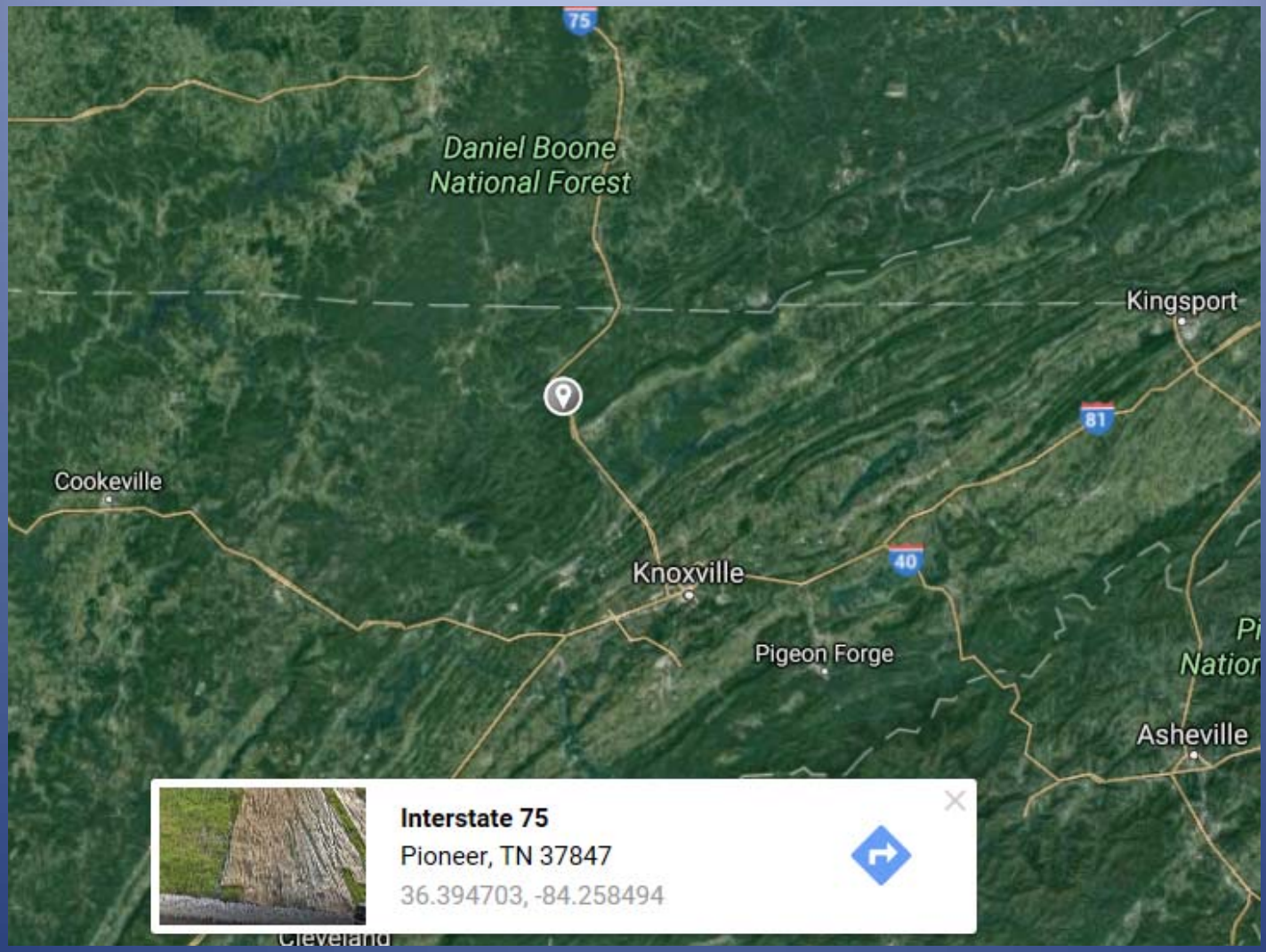
Block Slide/Rockfall on I-75 Campbell County, TN

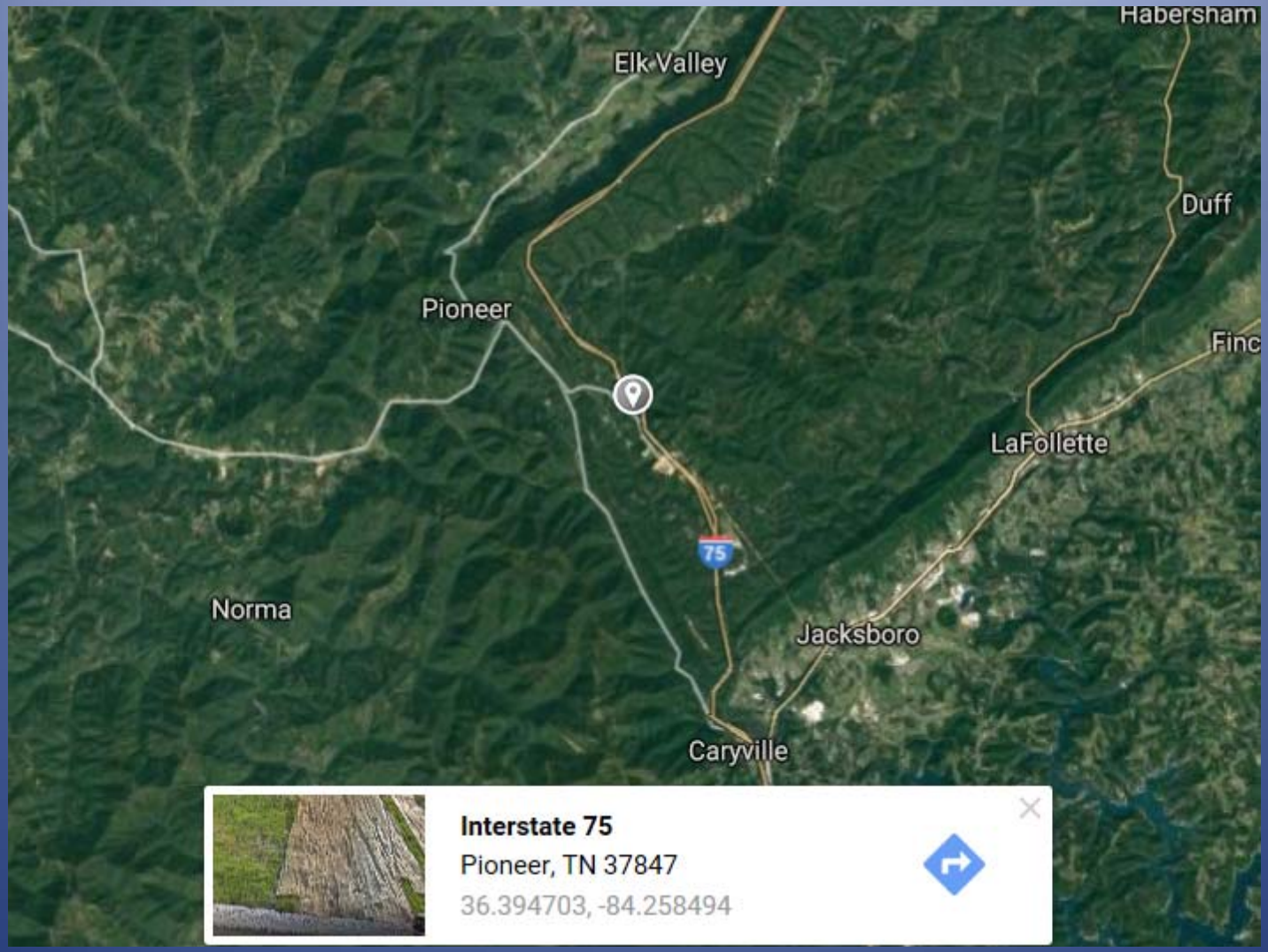
David Barker, PE

Tennessee DOT

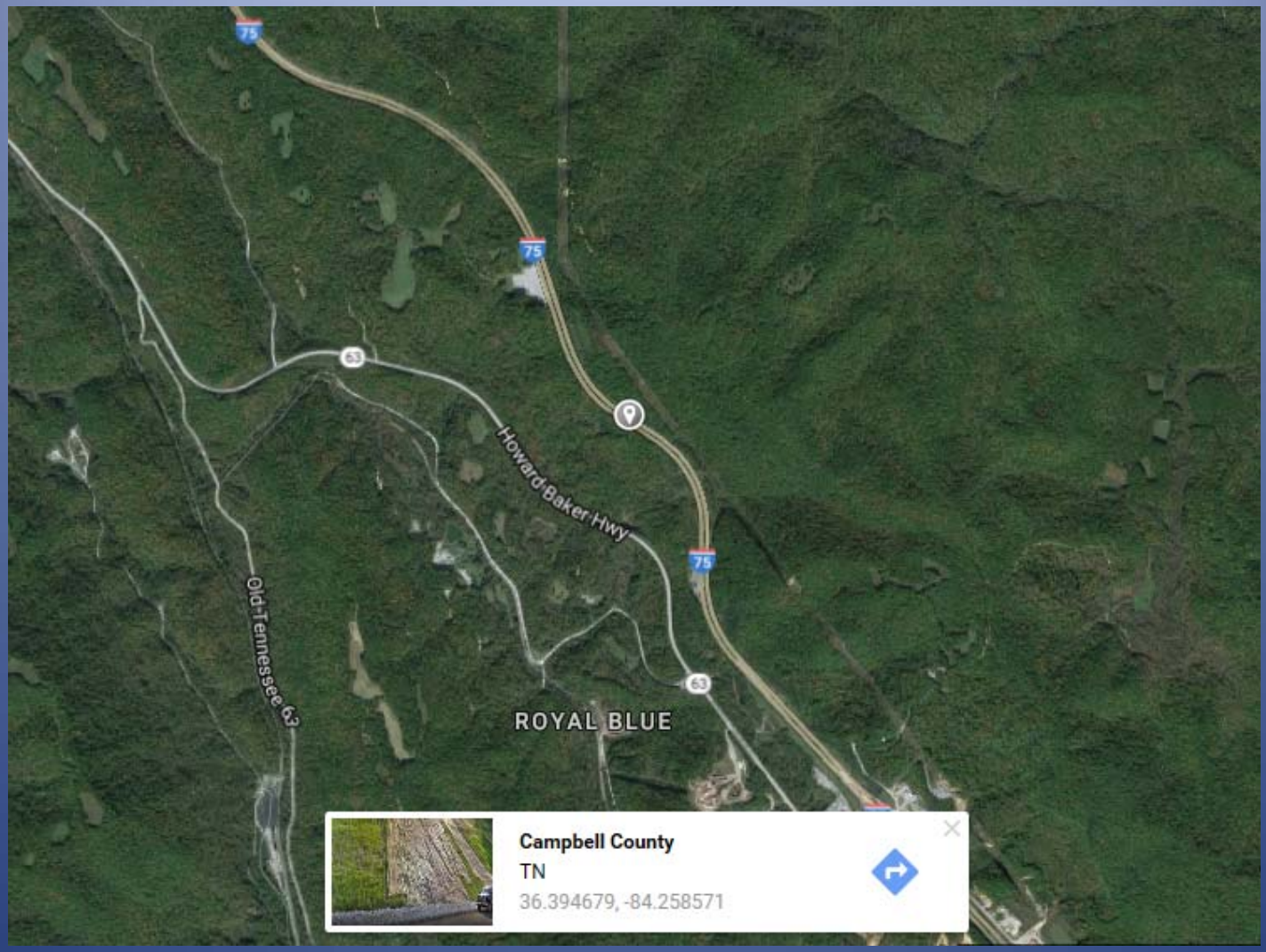
February 26, 2016



Location of Slide



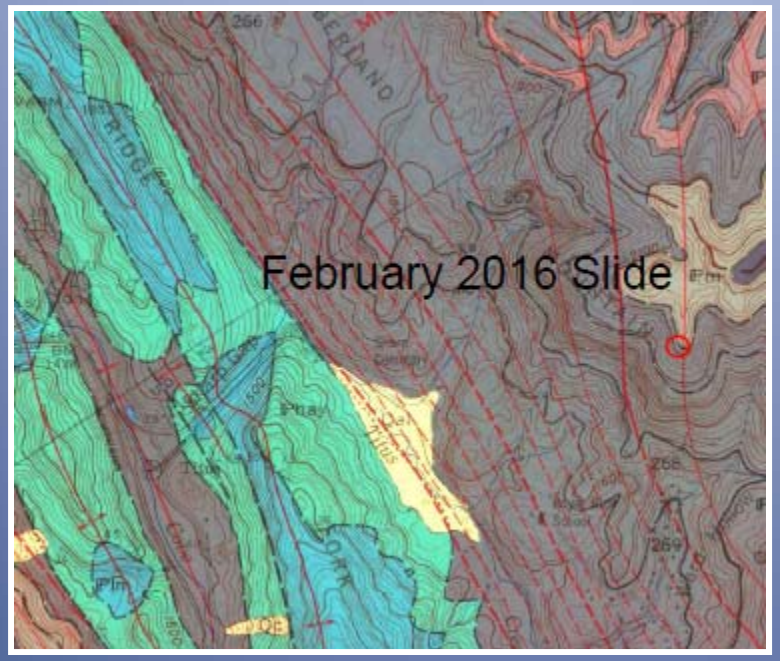
Location of Slide

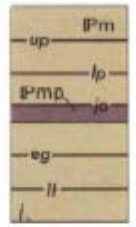

75
75
63
Howard Baker Hwy
75
63
Old Tennessee 63
ROYAL BLUE
Campbell County
TN
36.394679, -84.258571


75

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

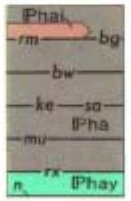
PROFESSIONAL PAPER 572
PLATE 3





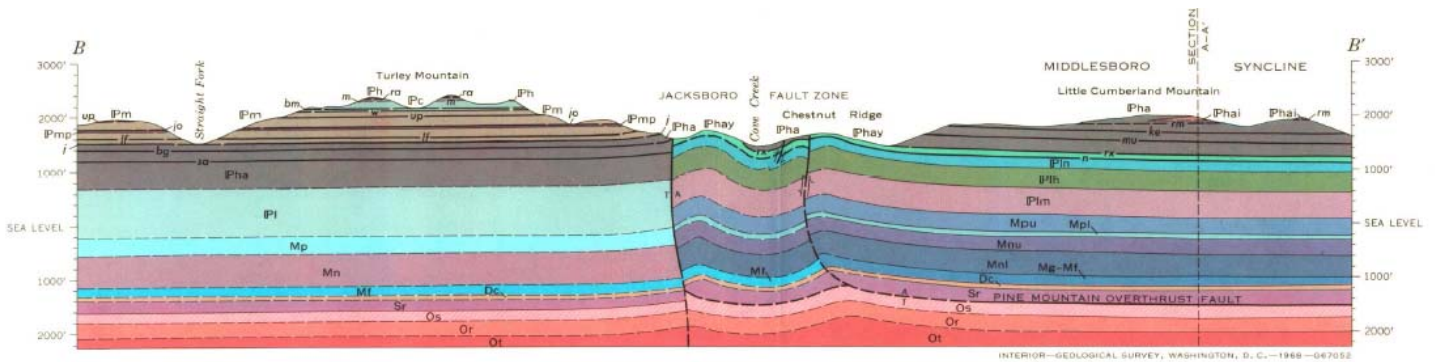
Mingo Formation

up, *Upper Pioneer coal bed*
lp, *Lower Pioneer coal bed*
jo, *Jordan coal bed*
IPmp, *Pioneer Sandstone Member*
eg, *Elk Gap coal bed*
lf, *Lick Fork coal bed*
j, *Jellico coal bed*

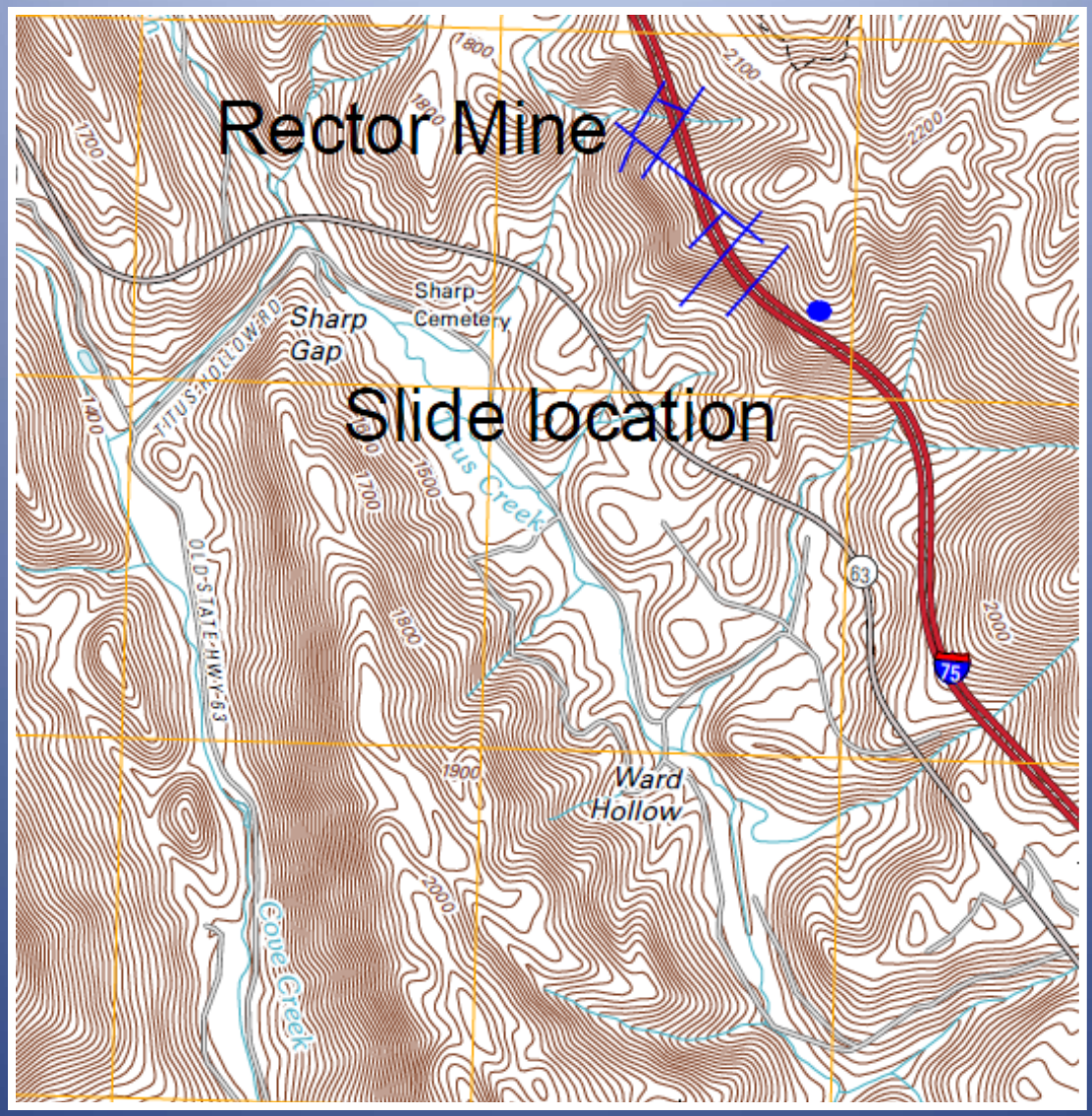


Hance Formation

IPhai, *Ivydell Sandstone Member*
rm, *Rich Mountain coal bed*
bg, *Blue Gem coal bed*
bw, *Black Wax coal bed*
ke, *Kent coal bed*
sa, *Swamp Angel coal bed; shown in section only*
mu, *Murray coal bed*
rx, *Rex coal bed*
IPhay, *Yellow Creek Sandstone Member*
n, *Nuese coal bed*



GEOLOGIC MAP AND SECTIONS OF THE PIONEER QUADRANGLE, TENNESSEE

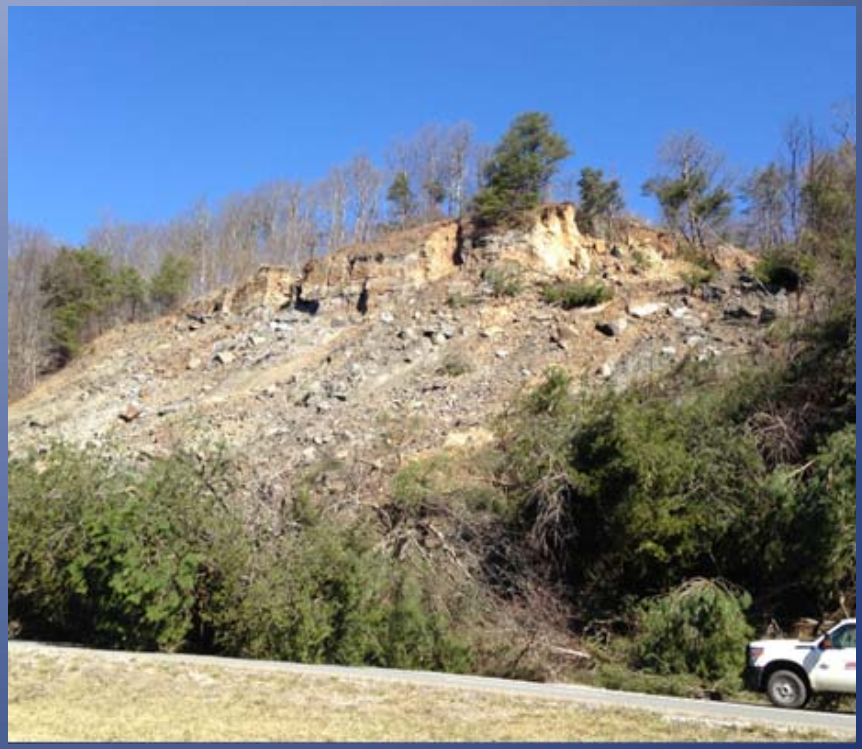


Portion of the Pioneer 7 1/2 ‘ Quadrangle

February 26, 2016

February 27, 2016

Before and After



February 28, 2016

Sunday after slide

February 28, 2016

Toe of sliding block looking south

Head scarp/top of release joint/high wall

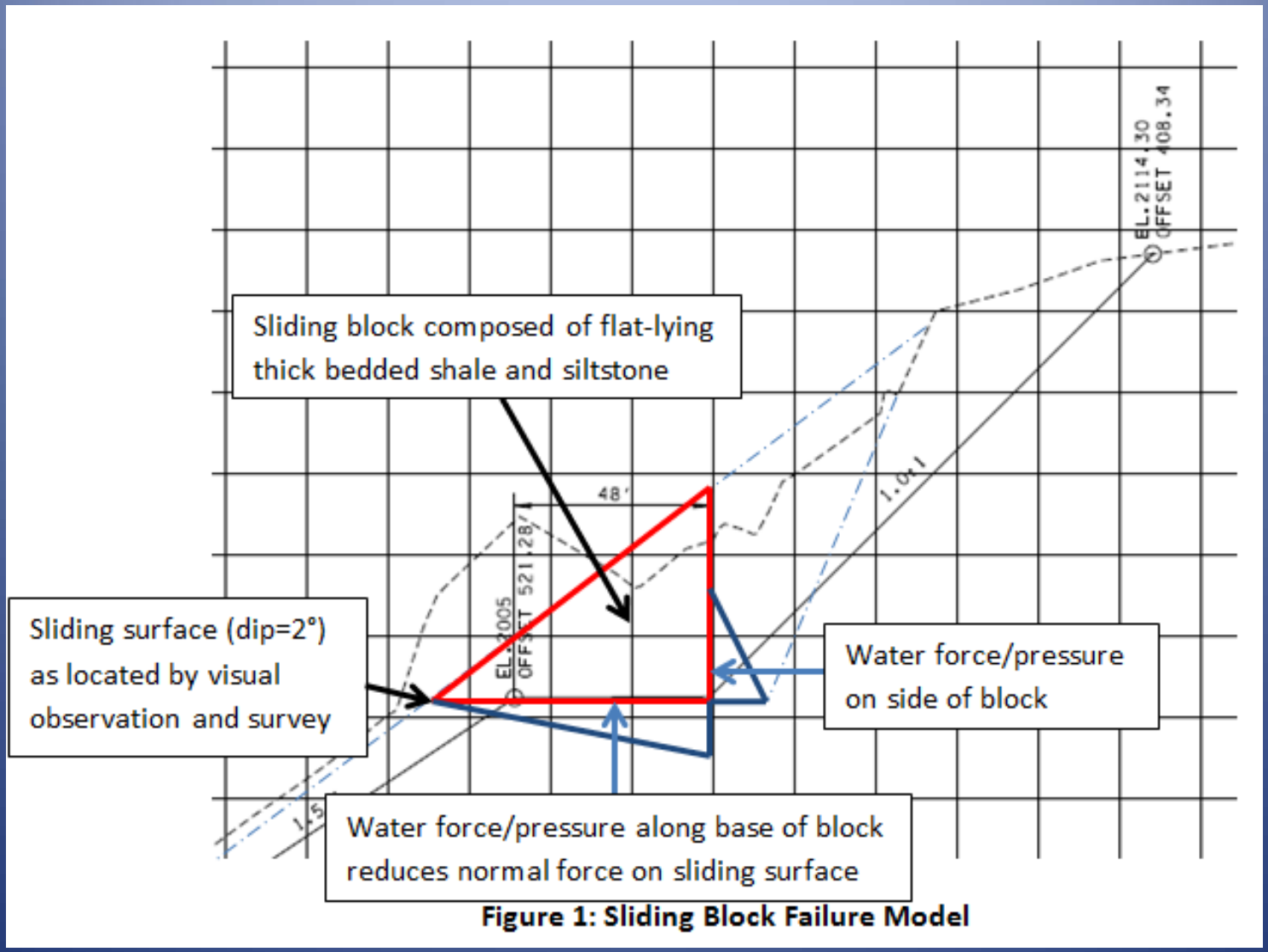


Figure 1: Sliding Block Failure Model

Low angle sliding block

Characteristics of Block

- Large – Approximately 90 feet thick/high along near-vertical release joint
- Near horizontal bedding, dipping toward roadway at 5 degrees or less
- Very low shear strength failure surface; coal seam or highly weathered clay shale
- Water assumed in vertical joint, pressure in joint and along base at time of failure unknown
- Well-defined sliding surface, shear strength of surface to be back-calculated

What has changed since the slope was built?

Clear cutting along transmission lines that removed undergrowth?
Increased precipitation? Progressive weathering of clay shale seam?

How did block travel so far? Momentum? Debris collapsing at release joint pushed outer material over slope?

To stabilize intact material below transmission lines

Anchor and shotcrete projection of exposed joint

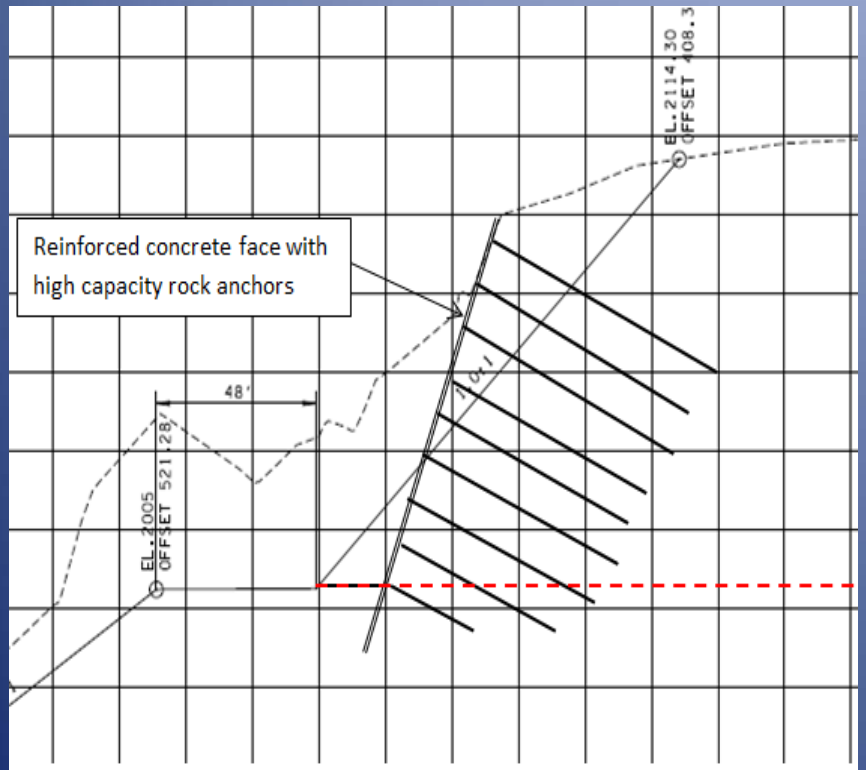


Figure 3: Cross section at Station 106+50 with anchored wall along scarp

Passive anchors/nails and wire mesh over 1:1 slope

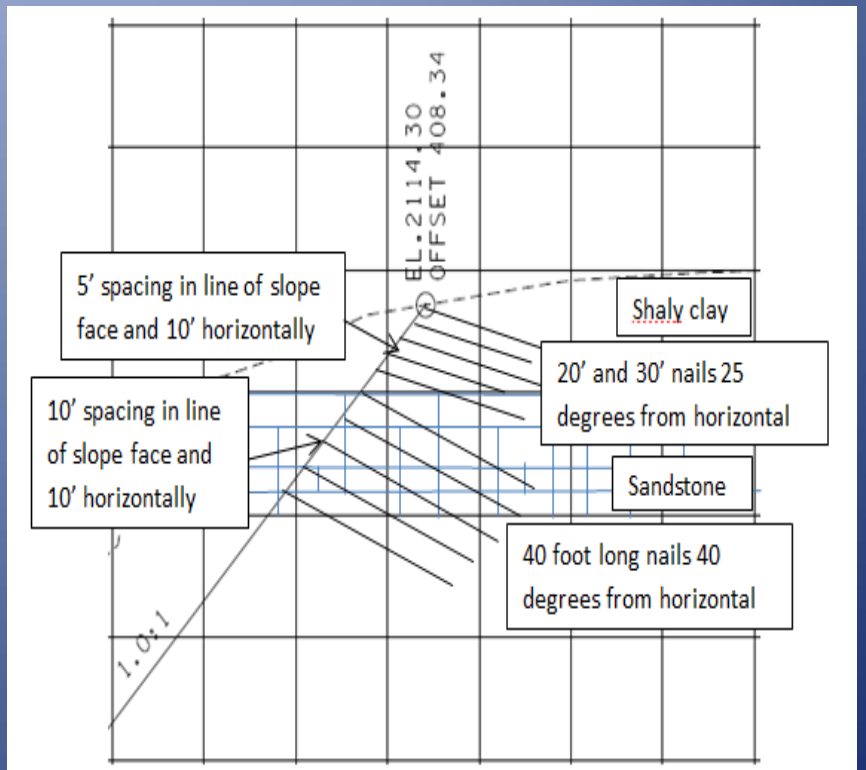


Figure 6: Cross Section of proposed nail/anchor configuration at top of 1:1 slope

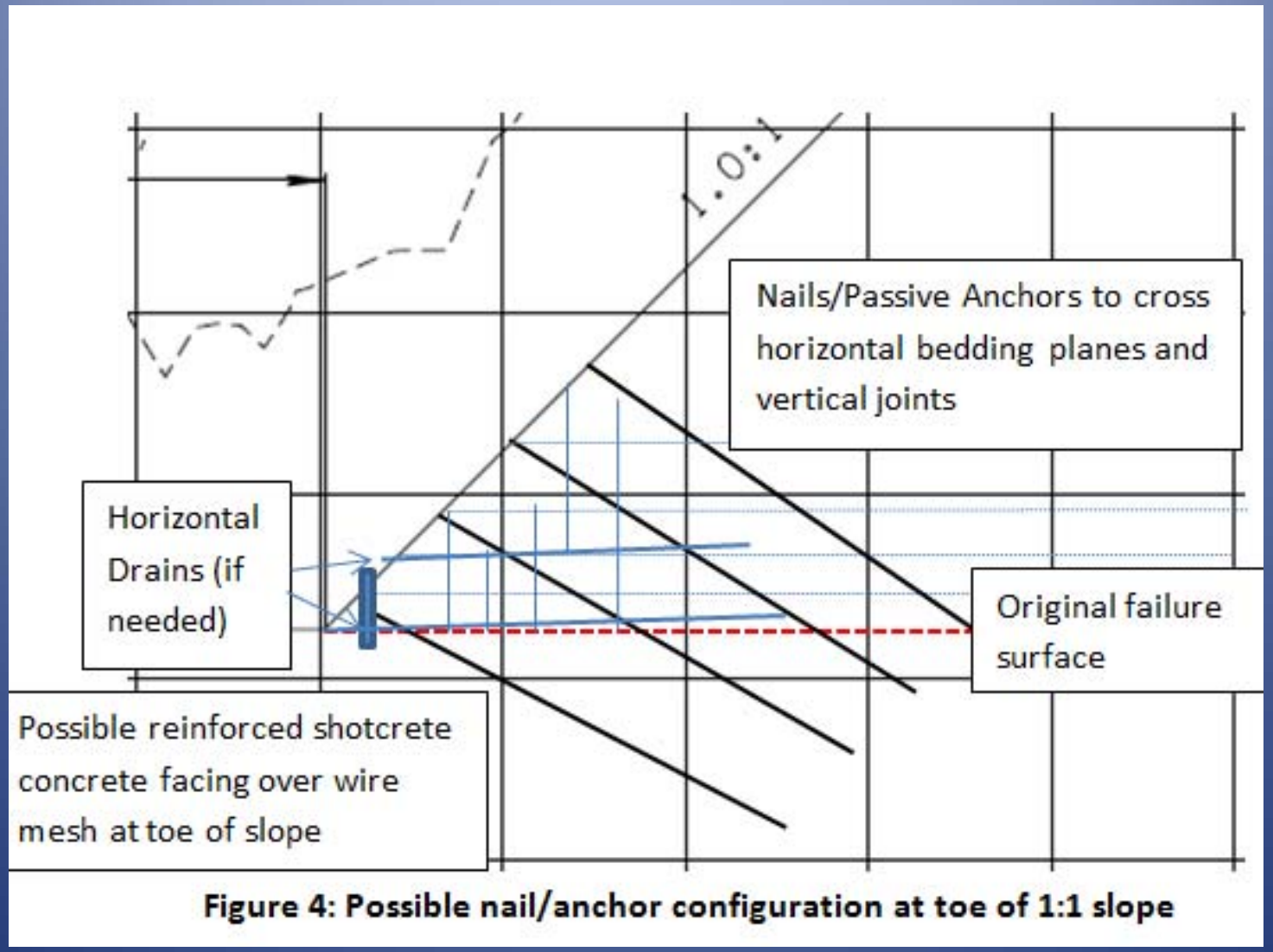


Figure 4: Possible nail/anchor configuration at toe of 1:1 slope

Anchors/Nails installed at steeper angles to act in shear as well as tension

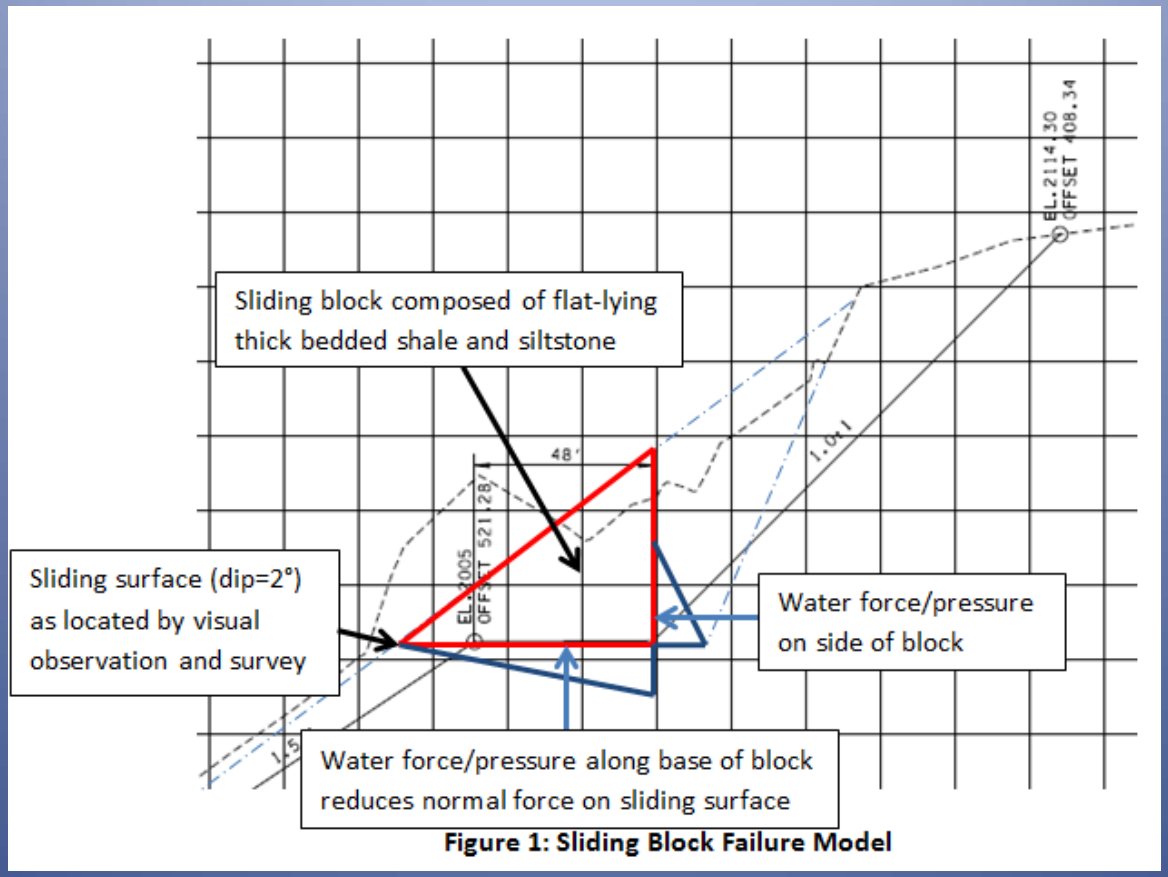
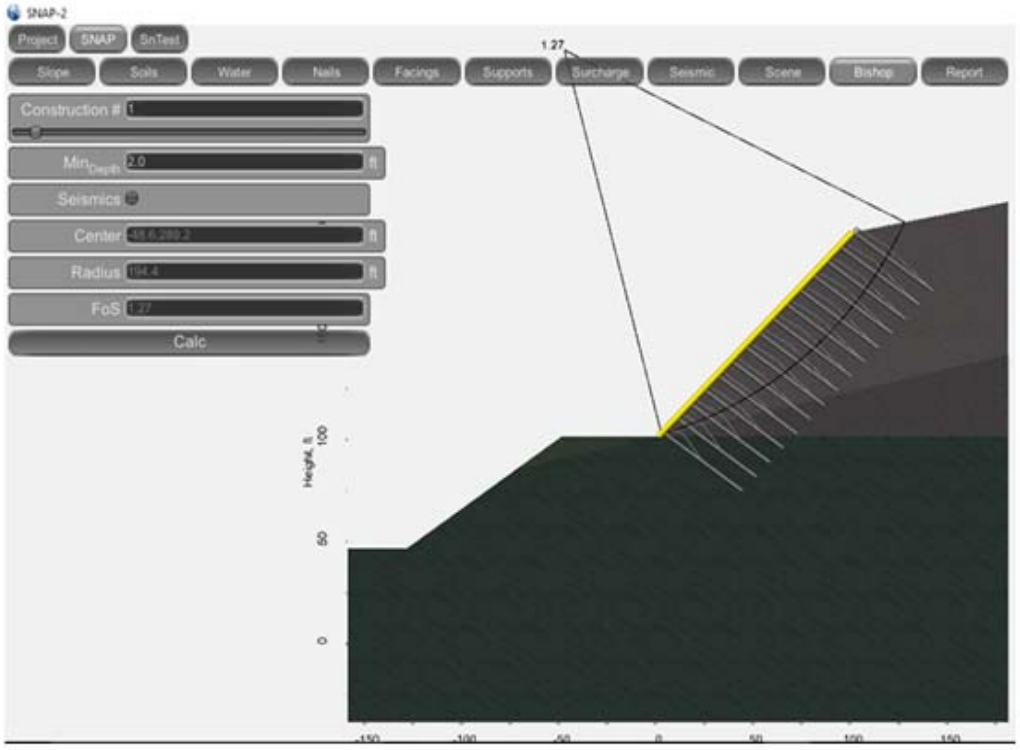


Figure 1: Sliding Block Failure Model

Analysis and Assessment of Failure Mode(s)

Sliding block movement along failure surface of known location, orientation and extent, back-calculated shear strength and assumed water conditions



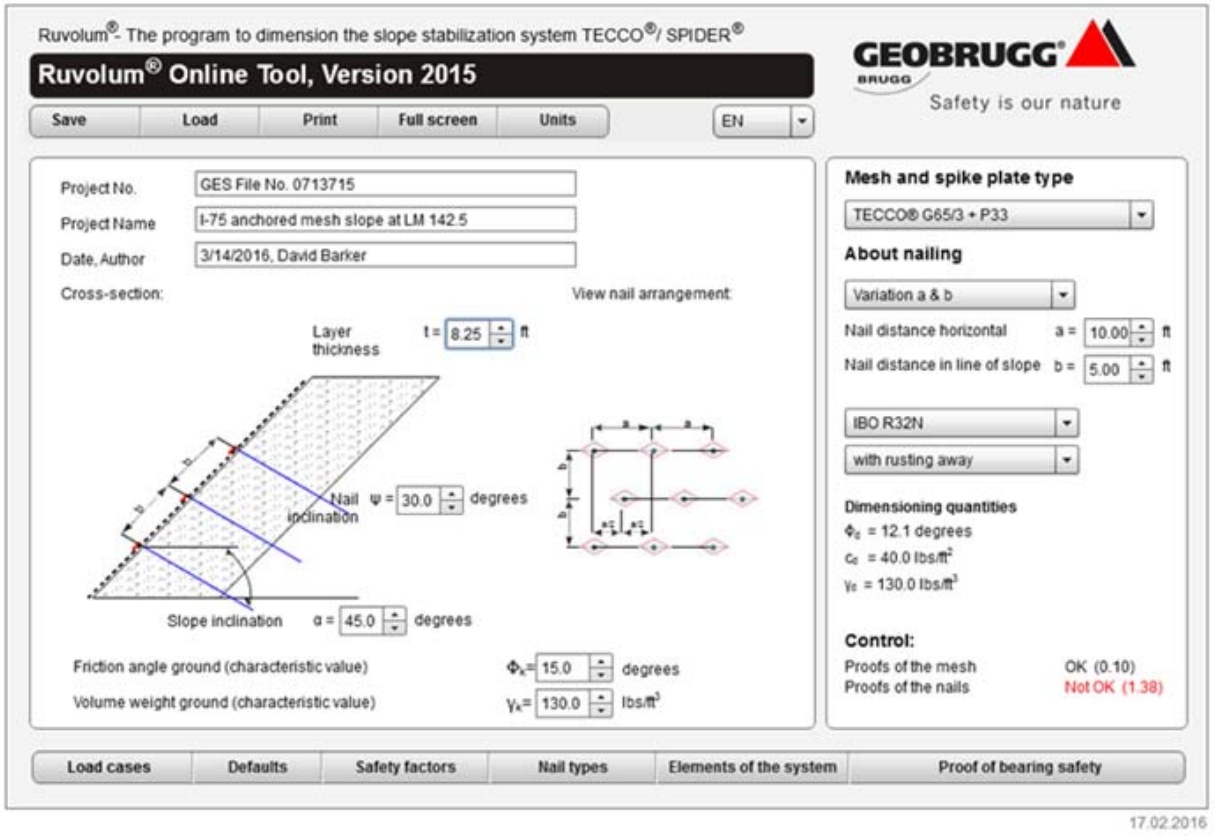
Modified Bishop Global Stability – Location of lowest FOS surface

It should be noted that decreasing the nail spacing/increasing the number of nails reduced the nail head force calculation but did not increase the Global FOS.

Analysis Tools

SNAP-2

Excerpt from memo dated March 15



Ruvolum online tool display

Analysis Tools

Ruvolum for analysis of material after weathering, shallow surface

Excerpt from memo dated March 15

March 3, 2016 - Removal of front of sliding block

March 4, 2016 - Removal of slide debris from slope

March 8, 2016, excavation of shaly clay at top of slope

Debris removal continues

March 10, 2106, southbound lanes open

March 15, 2016, release joint exposed/intercepted

Slope on March 18, 2016

Preparing to anchor and shotcrete lower slope 3/23/16

Northbound lanes reopened after construction of temporary lanes in median and removal of the least stable debris 3/26/16

Sandstone layers near top of slope, note dip of strata

March 28, insertion of anchors for combination shotcrete/wire mesh covered slope

March 29, grouted anchors for combination shotcrete/wire mesh covered slope

Anchors after grouting, prior to shotcreting

Drain strips, wire mesh, #4 bars, plates and nuts installed

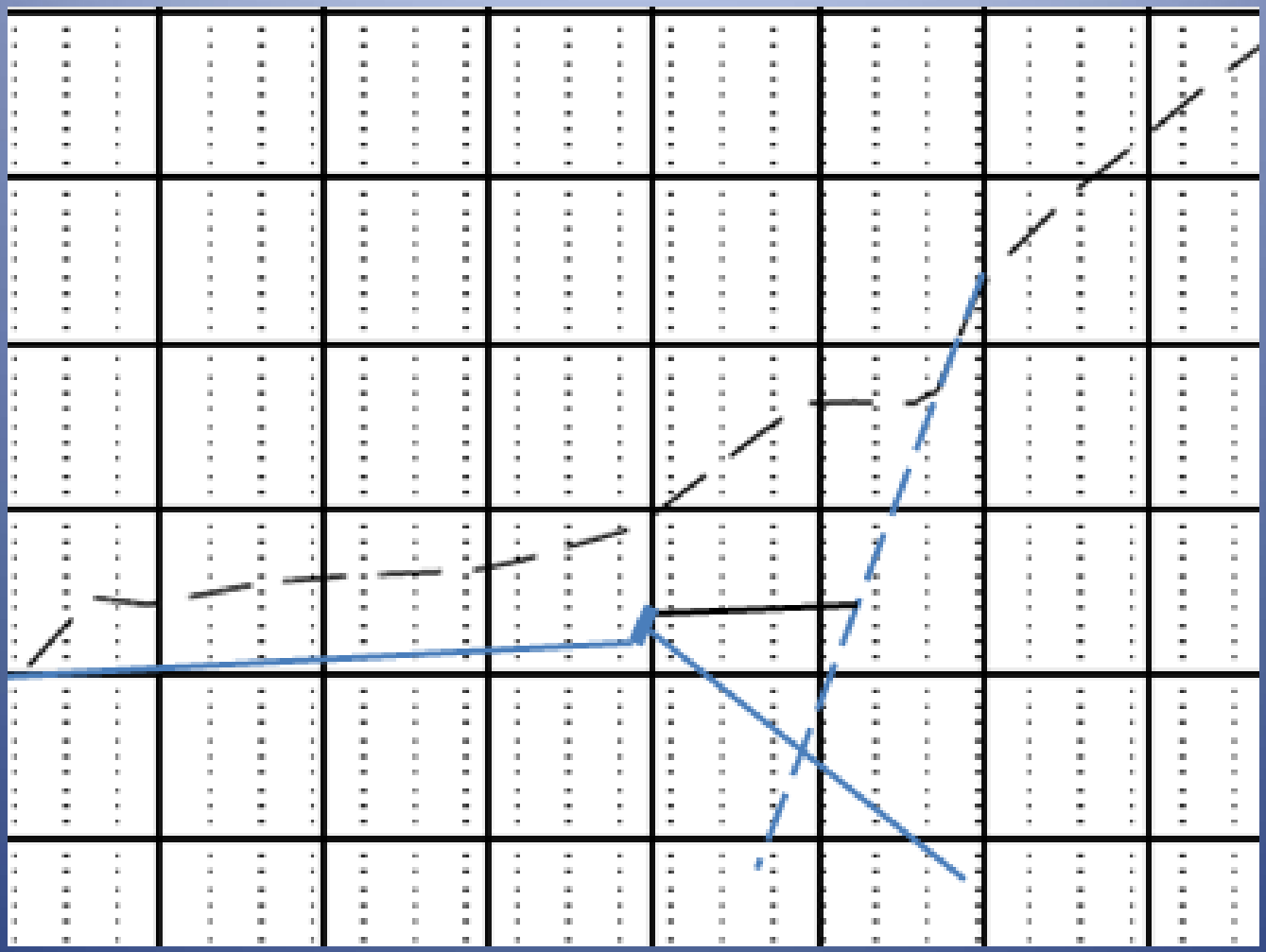
Slope after shotcrete application

Removal of slide debris from lower slope nearing completion April 13, 2015

Drilling for anchors in upper 1:1 slope

Installation of nails in shaly clay, note closer spacing

Placement erosion control matting prior to placement of wire mesh, May 23



Anchored grade beam installed in front of wall as alternative to continuing to excavation along release joint

Grade Beam in Place

Questions

How rare (or common) is this?

Can these sites be identified 20 to 50 years after construction and mature vegetation has been established?

What do we do about them? Flatten the slopes?, Install drains? Installed anchored grade beams?

What have other DOTs encountered?