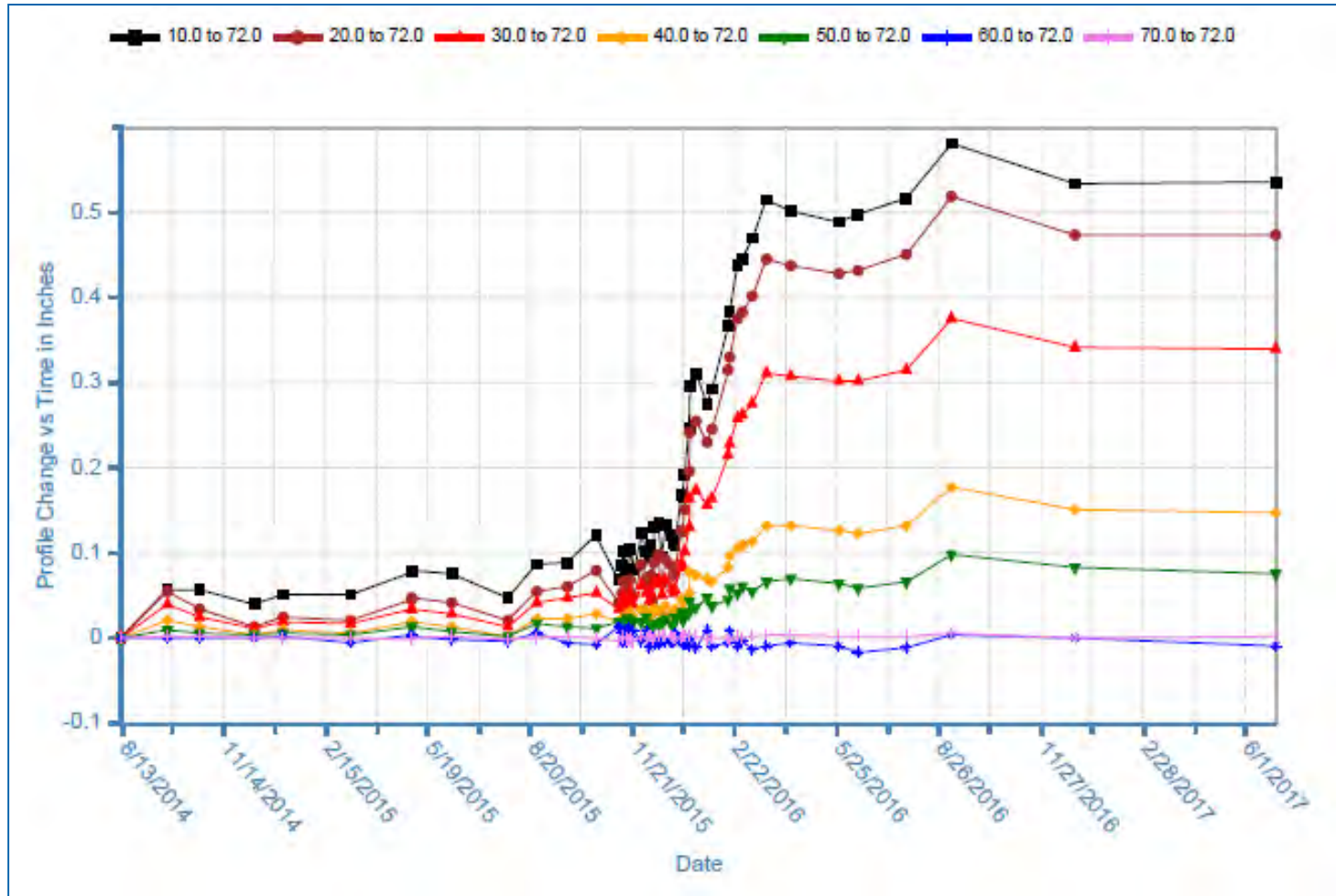


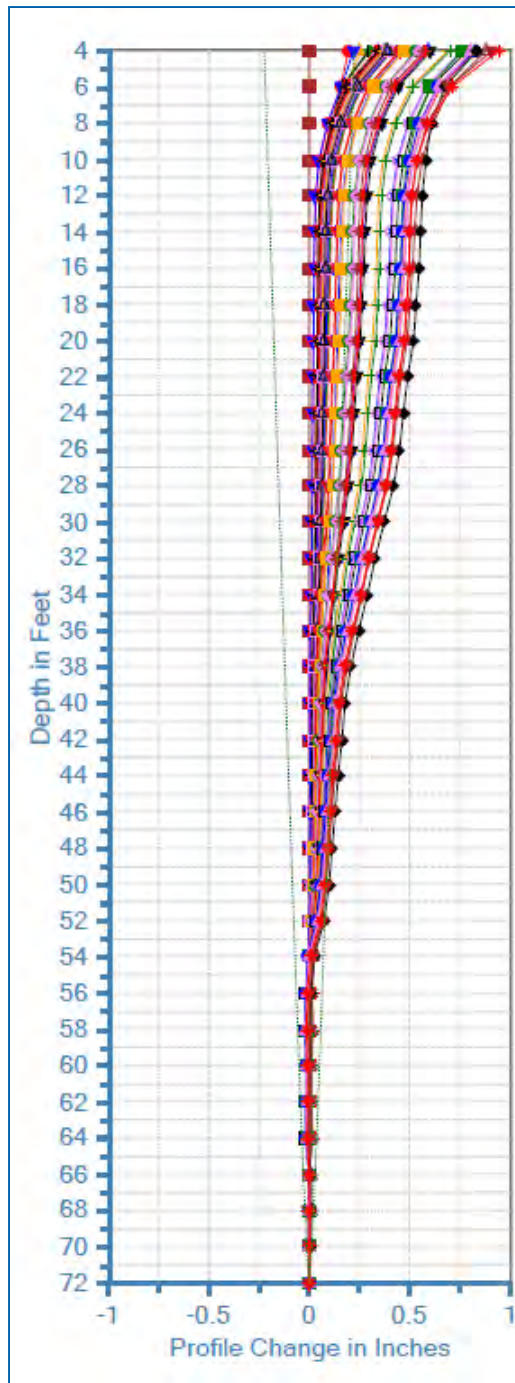


Horizontal Drains



Monitoring





Questions?

