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Landslide Stabilization
Blue Ridge Parkway MP 400.8

Brian K. Banks, PG
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STGEC
October 5, 2010

Outline

- Landslide history
- Field mapping data
- Slope stability analyses
- Landslide failure mechanism
- Remediation concepts
- “Final” design
- Construction progress

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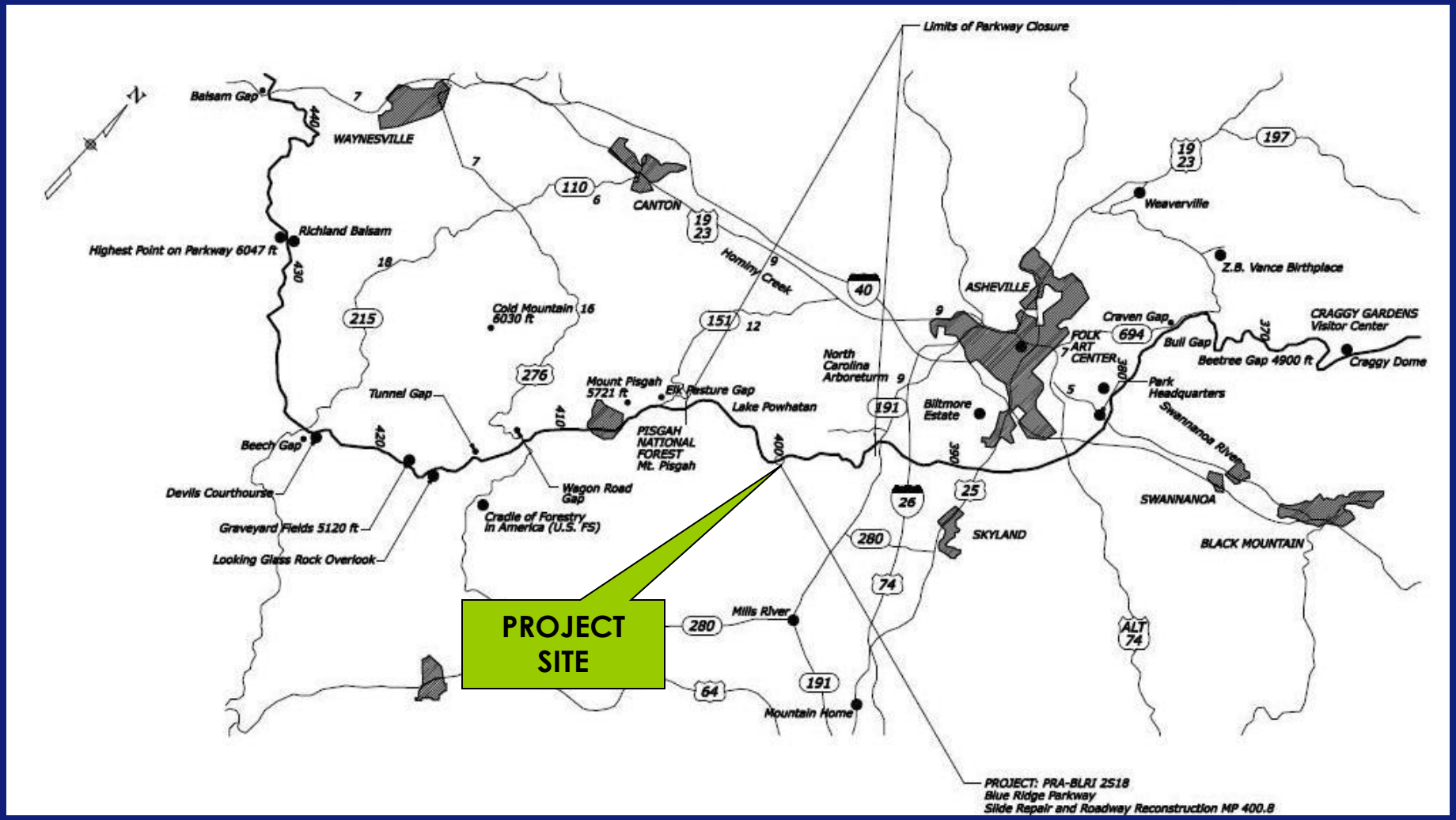
Site Location



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Landslide History

March 2002

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Initial Slope Repair

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Continued Movement

January 2009

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Bulging Pavement

January 2009

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Localized Rockfall

January 2009

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Tension Cracks

January 2009

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Tension Cracks

January 2009

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Tension Cracks

January 2009

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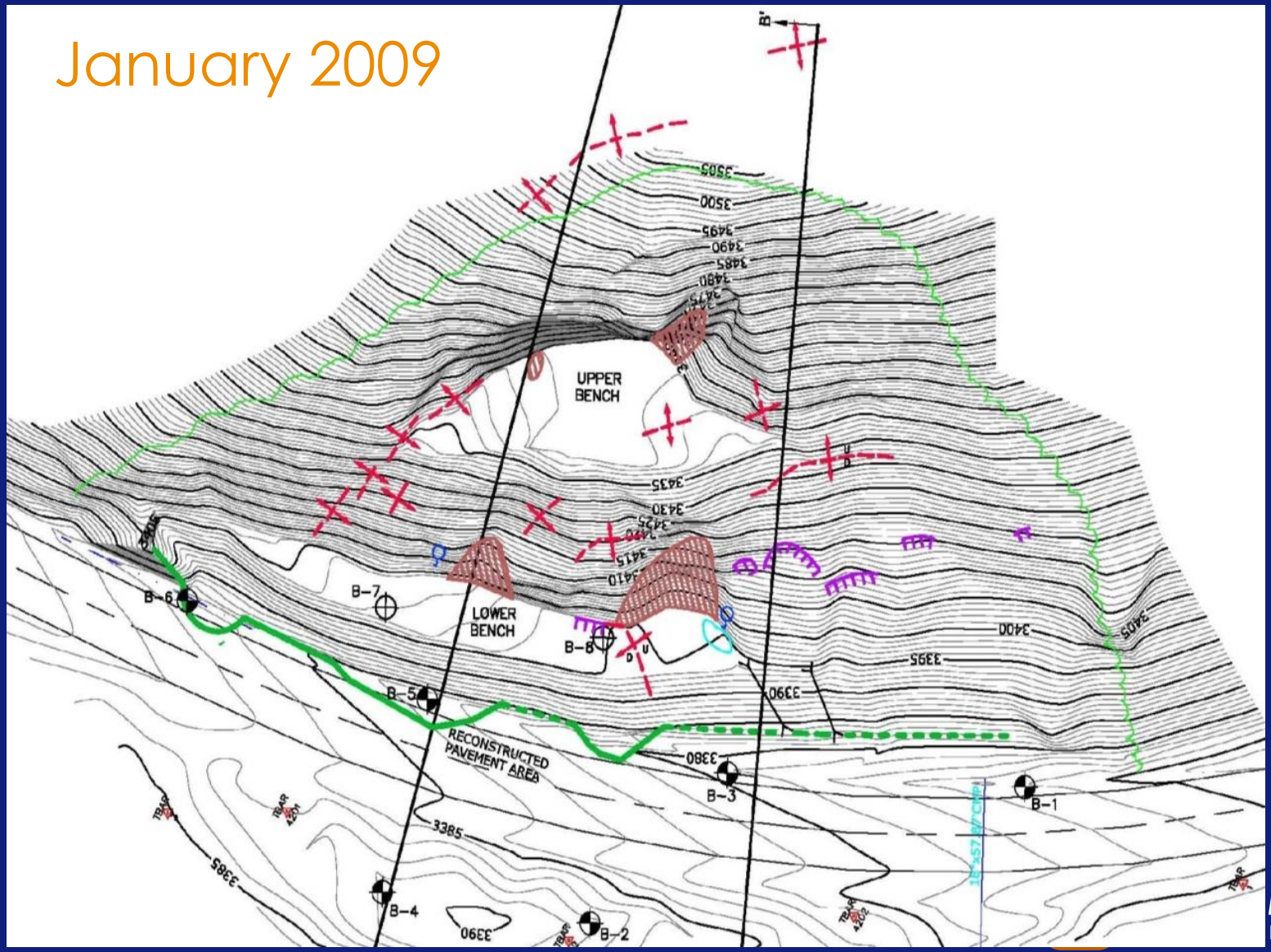
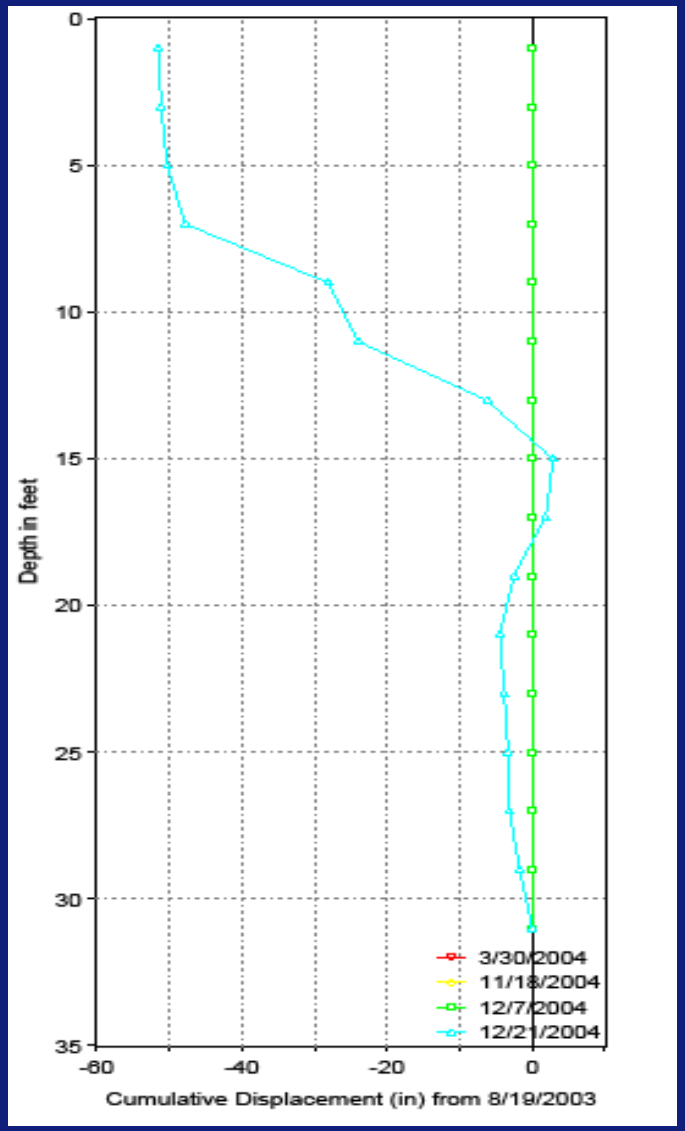
Field Mapping



Inclinometer Data

15 ft →



Weathered Rock

Competent Rock

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Rock Structure Mapping

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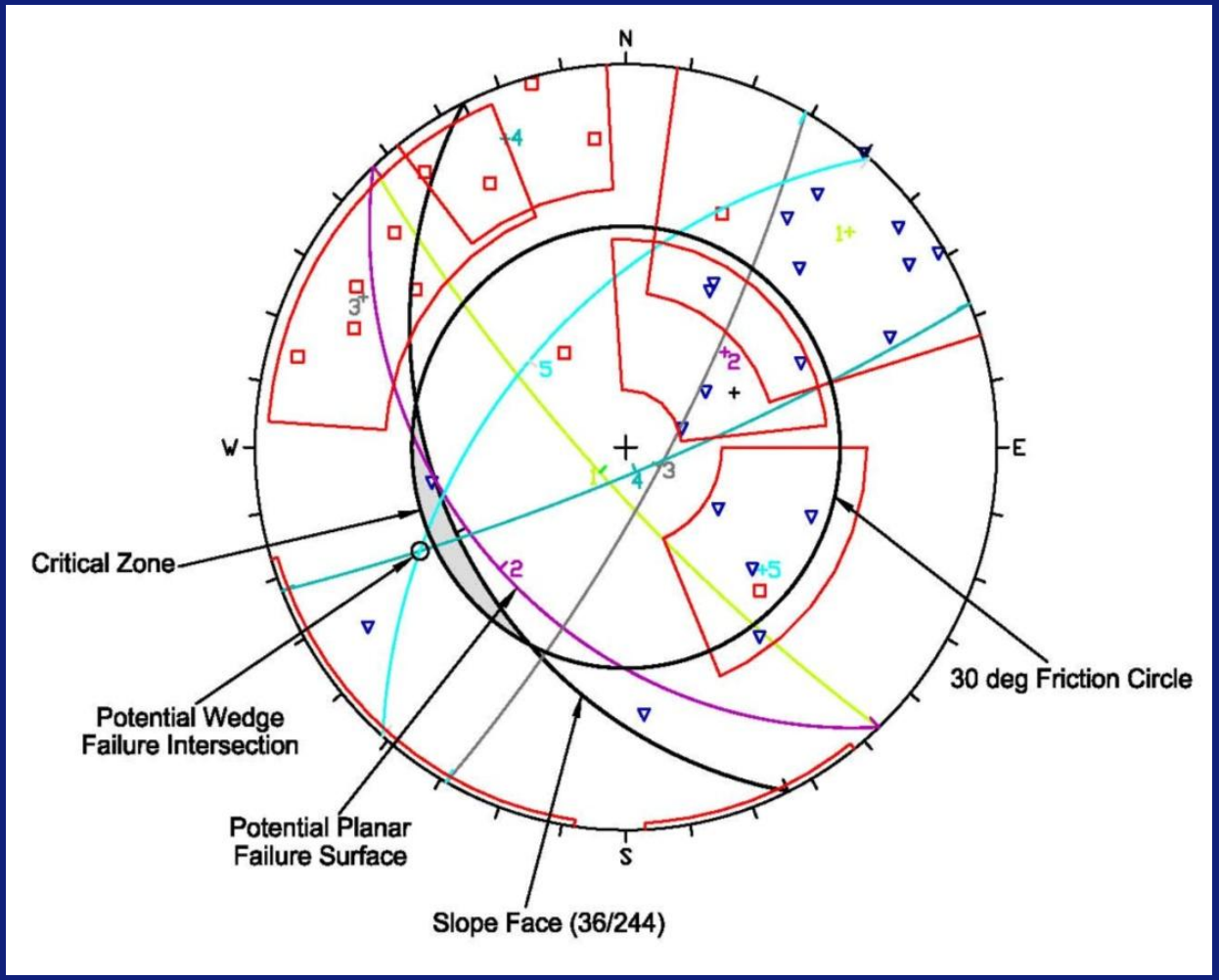
Stereonet



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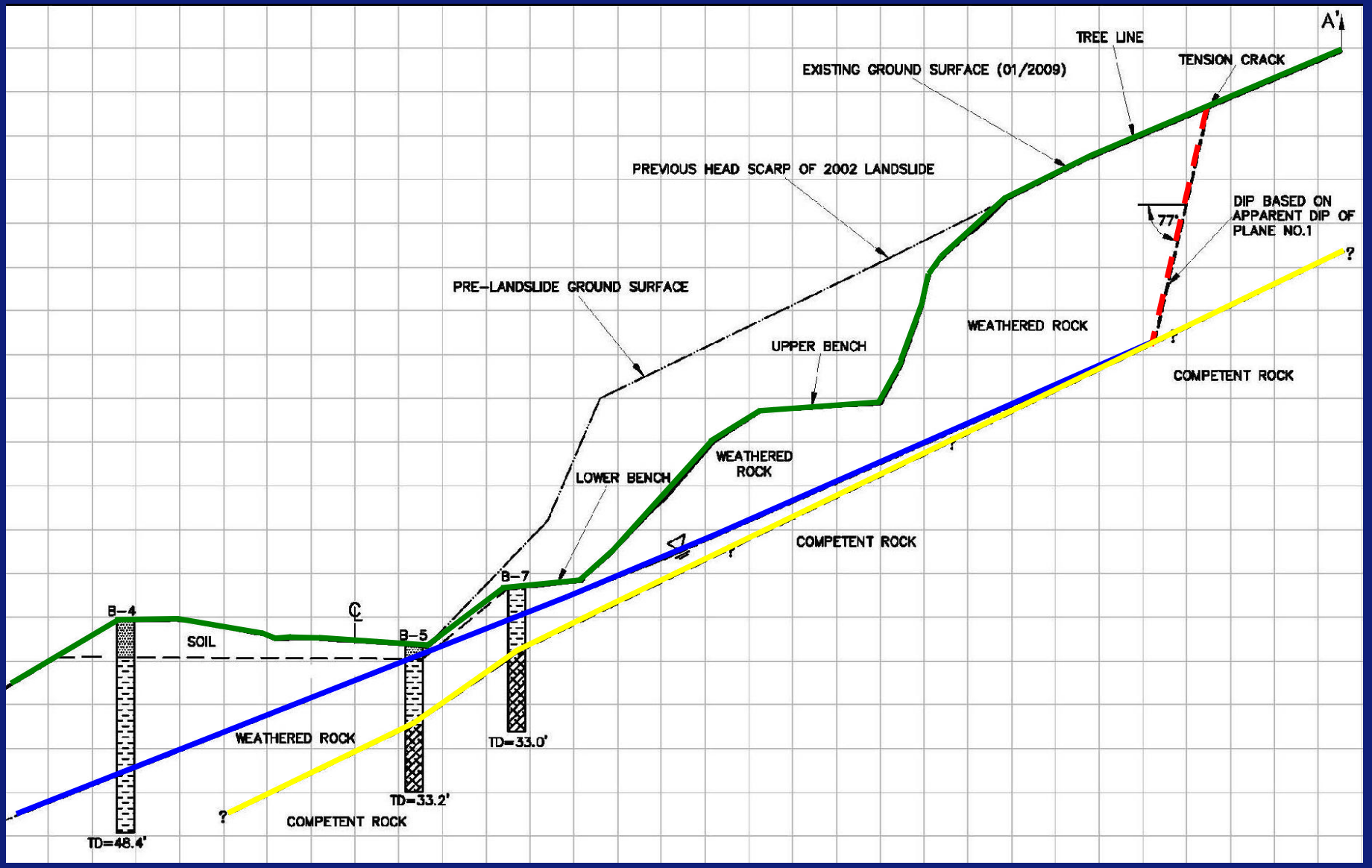
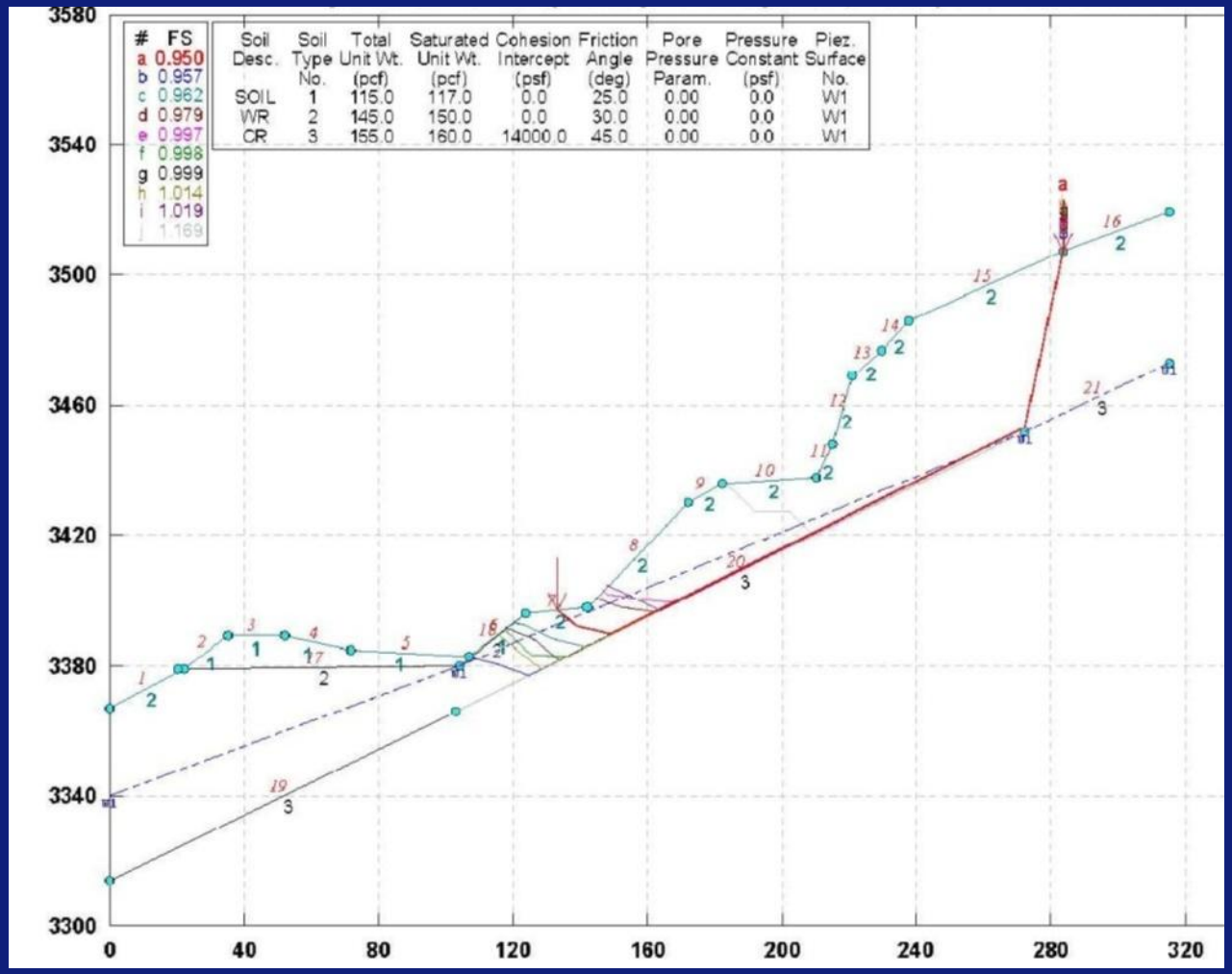
Failure Model



GSTABL7 Stability Analysis



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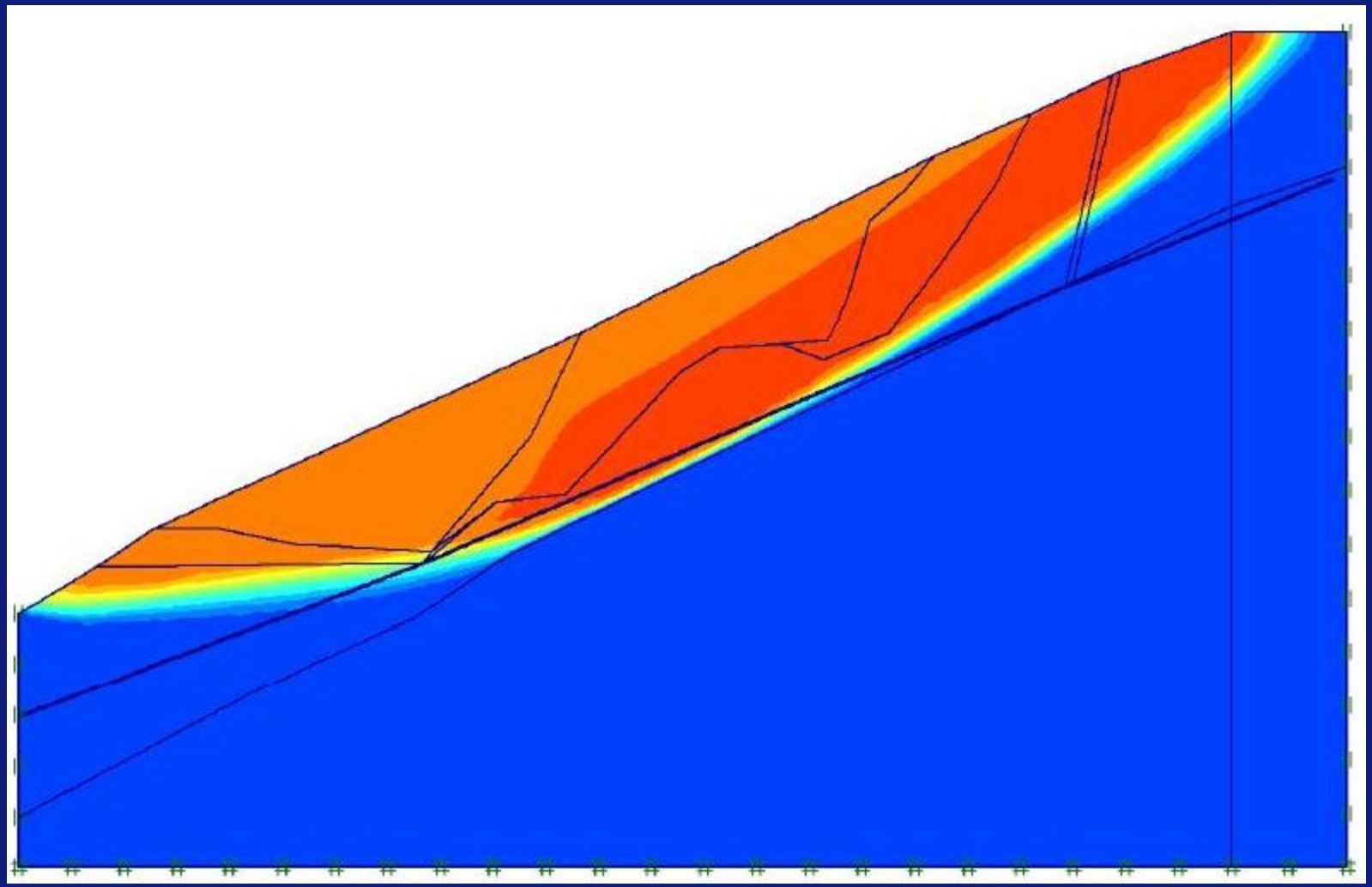
PLAXIS Stability Analysis



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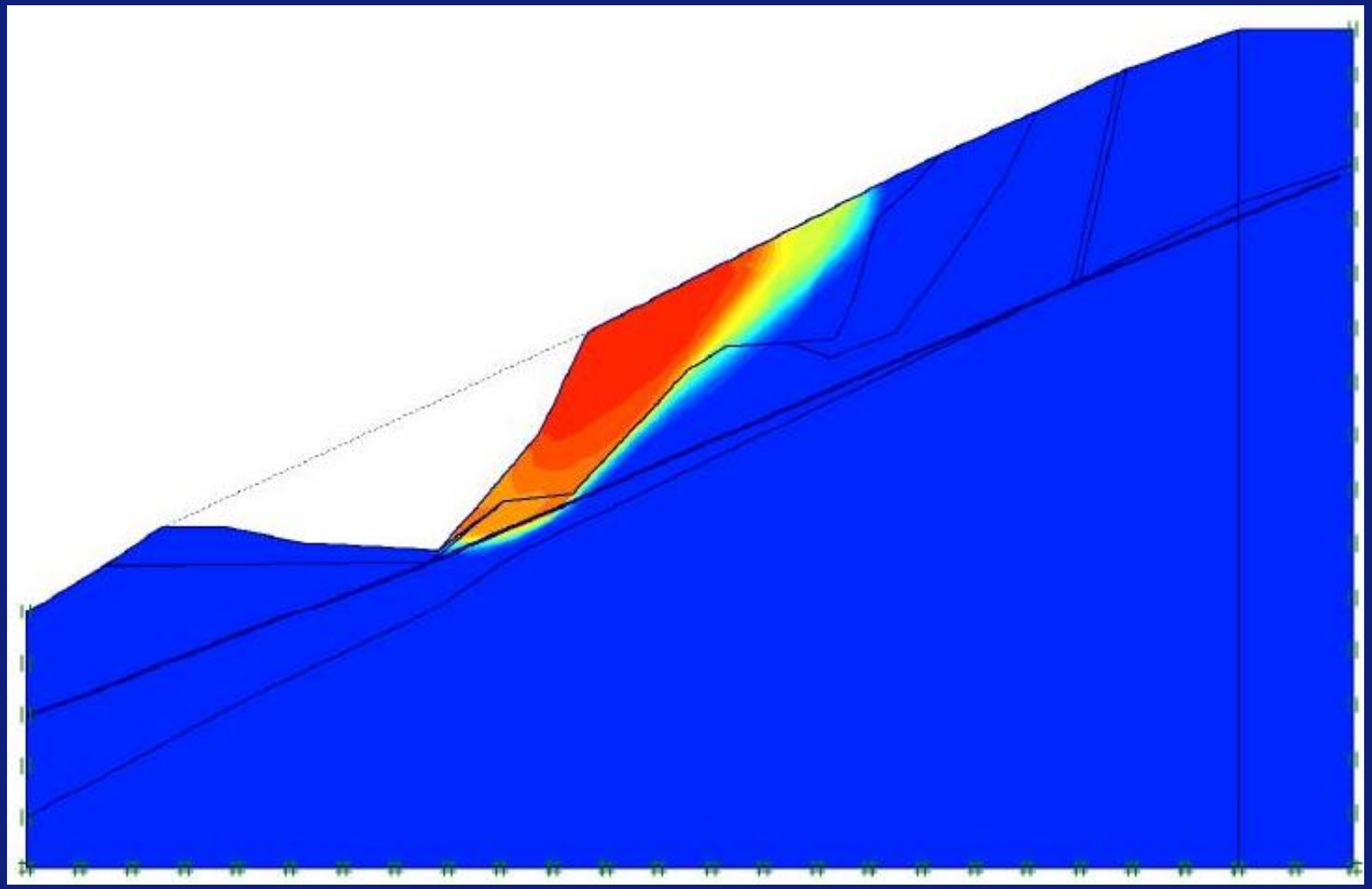
Stability of Initial Cut Slope



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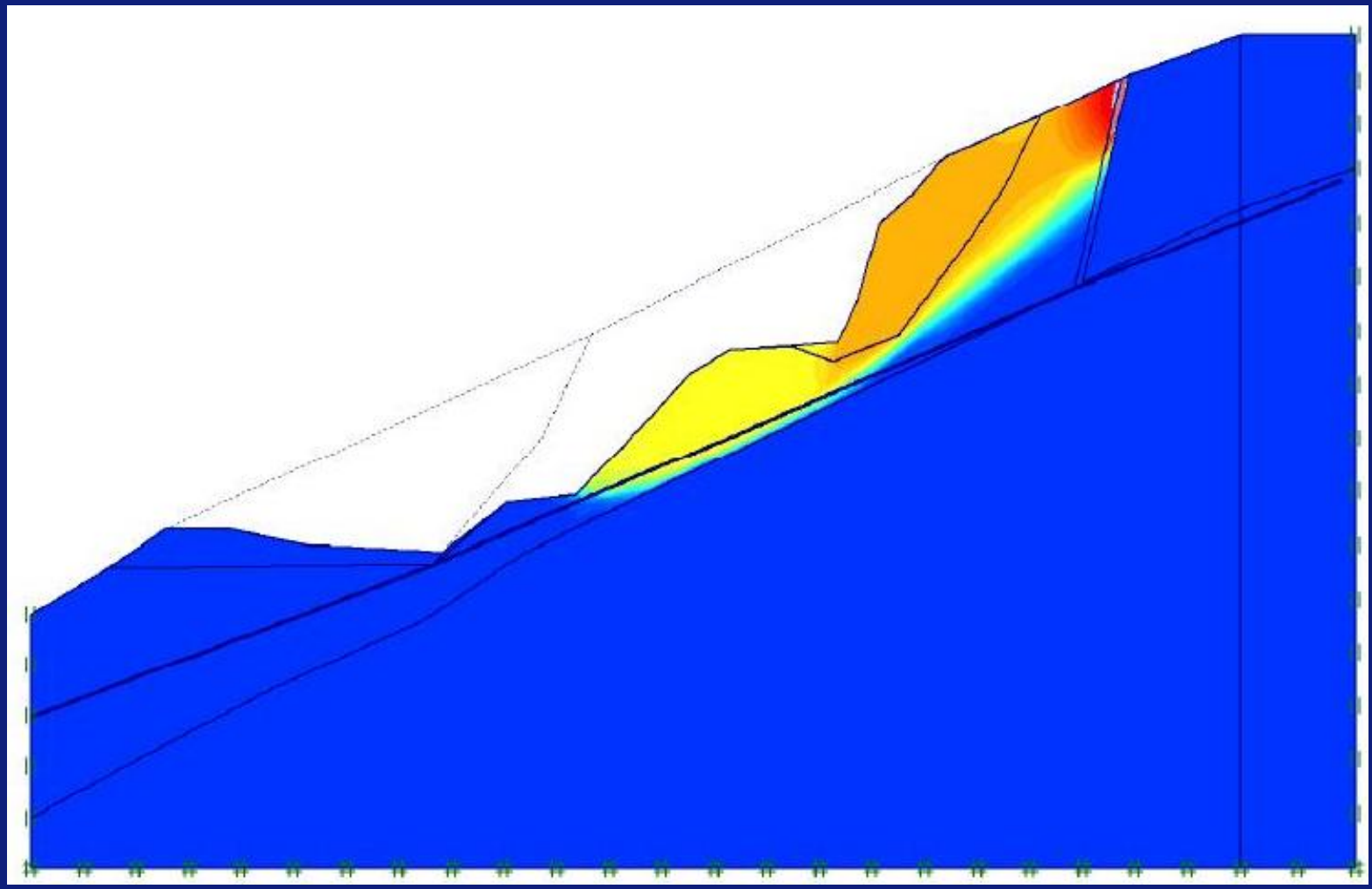
Stability of Benched Configuration



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Possible Stabilization Measures

- Mass grading – cut
- Mass grading – fill
- Rock anchors
- Rock gluing
- Retaining wall on drilled piles
- Rock-anchored retaining wall
- Rock Shed
- Hybrid Methods

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Design Concepts

- Option 1 – Rock Anchors
- Option 2 – Anchored Retaining Wall(s)

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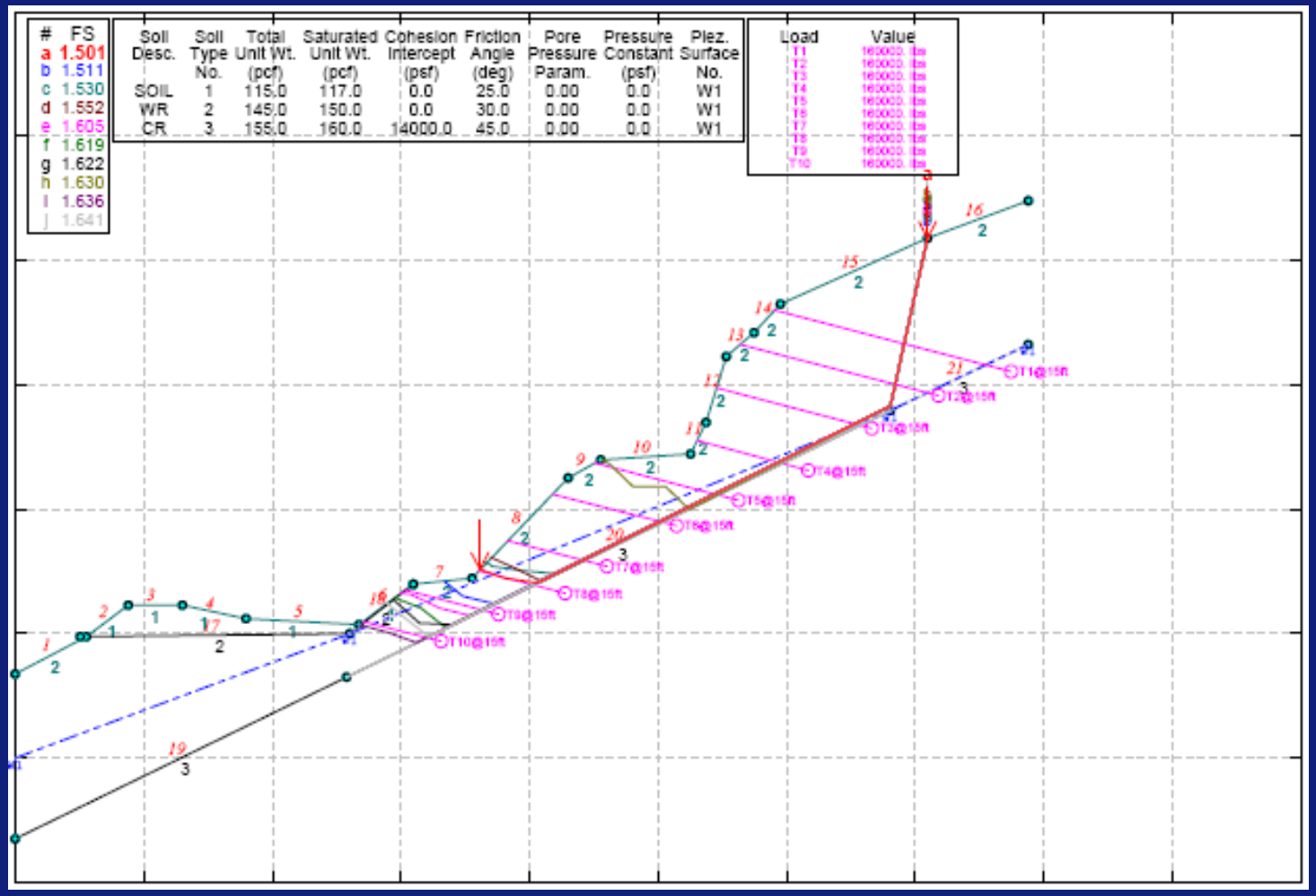
Option 1 – Rock Anchors



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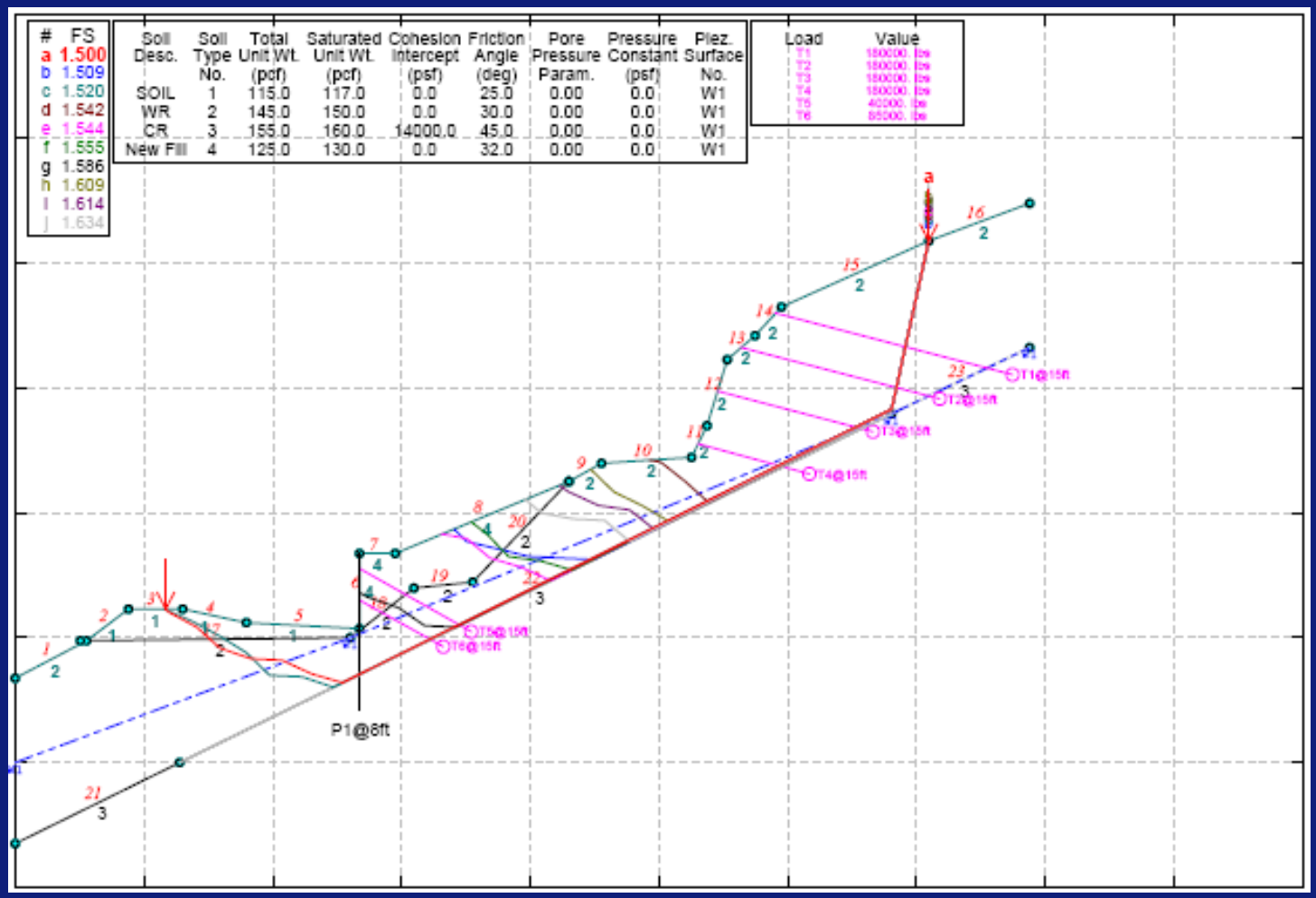
Option 2a – Anchored Retaining Wall



#	FS
a	1.500
b	1.509
c	1.520
d	1.542
e	1.544
f	1.555
g	1.586
h	1.609
i	1.614
j	1.634

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SOIL	1	115.0	117.0	0.0	25.0	0.00	0.0	W1
WR	2	145.0	150.0	0.0	30.0	0.00	0.0	W1
CR	3	155.0	160.0	14000.0	45.0	0.00	0.0	W1
New Fill	4	125.0	130.0	0.0	32.0	0.00	0.0	W1

Load	Value
T1	180000. lbs
T2	180000. lbs
T3	180000. lbs
T4	180000. lbs
T5	40000. lbs
T6	85000. lbs

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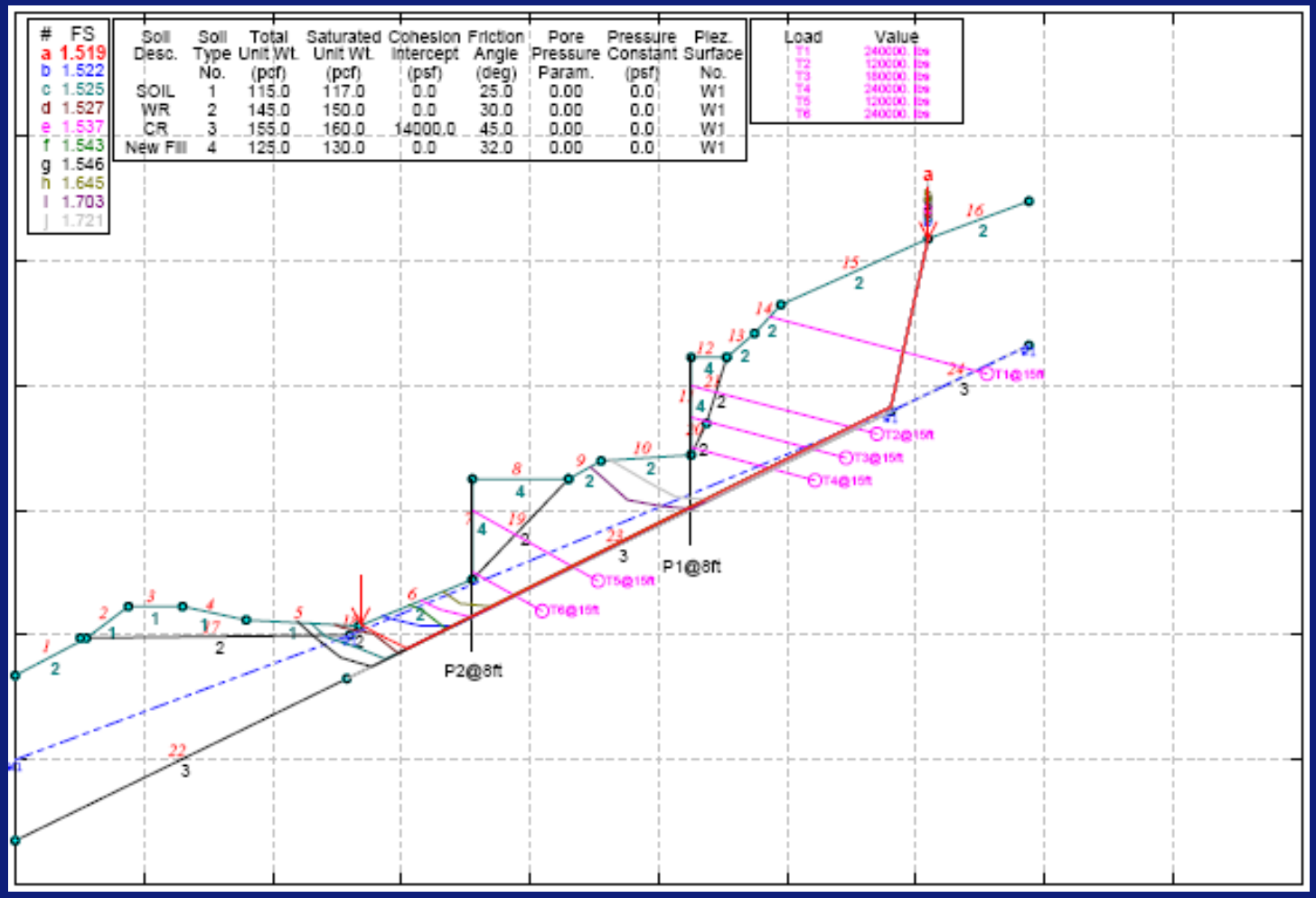
Option 2b – Anchored Retaining Walls



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Additional Recommendations

- Scaling
- Horizontal Drains
- Wire mesh

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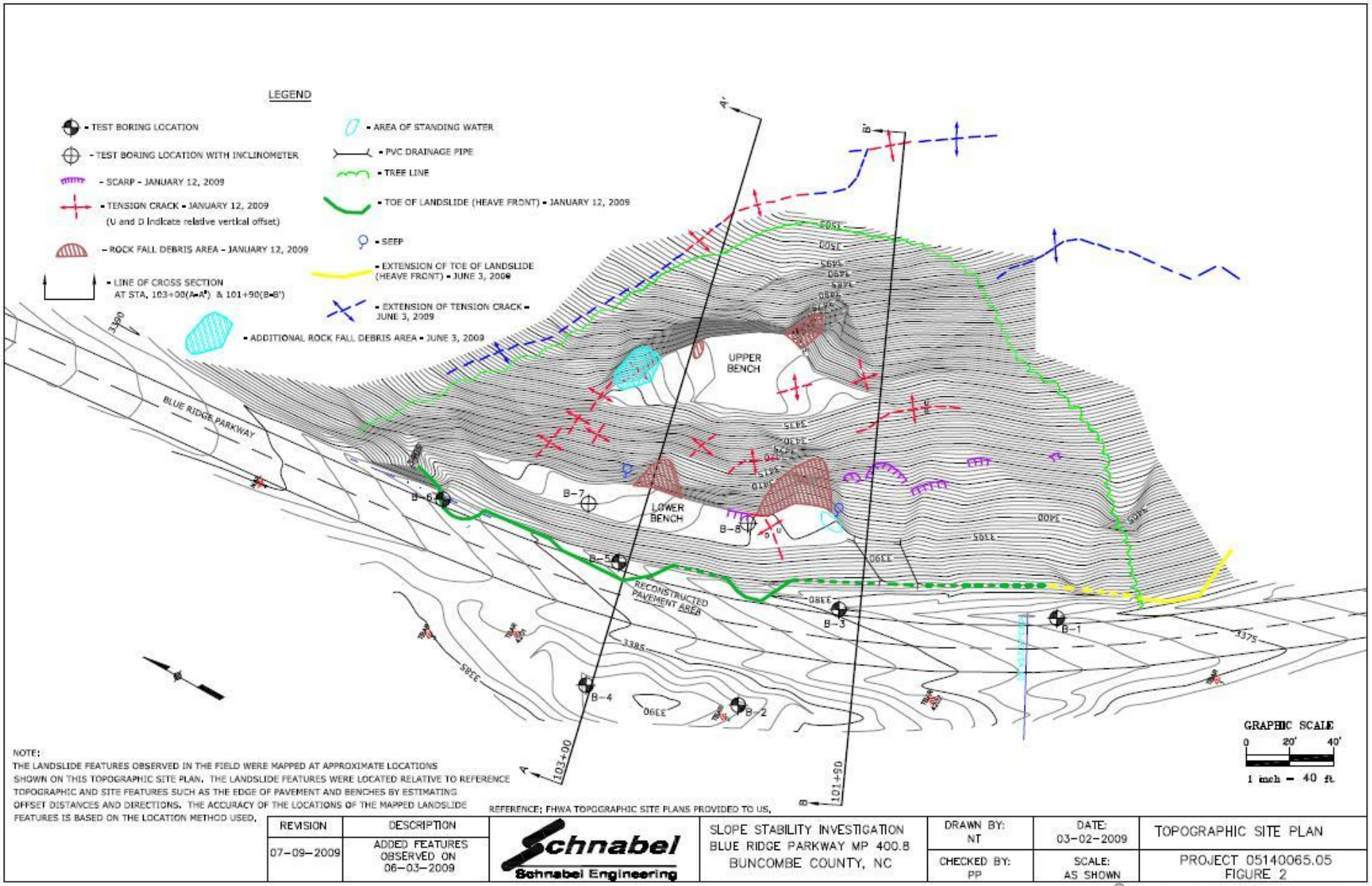

NOTE:
THE LANDSLIDE FEATURES OBSERVED IN THE FIELD WERE MAPPED AT APPROXIMATE LOCATIONS SHOWN ON THIS TOPOGRAPHIC SITE PLAN. THE LANDSLIDE FEATURES WERE LOCATED RELATIVE TO REFERENCE TOPOGRAPHIC AND SITE FEATURES SUCH AS THE EDGE OF PAVEMENT AND BENCHES BY ESTIMATING OFFSET DISTANCES AND DIRECTIONS. THE ACCURACY OF THE LOCATIONS OF THE MAPPED LANDSLIDE FEATURES IS BASED ON THE LOCATION METHOD USED.

REFERENCE: FHWA TOPOGRAPHIC SITE PLANS PROVIDED TO US.

REVISION	DESCRIPTION
07-09-2009	ADDED FEATURES OBSERVED ON 06-03-2009

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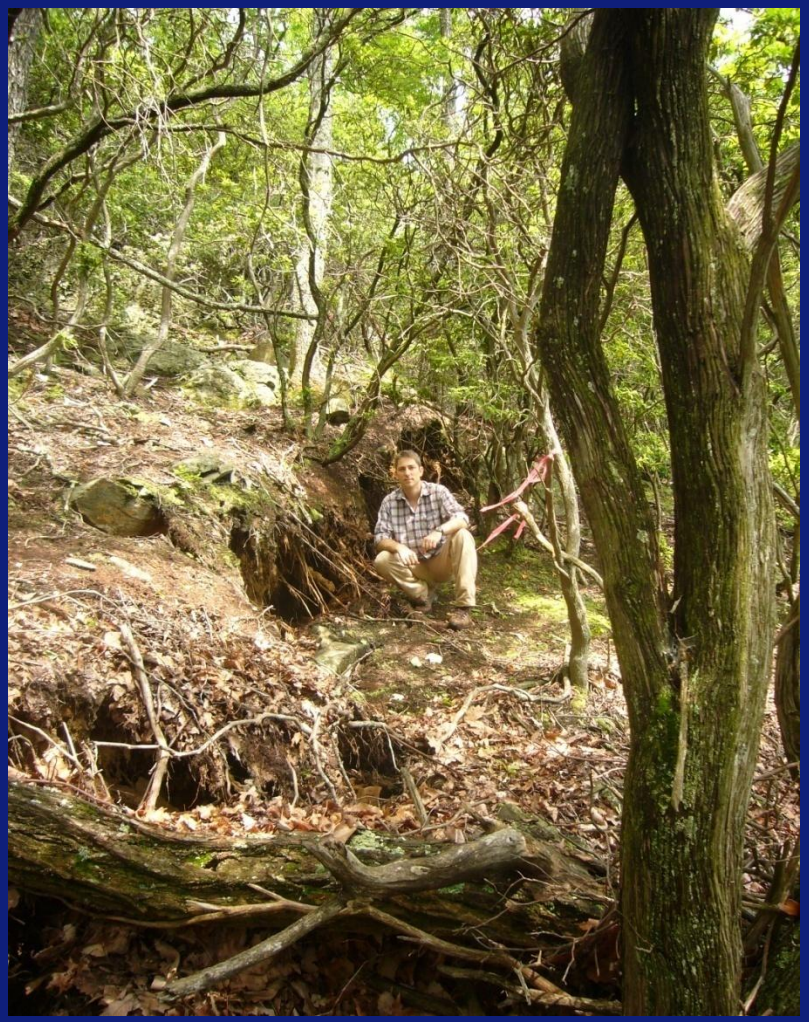
SLOPE STABILITY INVESTIGATION
BLUE RIDGE PARKWAY MP 400.8
BUNCOMBE COUNTY, NC

DRAWN BY: NT	DATE: 03-02-2009	TOPOGRAPHIC SITE PLAN
CHECKED BY: PP	SCALE: AS SHOWN	PROJECT 05140065.05 FIGURE 2

Ongoing Movement



June 2009

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Ongoing Movement

June 2009

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Ongoing Movement

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Ongoing Movement

June 2009

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“Final” Design

- Completed by EFLHD
- Rock anchor solution chosen due to aesthetic and cost considerations
- Treatment area was expanded
- Also included:
  - grouting of tension cracks
  - additional high-angle anchors in the road
  - temporary wire mesh

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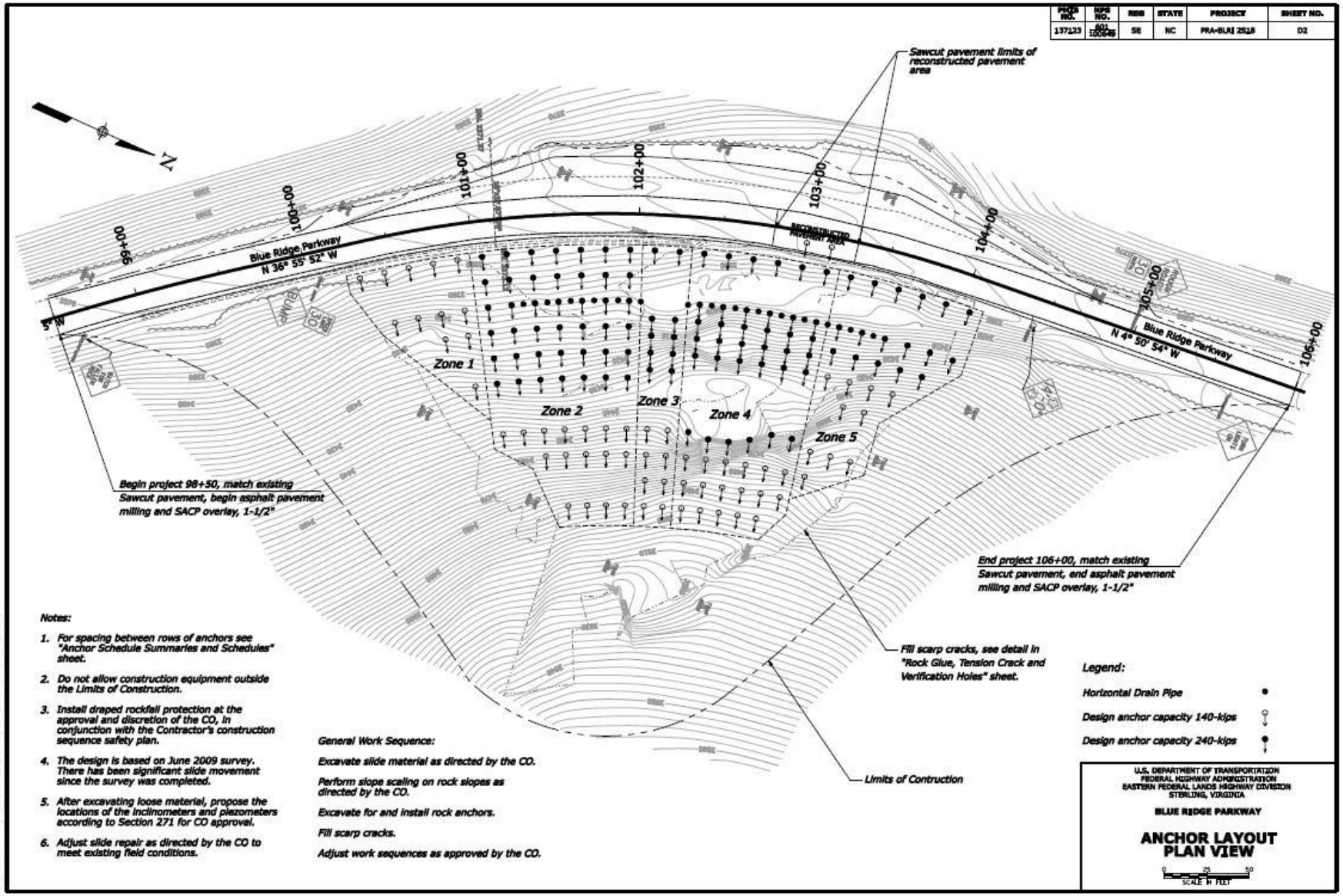
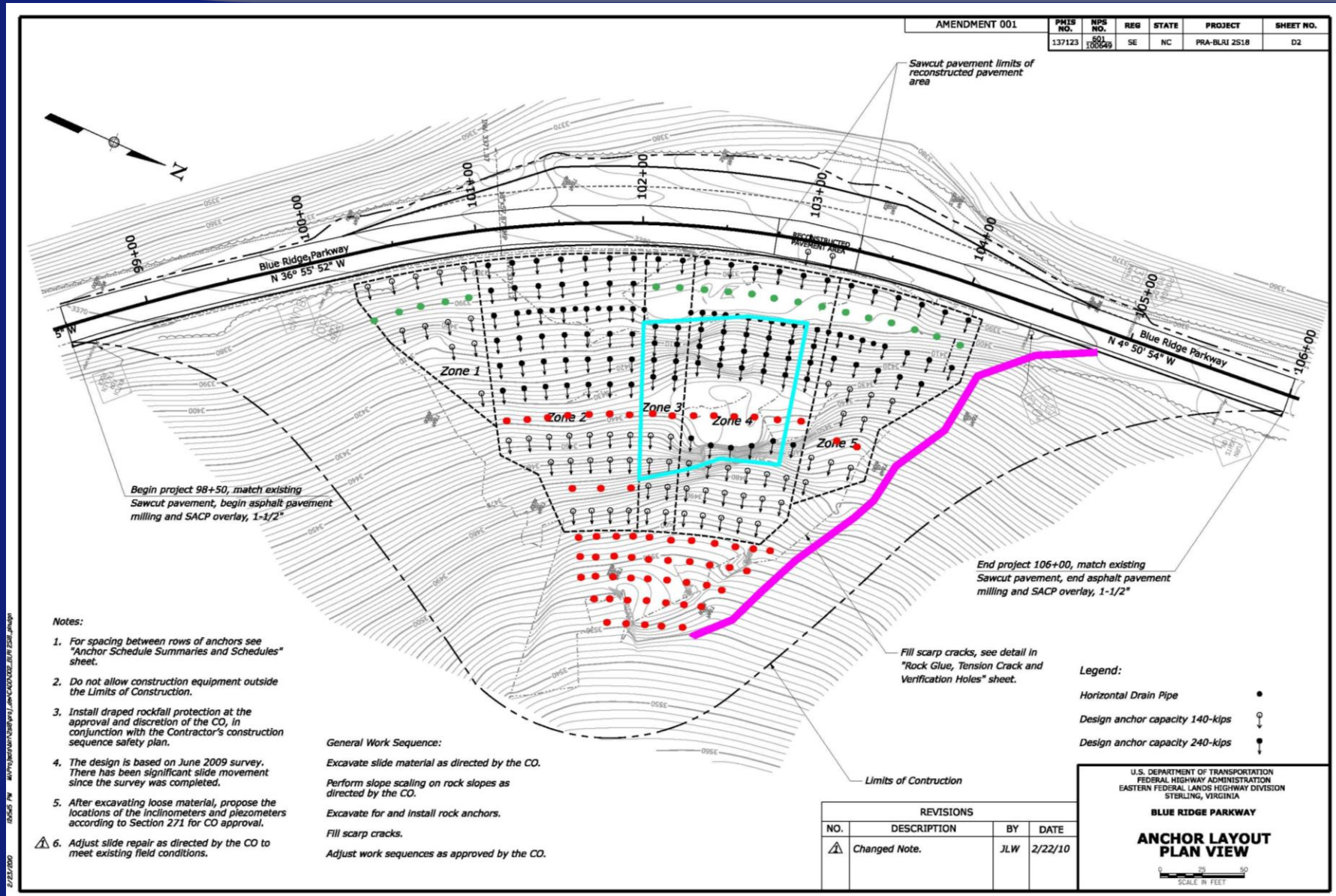
“Final” Design



Final Design



Recessed Anchors

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Recessed Anchors

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Access Road

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Anchor Pads

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Wire Mesh

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Upper Work Bench

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Bench Failure

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Bench Failure

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Thank you!

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