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Ralph B. Peck Lecture

November 6, 2025

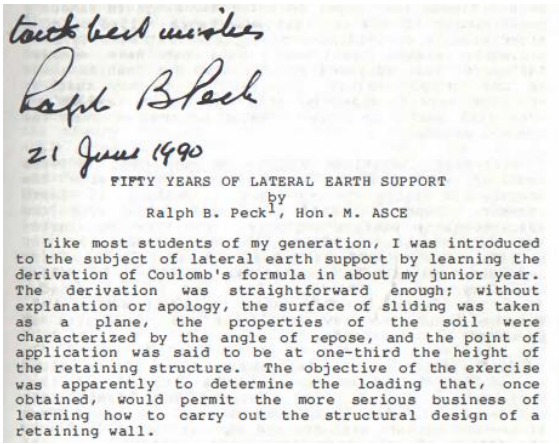
John R. Wolosick, PE, SE, BC.GE, F.ASCE
Keller North America
Atlanta, GA

G-I GEO-INSTITUTE ASCE

Dr. Ralph Brazelton Peck

- Professor University of Illinois at Urbana-Champaign
- Retired from U of I 1974
- Eminent Consultant/Geotechnical Engineer
- Mentee of Karl Terzaghi
- Co Author: Terzaghi & Peck, Terzaghi, Peck and Mesri
  Soil Mechanics in Engineering Practice
- Developed Graduate Course
  CEE 584 Geotechnical Case Histories
  Required 1 Page Summaries

Ralph Peck,
Walter Hanson,
Reza Mesri



Best wishes
Ralph B Peck
21 June 1990

FIFTY YEARS OF LATERAL EARTH SUPPORT
by
Ralph B. Peck[1], Hon. M. ASCE

Like most students of my generation, I was introduced to the subject of lateral earth support by learning the derivation of Coulomb's formula in about my junior year. The derivation was straightforward enough; without explanation or apology, the surface of sliding was taken as a plane, the properties of the soil were characterized by the angle of repose, and the point of application was said to be at one-third the height of the retaining structure. The objective of the exercise was apparently to determine the loading that, once obtained, would permit the more serious business of learning how to carry out the structural design of a retaining wall.

Reza Mesri,
Ralph Peck,
H.O. Ireland

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Slope Stabilization using Tall Soil Nail Walls at Natchez National Cemetery and Teton Pass

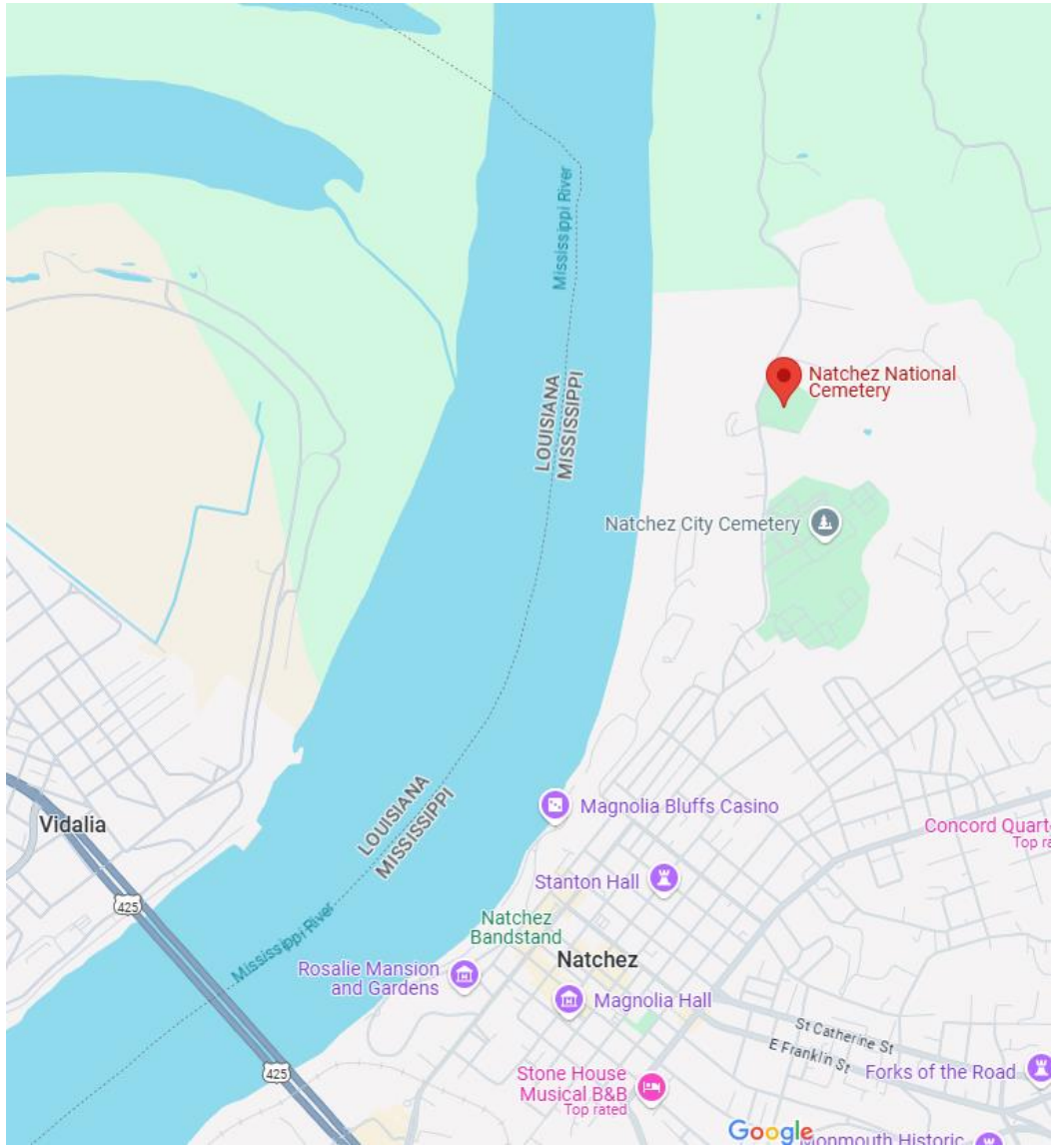
John R. Wolosick, PE, SE, BC.GE, F.ASCE

Case Histories: Two Major Landslides Repaired using Soil Nailing

1. Natchez National Cemetery, 2021-2023
   Client: US Army Corps of Engineers
   Wall Length = 1,270 LF
   Wall Height = 48 ft max, 31.5 ft avg
   Wall Area = 40,000 Square Feet
   $9.8M General Contract

2. Teton Pass Landslide – 'Big Fill Slide,' 2024-2025
   Owner: Wyoming Department of Transportation
   Wall Length = 525 LF
   Wall Height = 110 ft in corner
   Wall Area = 60,000 Square Feet
   $6.6M soil nailing, $2.2M micropiles
   Subcontract

Natchez National Cemetery



- The city of Natchez lies on the southwestern border of Mississippi and is the oldest city on the Mississippi River.
- The Natchez National Cemetery is located on the Bluff overlooking the Mississippi River on the North side of the city and was established after two Civil War engagements in 1863 and 1864 at this location. The Cemetery was listed in the National Register of Historic Places in 1999. It is open for burials of all members of the armed forces.

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Previous Slide Repairs in Natchez, Mississippi for the City of Natchez and the US Army Corps of Engineers

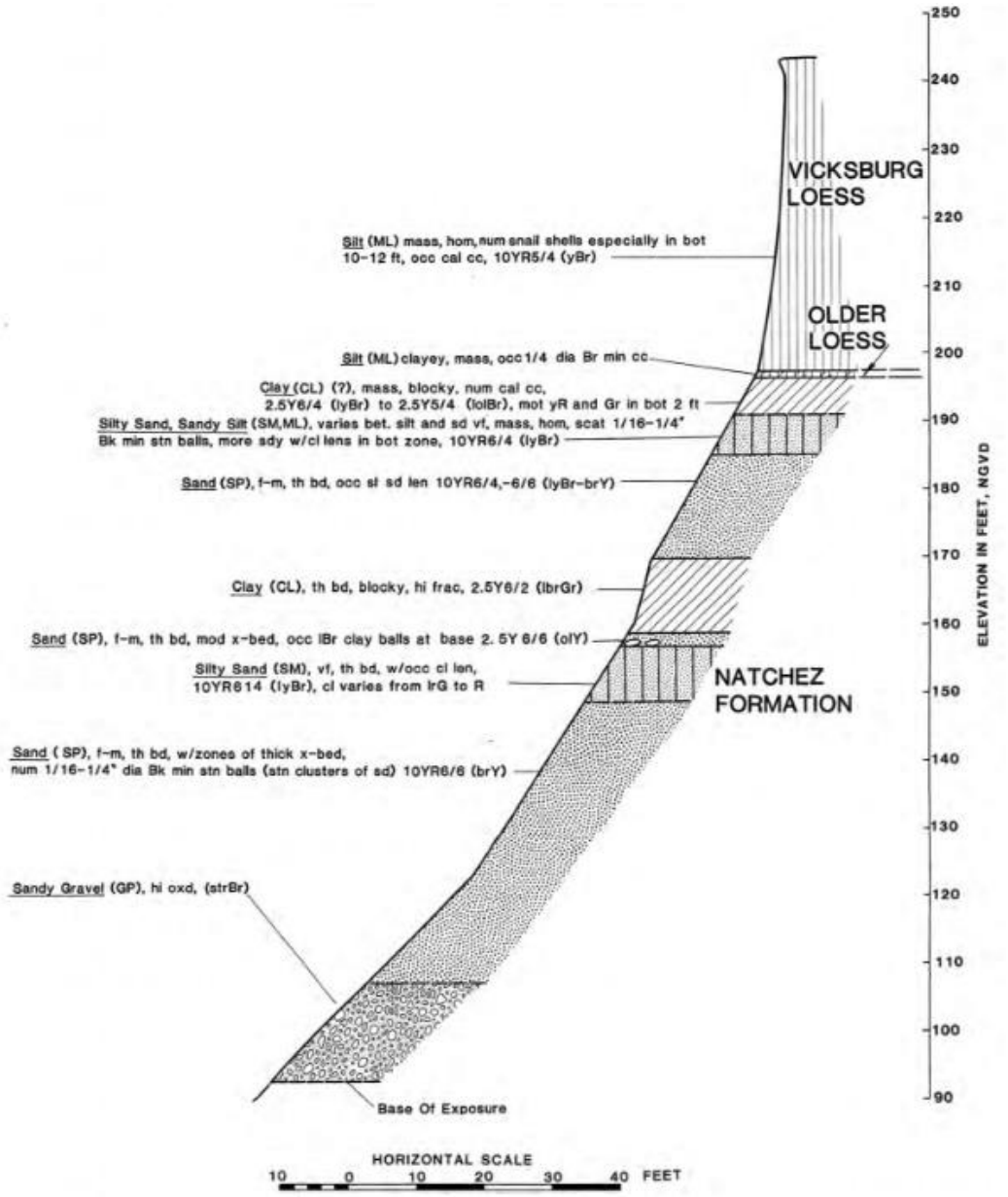
Clifton Avenue and Learneds Mill Road
74 foot tall Soil Nail Walls with Tieback Anchors and MSE wall. 1997-1999.

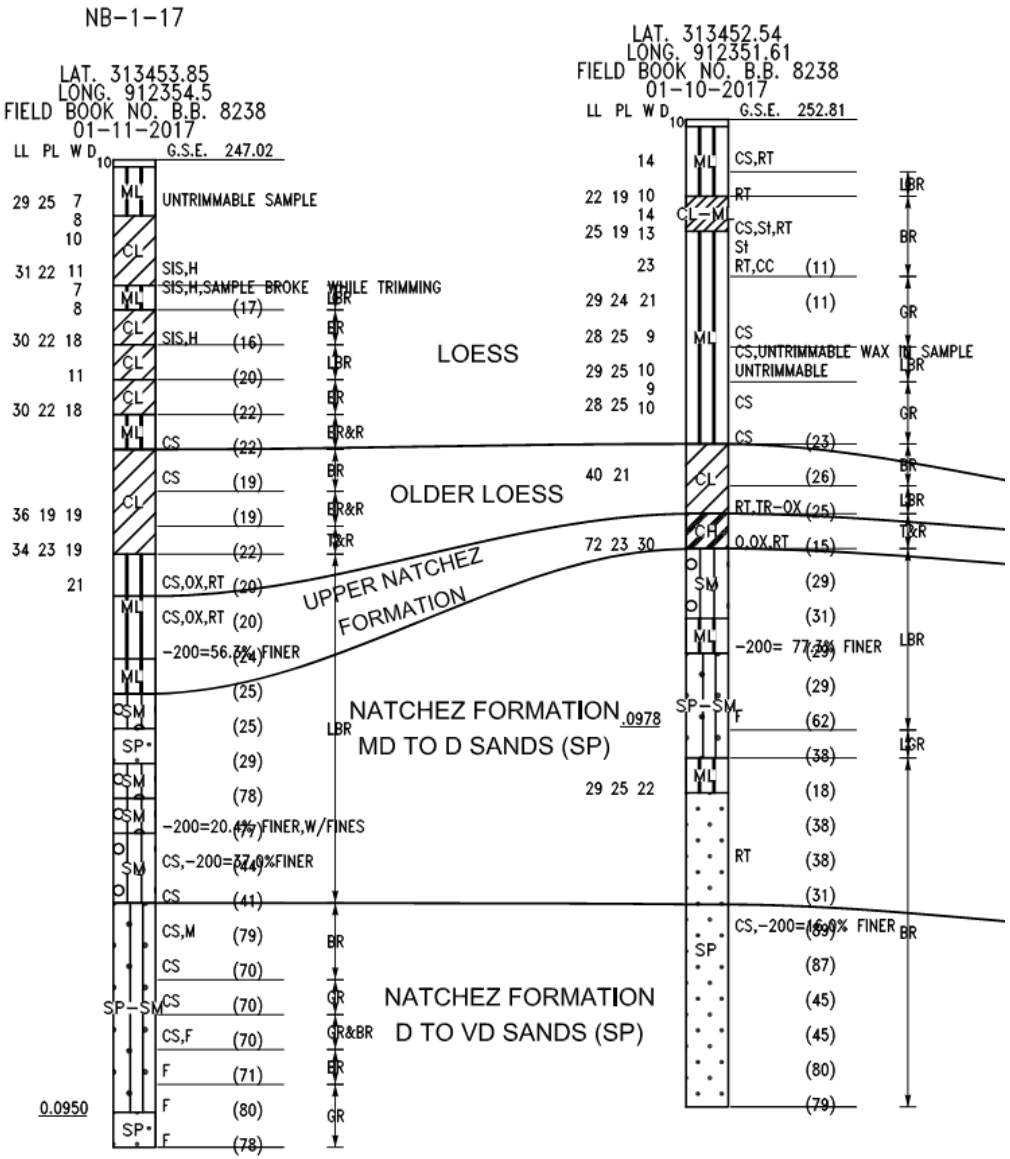
Natchez Under the Hill
Rosalie Mansion and
Silver Street
Soil Nail Wall with Tieback Anchors
2000-2001.

Major Erosion Event 2021

Major Erosion Event 2021

Geotechnical Conditions





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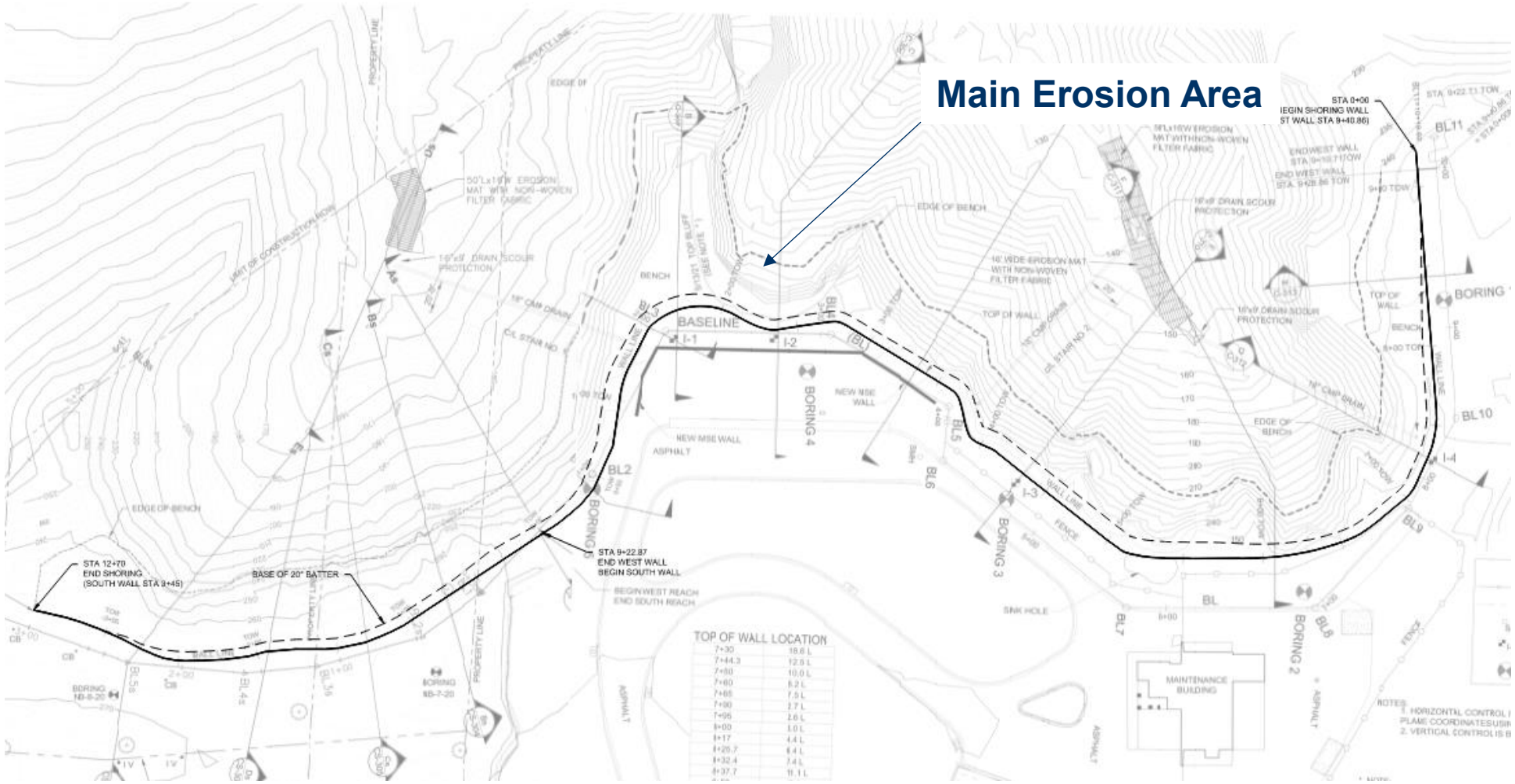
Anchored Soil Nail Wall Solution

River side



- 40,000 SF
- 1,270 LF
- Max H = 48 FT

N

Cemetery

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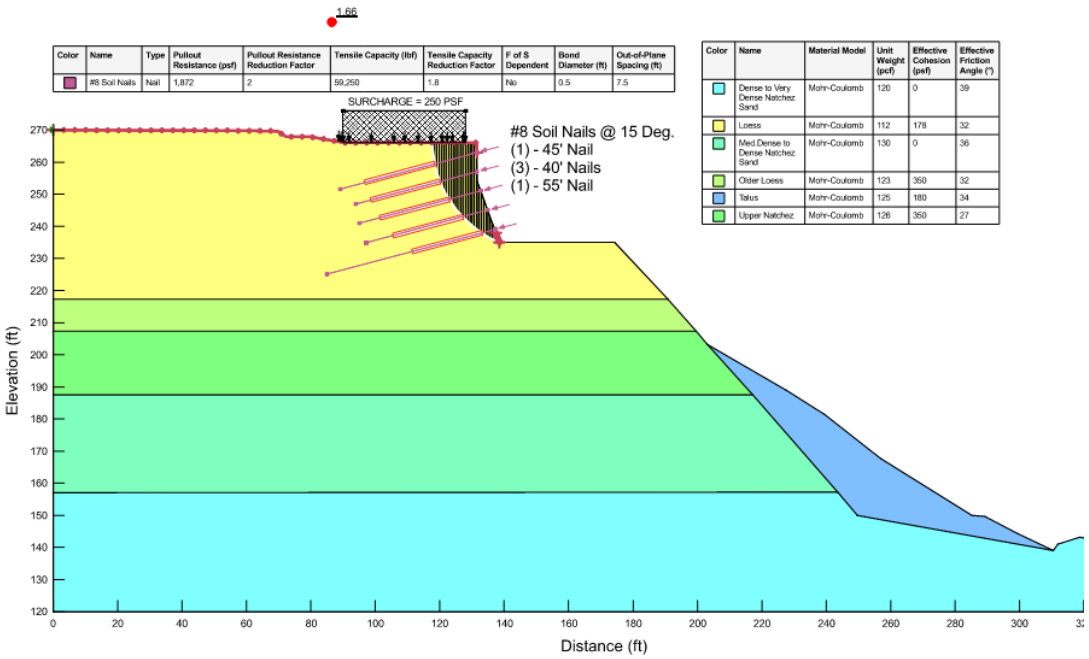
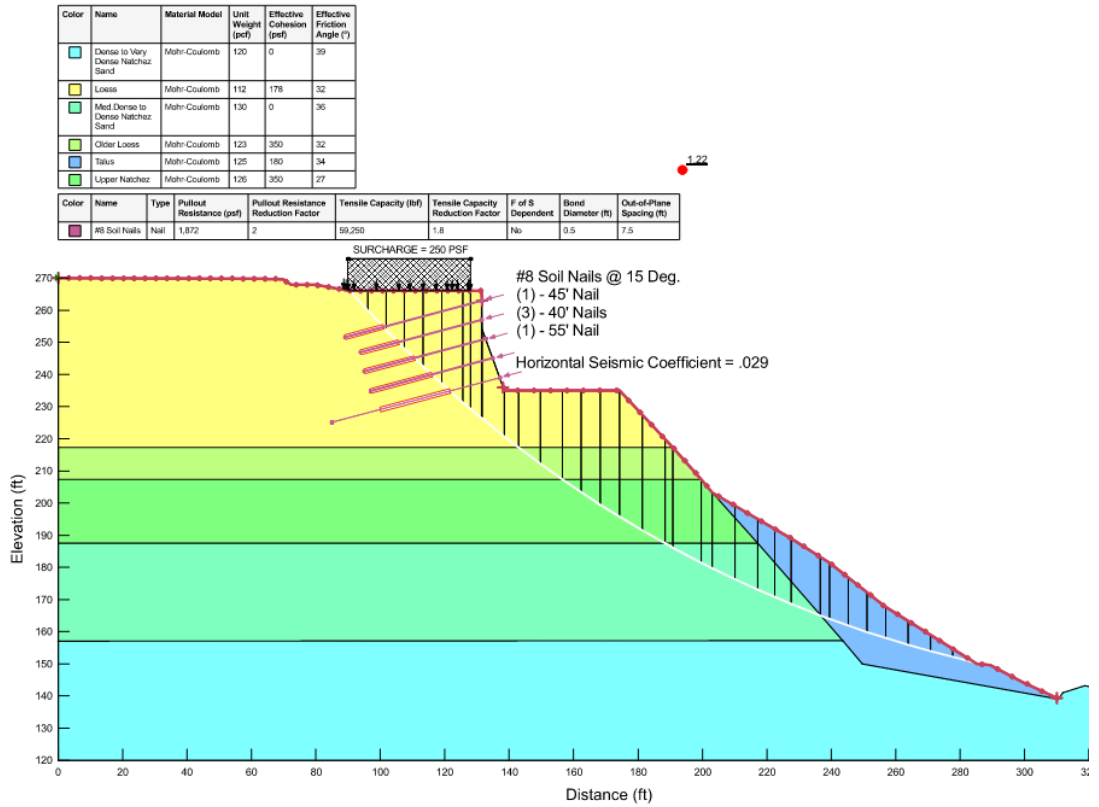
Some Design Sections



Color	Name	Type	Pullout Resistance (psf)	Pullout Resistance Reduction Factor	Tensile Capacity (lbf)	Tensile Capacity Reduction Factor	F of S Dependent	Bond Diameter (ft)	Out-of-Plane Spacing (ft)
	#8 Soil Nails	Nail	1,872	2	59,250	1.8	No	0.5	7.5

Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Dense to Very Dense Natchez Sand	Mohr-Coulomb	120	0	39
	Loess	Mohr-Coulomb	112	178	32
	Med.Dense to Dense Natchez Sand	Mohr-Coulomb	130	0	36
	Older Loess	Mohr-Coulomb	123	350	32
	Talus	Mohr-Coulomb	125	180	34
	Upper Natchez	Mohr-Coulomb	126	350	27

Design Section Bs - Effective Stress Internal



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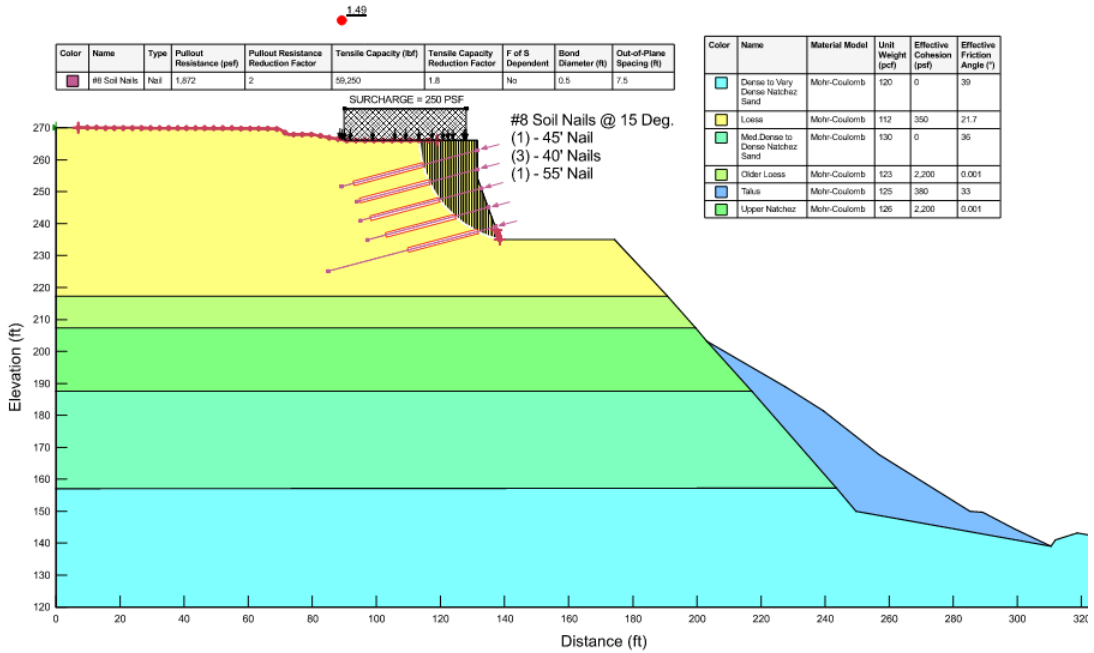
Design Section Bs - Effective Stress Seismic

Some Design Sections



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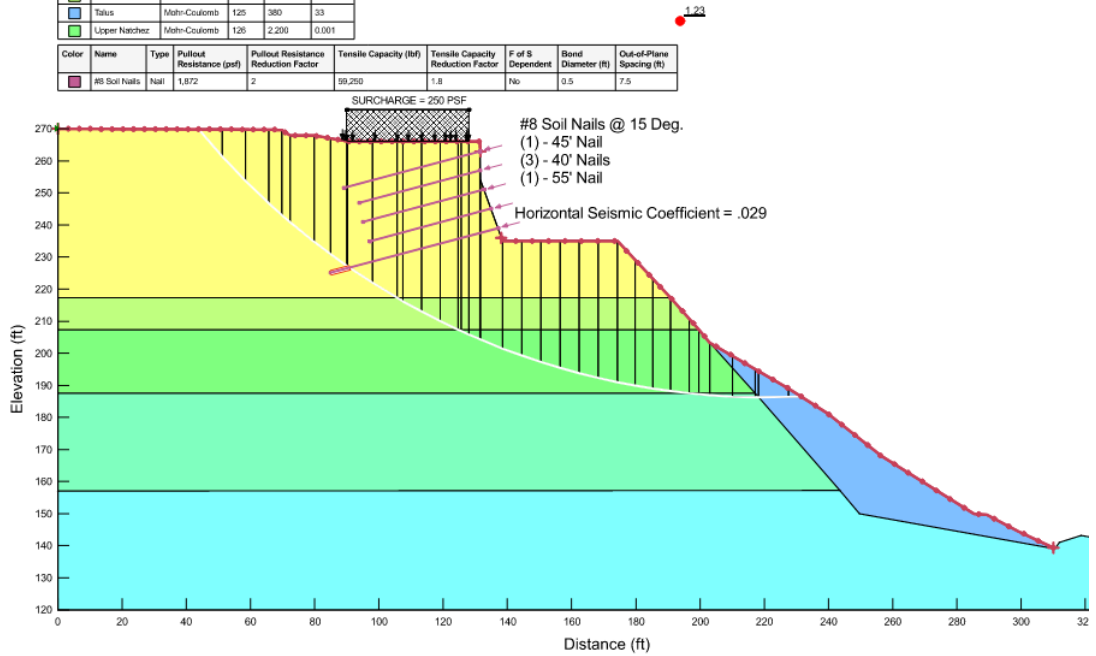
	Loess	Mohr-Coulomb	112	350	21.7
	Med.Dense to Dense Natchez Sand	Mohr-Coulomb	130	0	36
	Older Loess	Mohr-Coulomb	123	2,200	0.001
	Talus	Mohr-Coulomb	125	380	33
	Upper Natchez	Mohr-Coulomb	126	2,200	0.001

Design Section Bs - Total Stress Internal Stability



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
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	Talus	Mohr-Coulomb	125	380	33
	Upper Natchez	Mohr-Coulomb	126	2,200	0.001

Color	Name	Type	Pullout Resistance (psf)	Pullout Resistance Reduction Factor	Tensile Capacity (lbf)	Tensile Capacity Reduction Factor	F of S Dependent	Bond Diameter (ft)	Out-of-Plane Spacing (ft)
	#8 Soil Nails	Nail	1,872	2	59,250	1.8	No	0.5	7.5

Design Section Bs - Total Stress Seismic

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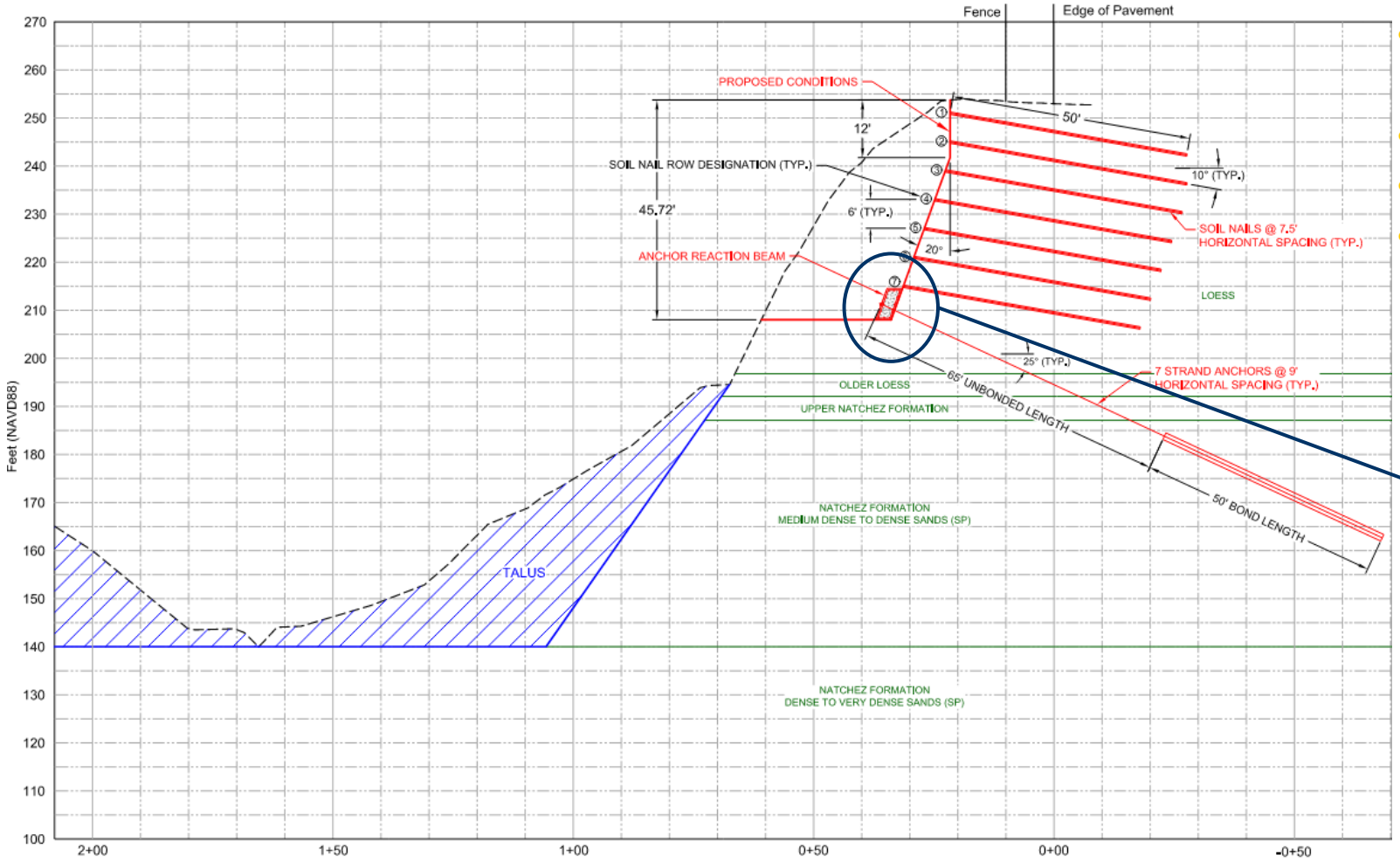
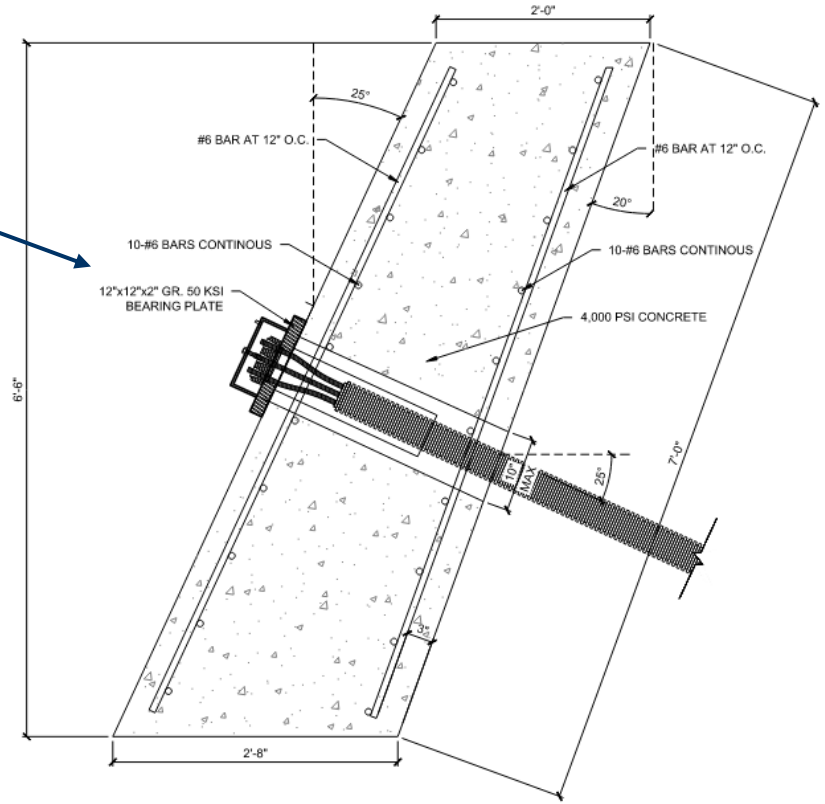
Anchored Soil Nail Wall Solution

- 7 rows of 40 ft to 50 ft soil nails
- 6’ x 6’ and 7.5’ x 6’ Spacings
- 1 row of Ground Anchors of 150 to 180 LF at base for Global Stability
- Shotcreted Anchor Reaction Beam
- Top two lifts vertical
- Remaining lifts battered at 20 degrees





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Separation of Work Area from Public Area

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Demolition of MSE Wall and Pavilion adjacent to Erosion Area

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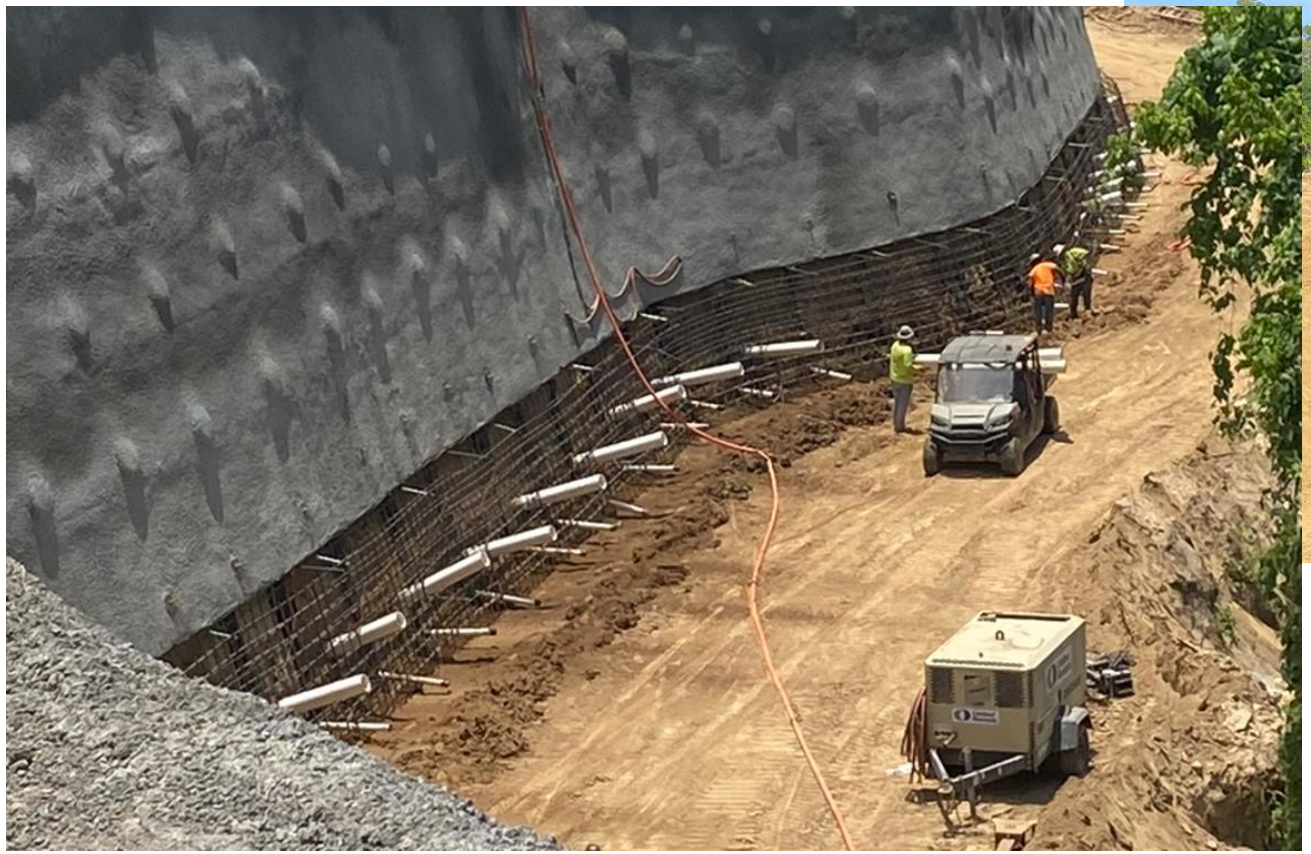
First Lift Construction – Vertical Lifts

Sacrificial Test Nails to Confirm Assumed Bond Stress

Remaining Wall Construction – Battered Lifts

Bottom of Wall Reinforcement and Drainage Details including Deep Tieback Anchor Locations

Shotcrete Tieback Anchor Reaction Beam



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Steel Strand Tieback Anchors – 4-7 Strands - 245 kip max
Spacing varies 6ft, 9ft, 10ft c-c

Tricky Outside Corner

Rebuilt MSE Wall (subcontract) above Soil Nail Wall and Wall Staining

New Storm Drainage

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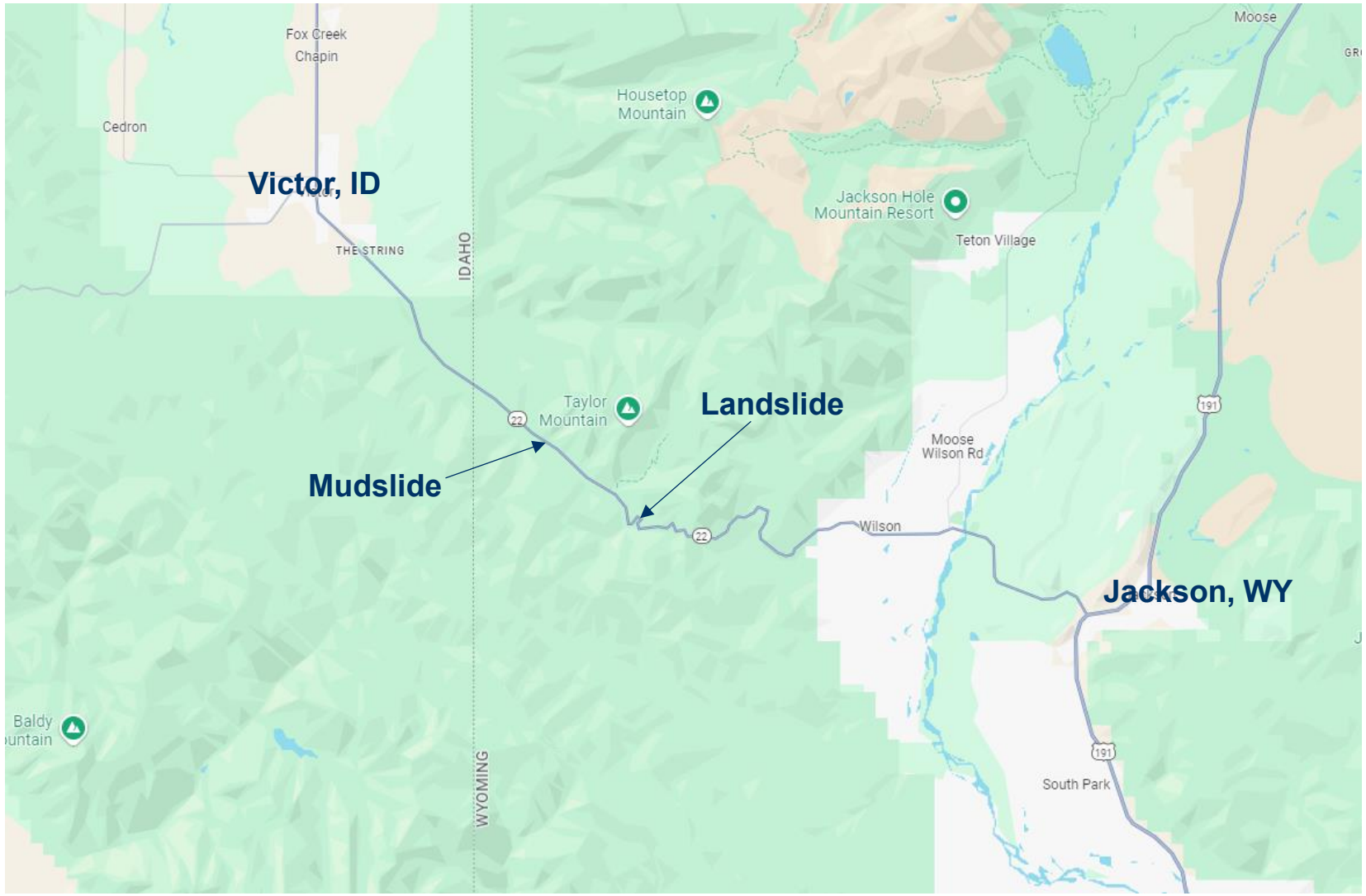
Teton Pass Highway 22



- Teton Pass Wyoming Highway 22 is a major road connecting Wyoming and Idaho. Thousands of people commute between Eastern Idaho and Northwestern Wyoming every day.
- A mudslide took place June 7th, 2024 on part of Highway 22 leading WYDOT to close the road. The following day, a slope failed about 2.5 miles East causing a landslide and washing out part of the road. There were no casualties since the road was already closed, but the driving time for commuters tripled.
- Keller was hired by Ames to provide soil nail temporary slope stabilization and permanent micropile shear pins.

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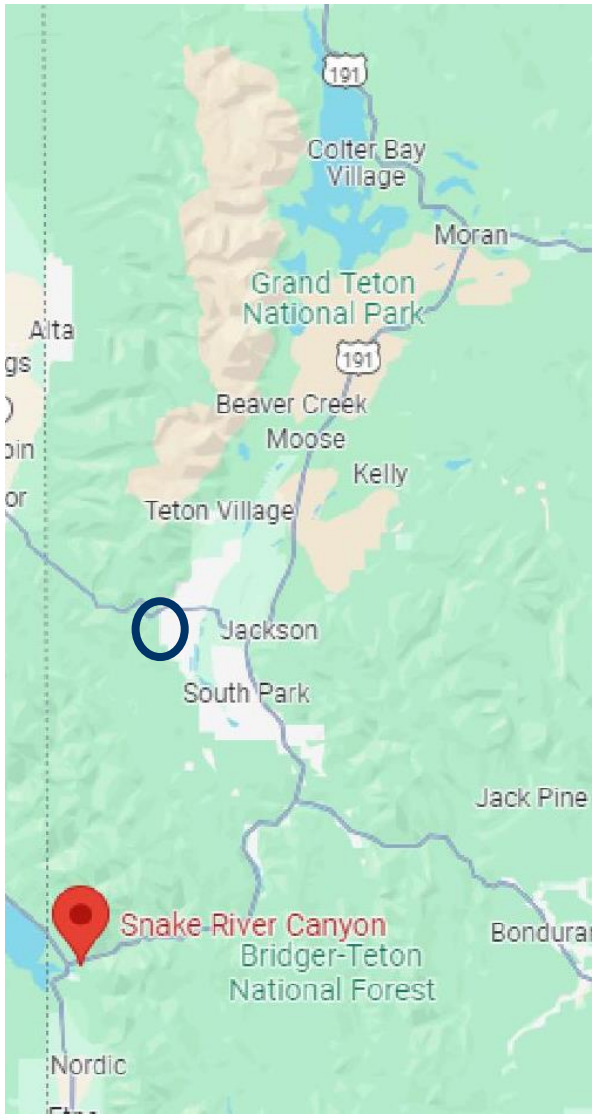
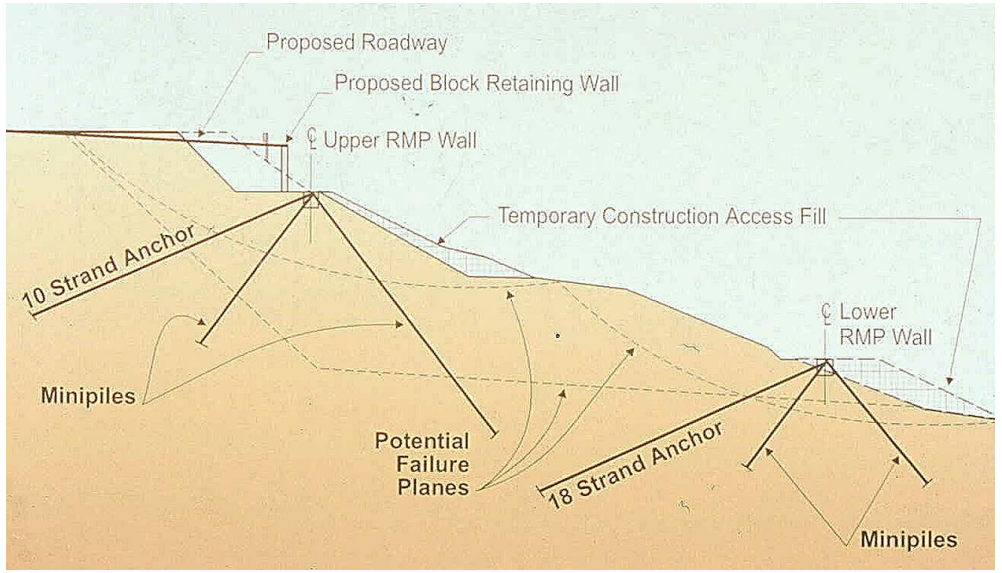
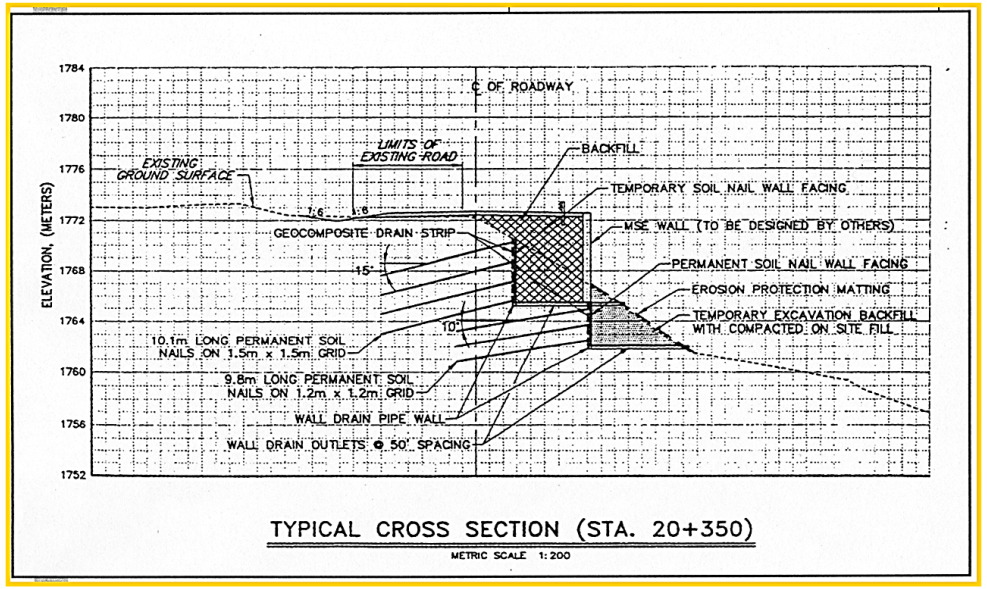
Previous Slide Repairs at Snake River Canyon Wyoming DOT



Blue Trail Slide

Micropile Walls with Tieback Anchors and MSE wall. 1997.





The Elbow Slide

Soil Nail walls with MSE Wall. 1998-1999.

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Previous Slide Repairs for WYDOT – Blue Trail Slide

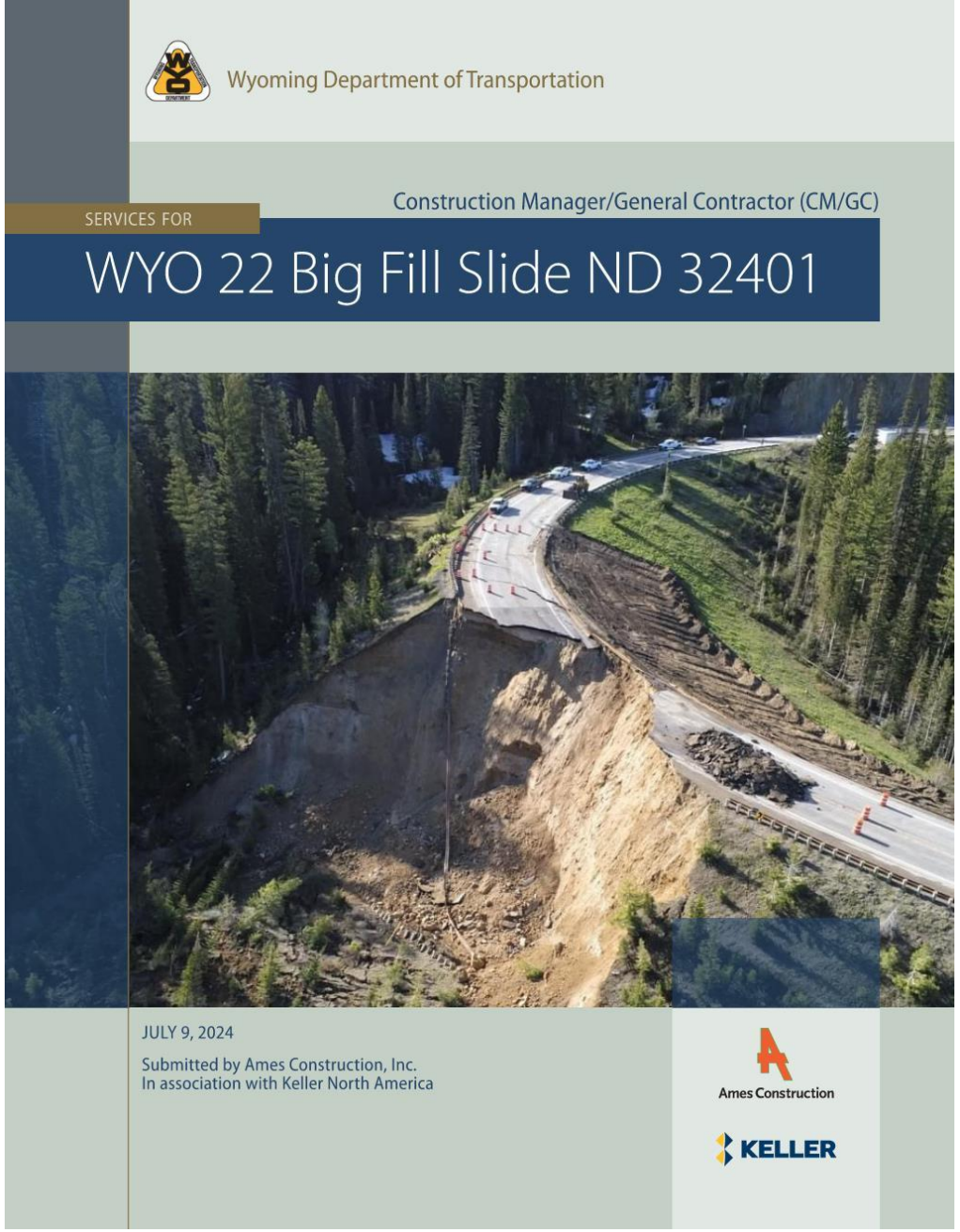
- Upper, intermediate and lower walls constructed
- Micropiles used to construct the “A” portion of the walls
- Strand anchors also used for tieback elements

Previous Slide Repairs for WYDOT – Elbow Slide

- Upper and lower soil nail walls
- Shotcrete facing for lower wall
- Temporary steel mesh for upper wall
- Upper wall was relied on through winter
- MSE wall constructed in front of upper soil nail wall the following season

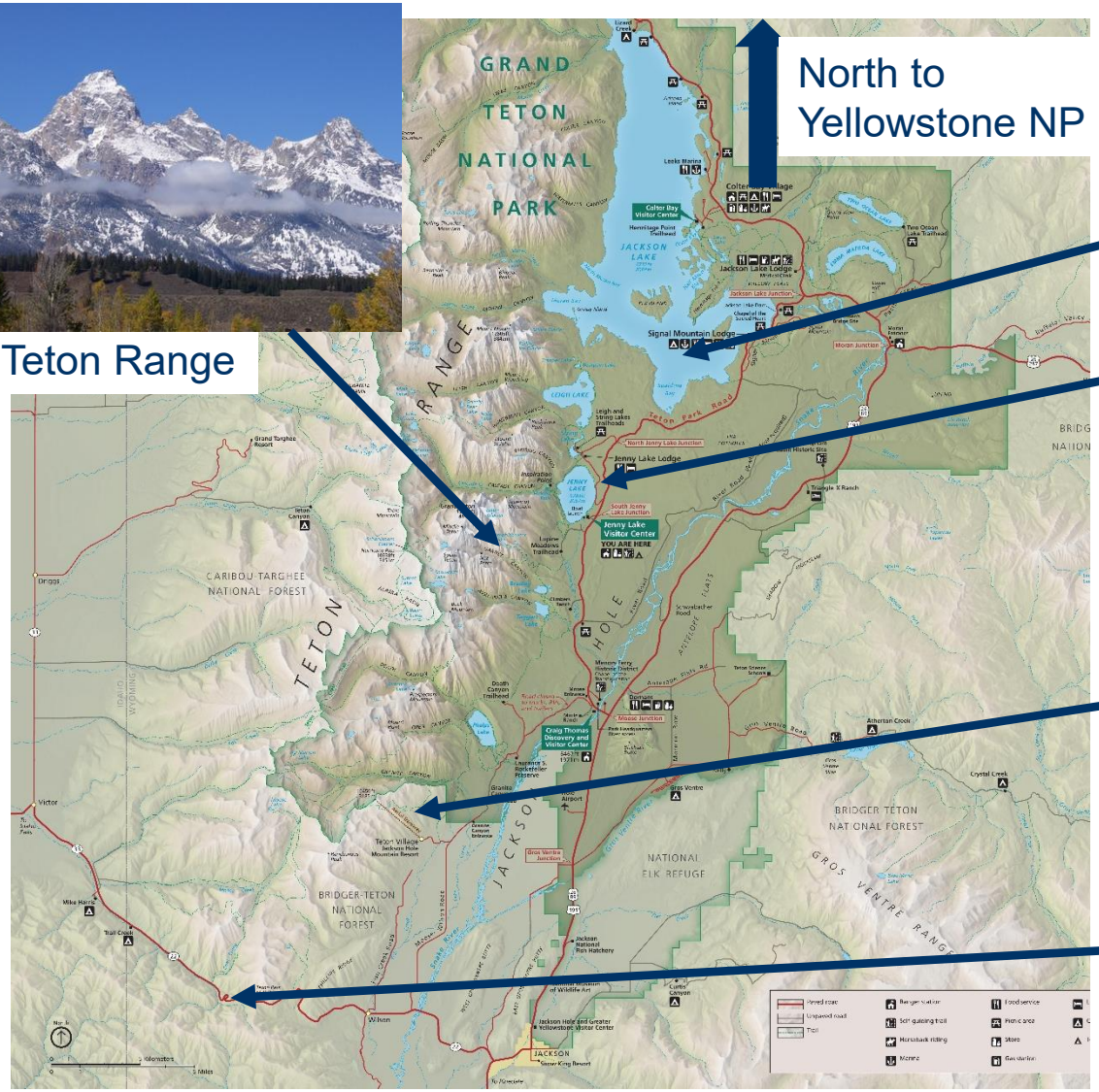
CMGC Proposal

- Keller teamed up with Ames Construction
- CMGC = Construction Manager General Contractor
- Collaborative process whereby the Contractor works with the Owner to develop solution, design and estimate cost concurrently
- Final cost proposal reviewed and verified by ICE (Independent Cost Estimator)



Not a bad place to work!

Teton Range



Jackson Lake

Jenny Lake

Jackson Hole
Ski Resort

Jobsite

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Mudslide on Teton Pass Hwy 22

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Teton Pass Highway 22 Landslide

BEFORE

AFTER

KELLER

Teton Pass Highway 22 Landslide

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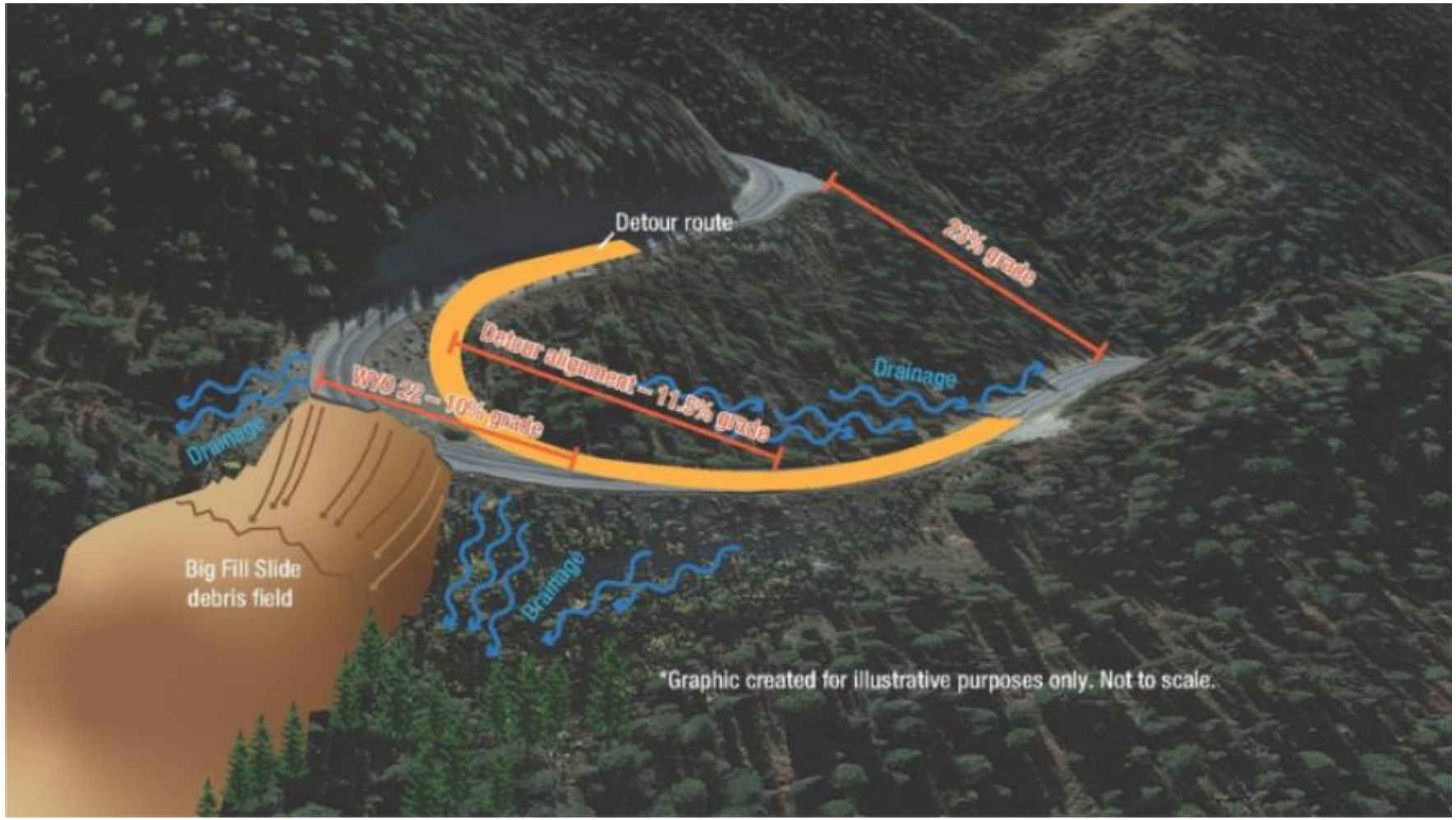
Teton Pass Highway 22 Landslide

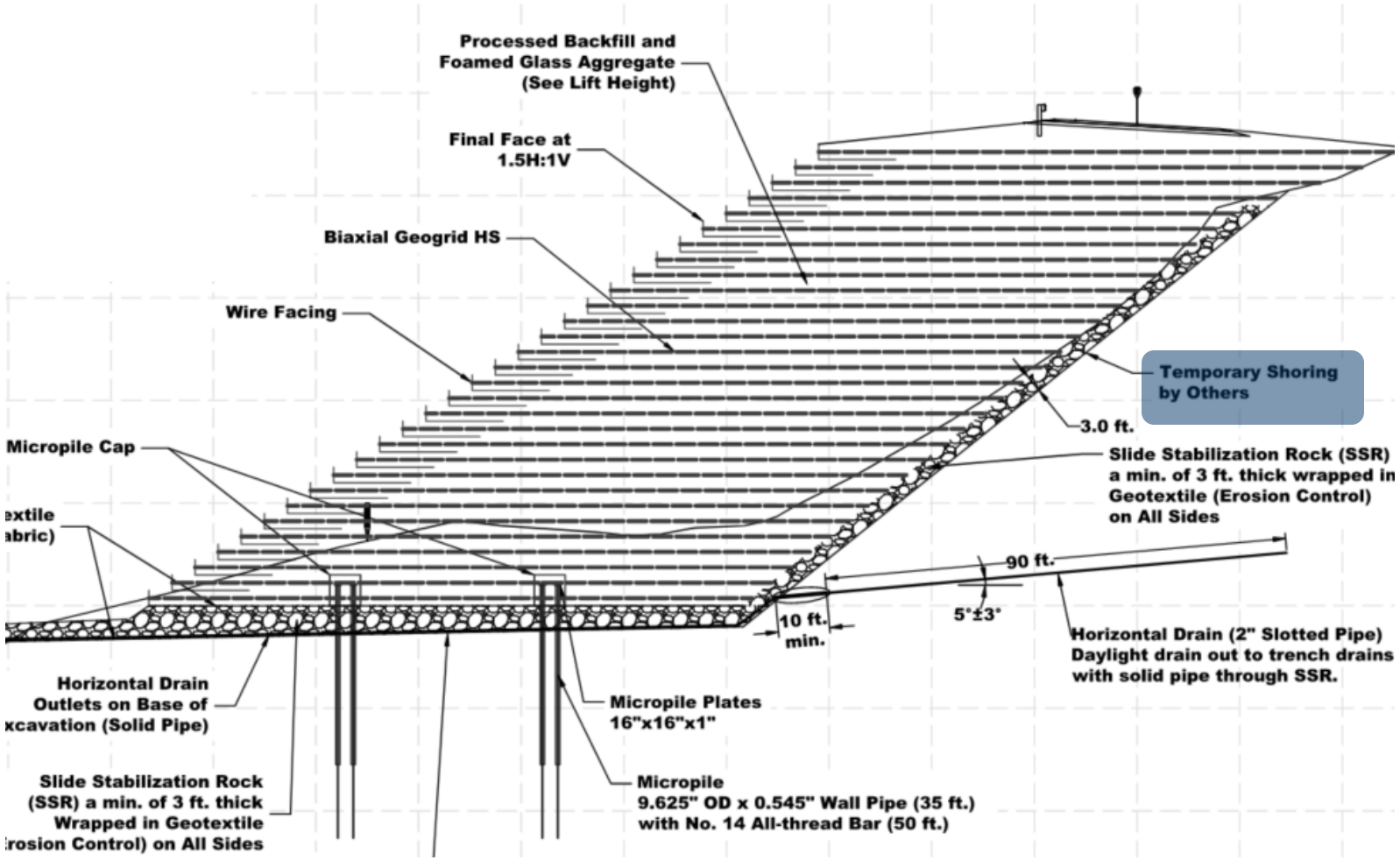
Teton Pass Highway 22 detour



- WYDOT opened a temporary detour in 3 weeks after the failure while working toward a full repair on the same section of the highway.
- The pass typically has grades of 10%, but the detour section increases to 11.3%.
- The failed section of the road will be rebuilt at its previous location once the permanent slope stabilization is completed.

FINAL PLAN – replace embankment with lightweight fill, geogrid, improved drainage and micropile shear support at base

- 1.25H:1V Excavation adjacent to detoured roadway
- Depth of Excavation = 100 ft +
- Time of Construction greatly reduced due to winter weather threat
- Temporary Shoring by Contractor
- Soil Nailing was performed 24/7
- Final Design by RJ Engineering for WYDOT



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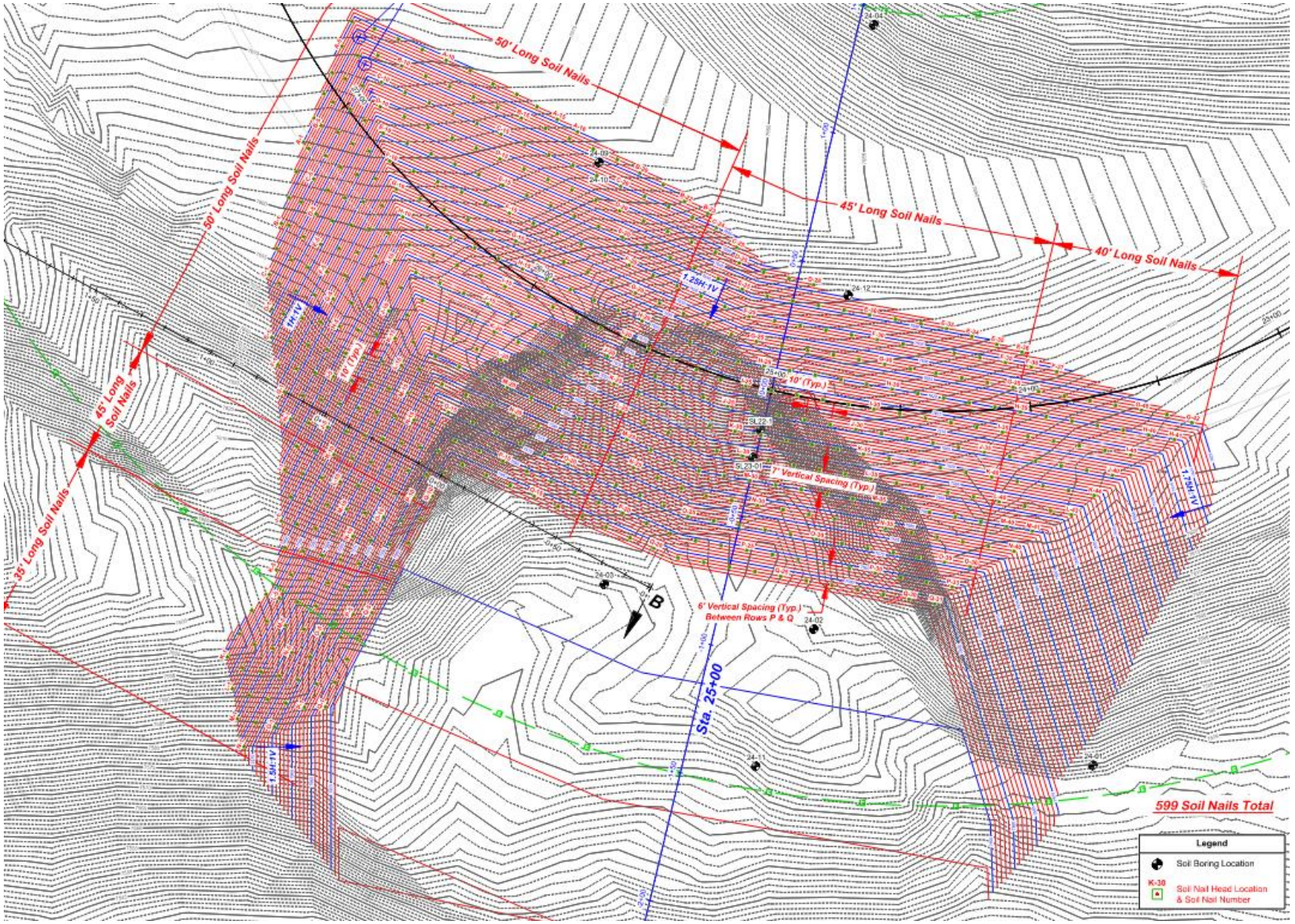
Temporary Shoring Plan



- Temporary shoring solution consists of about 60,000 SF of geotextile and wire mesh facing and 583 (as-built) soil nails, 40-50 ft long.
- L- shaped wall lengths were 410 ft and 115 ft, respectively
- The temporary slope parallel to the road was 1.25(H):1(V) ratio, and 1(H):1(V) ratio perpendicular to the highway

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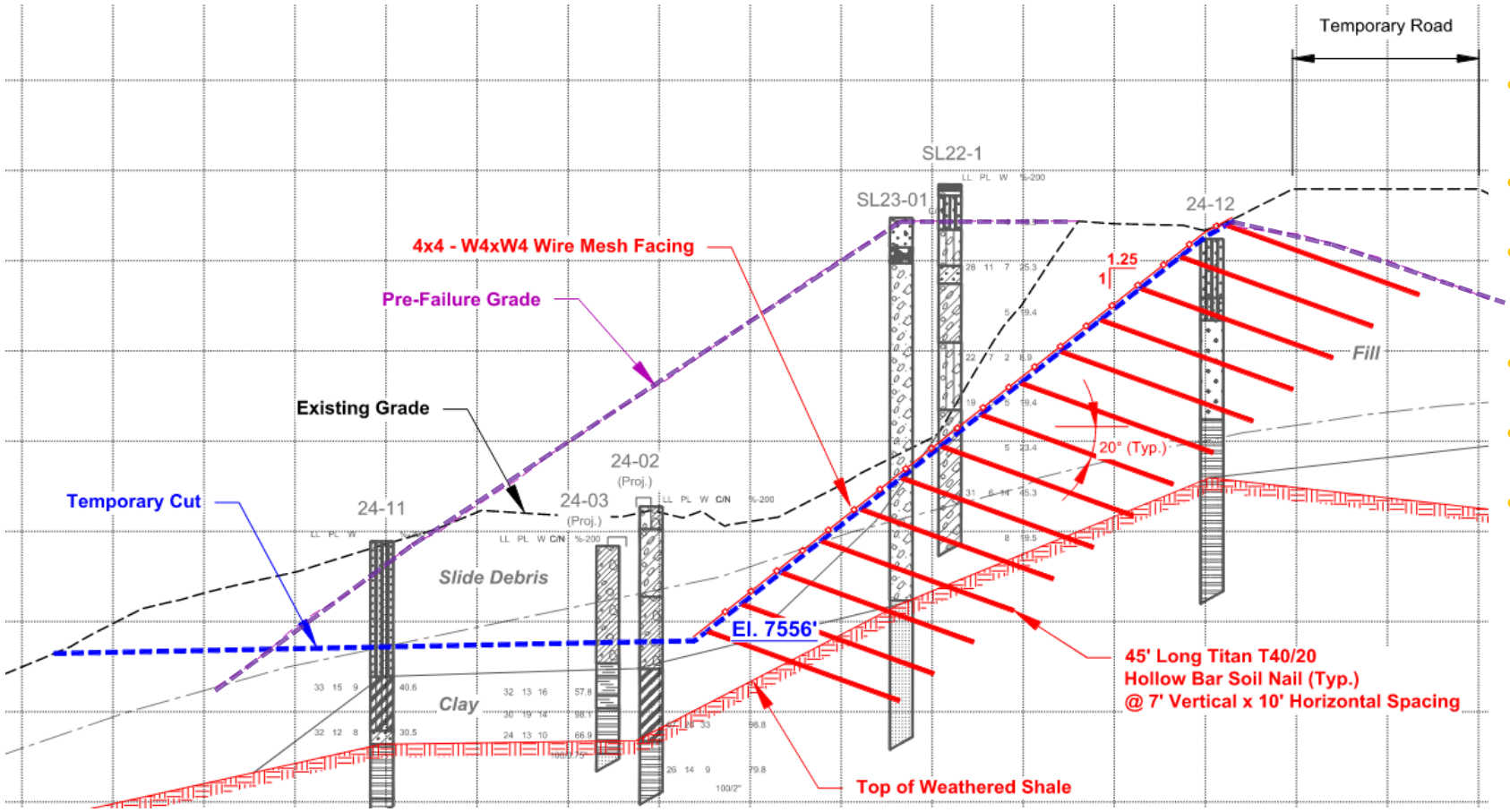
Temporary Shoring – Soil Nailing



- Notes from boring 24-12 (not sampled) modified design section
- Maximum soil nail length is 50 ft
- Installed on 10 ft horizontal and 7 ft vertical spacing
- Staggered diamond pattern
- Inclined 20 degrees from horizontal
- Geotextile and steel mesh facing with horizontal steel bar wales

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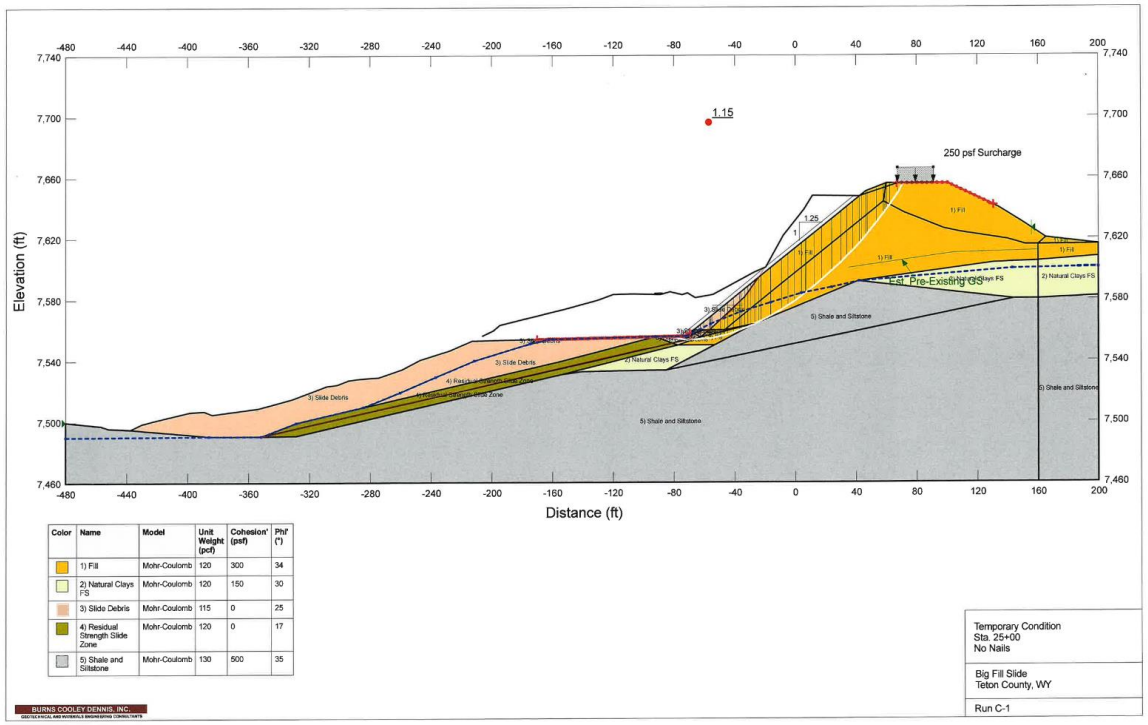
Some Design Sections

Right Side of Cut: 1.25(H):1.0(V)

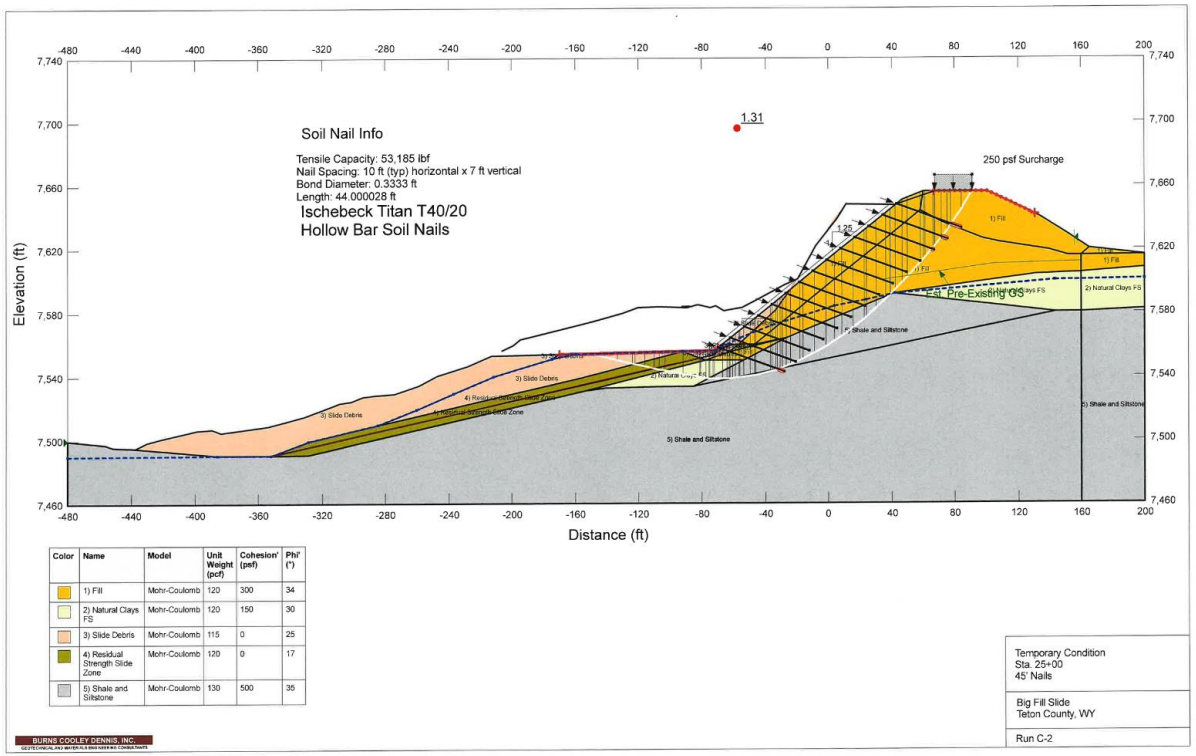
Pre-Failure Back Analysis

FS = 1.15 (note: initially lower)



After Soil Nailing

FS = 1.31



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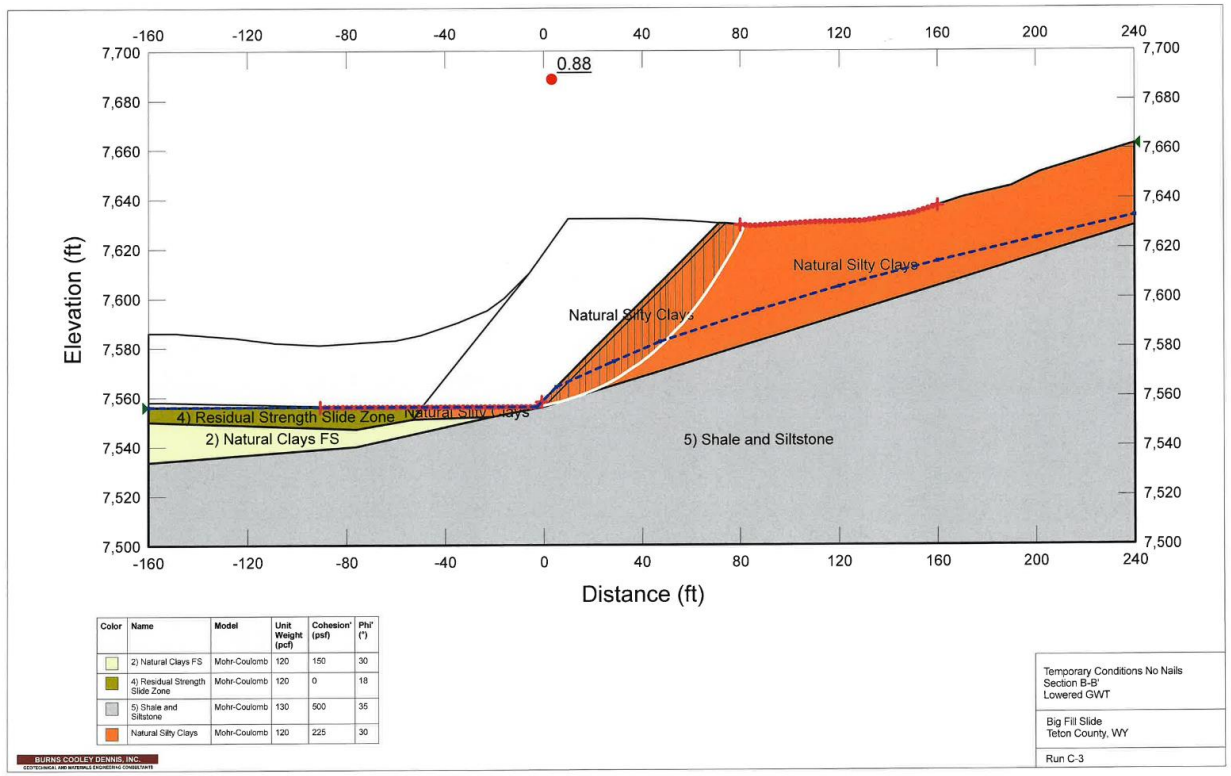
Some Design Sections

Left Side of Cut: 1.0(H):1.0(V)

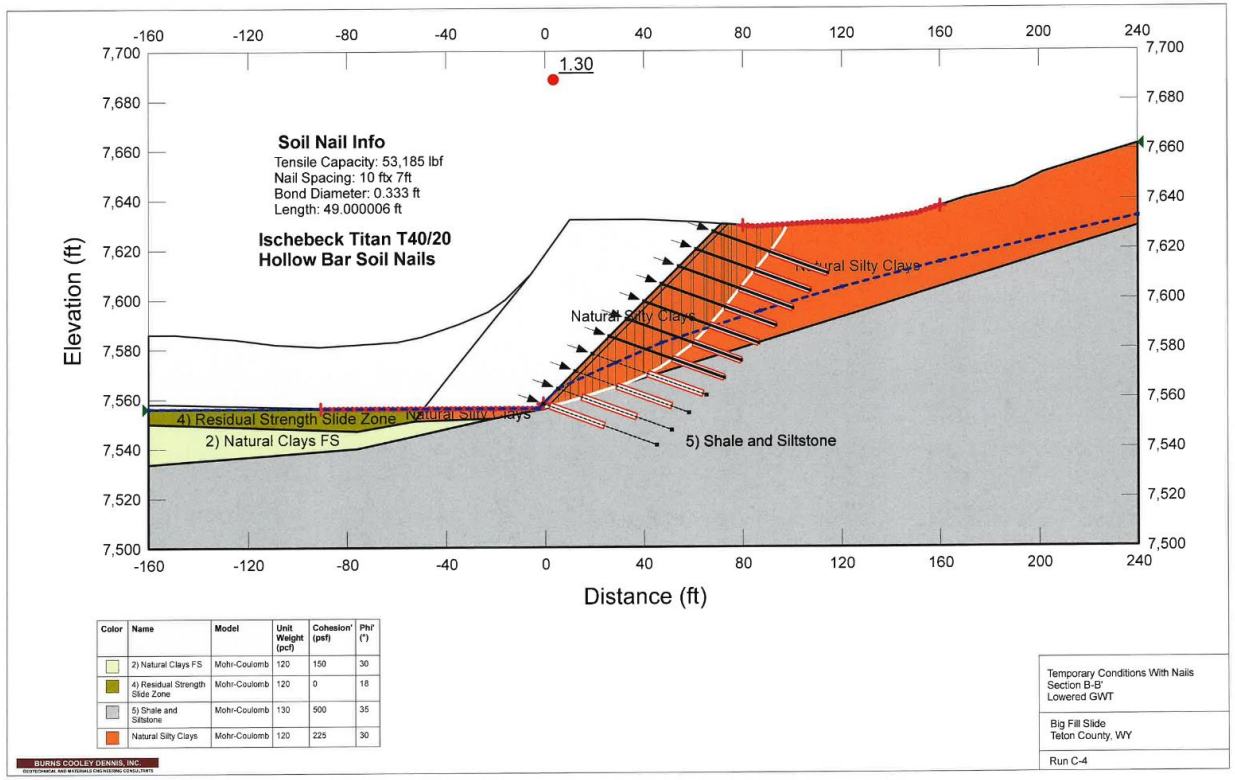
Pre-Failure Back Analysis

FS = 0.88



After Soil Nailing

FS = 1.3



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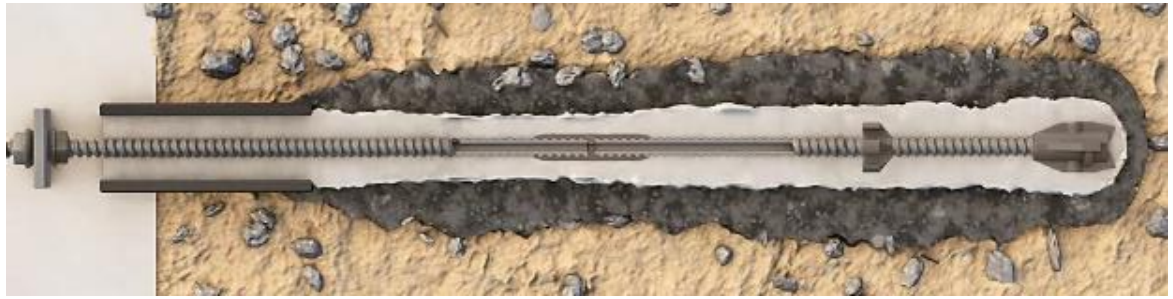
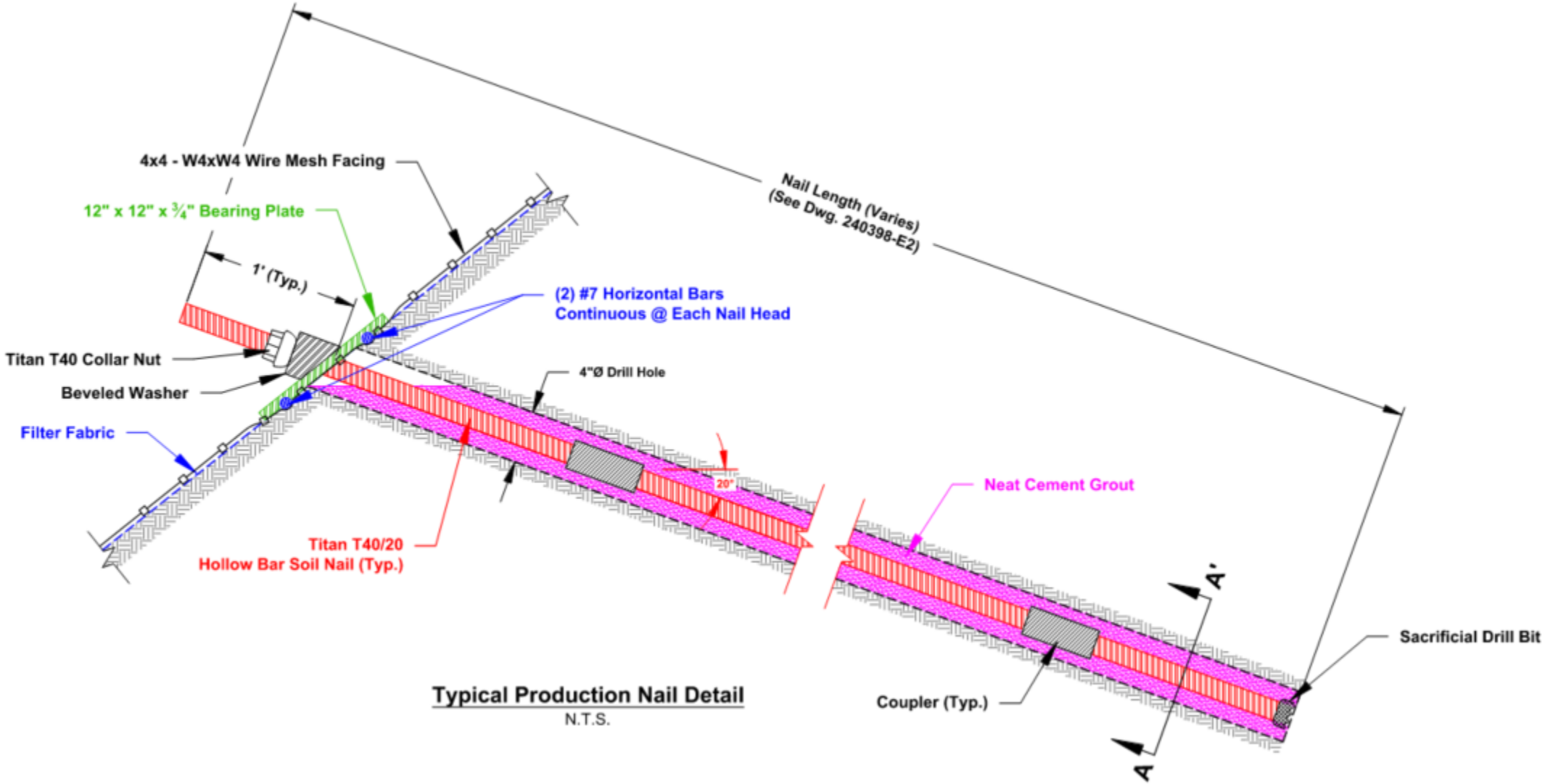
Soil Nail Drilling

- 25 ft and 14 ft masts with top drive drill heads mounted on 20 ton excavators.
- Ishebeck Titan Hollow Bar soil nails 40/20



Soil Nail Detail



Typical Production Nail Detail
N.T.S.

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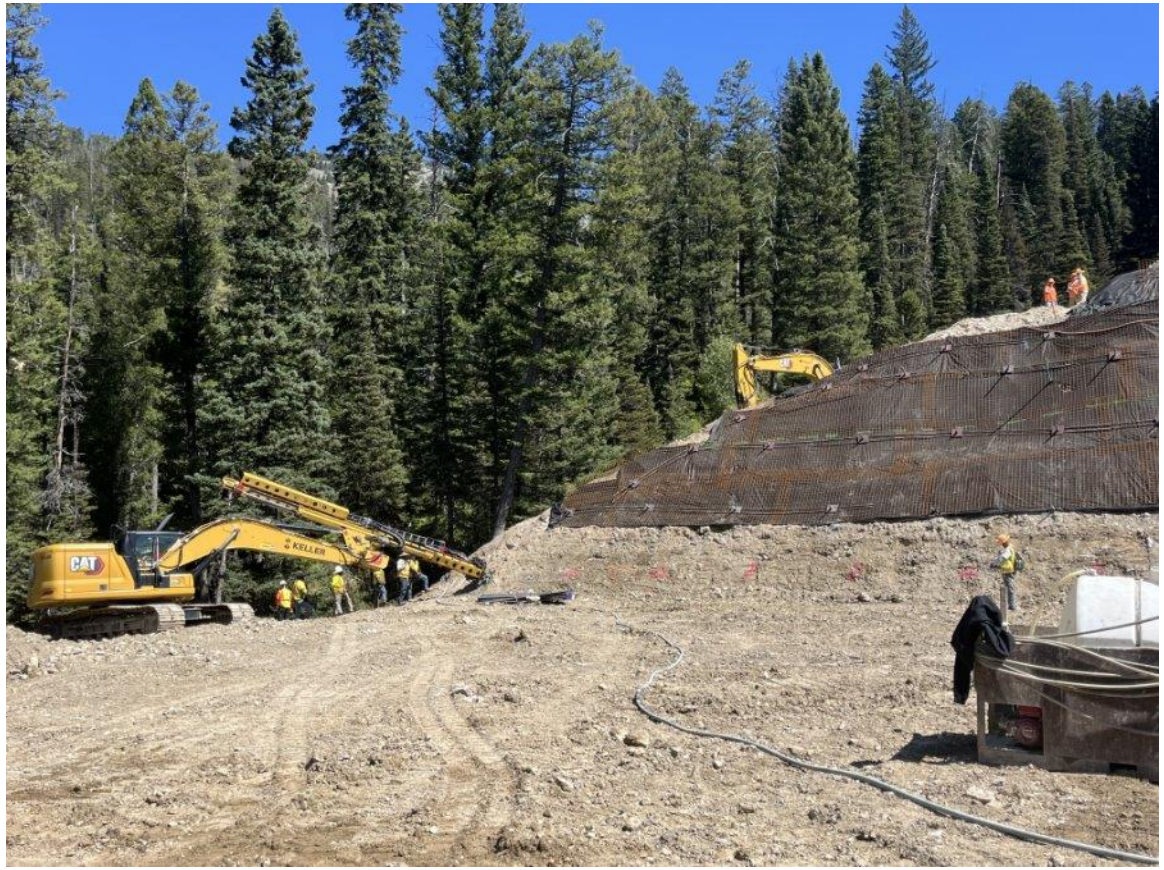
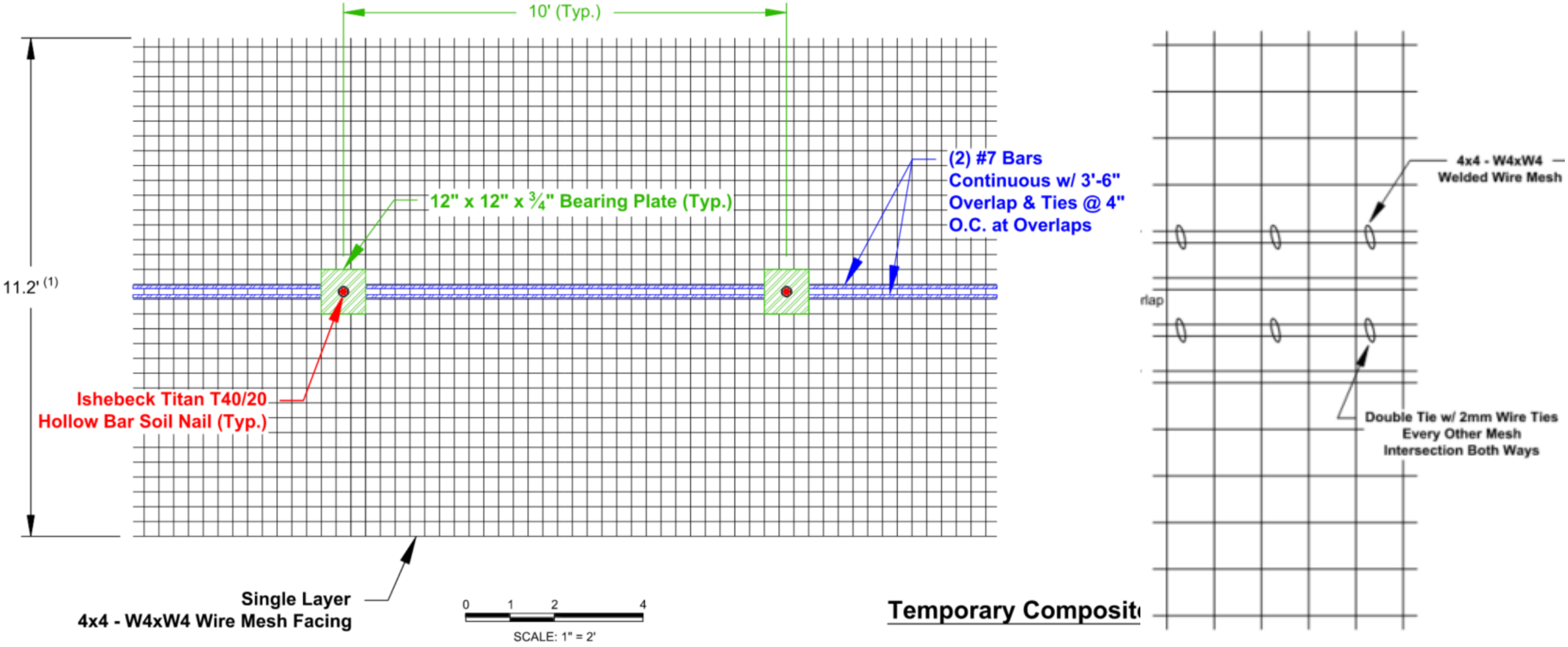
Soil Nail Facing



- High strength wire mesh facing with parallel steel reinforcing bars acting as wales
- Geotextile fabric on the backside against the soil

Soil Nail Facing Detail



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Facing Installation Process

Step 1: Place and secure geotextile.

Step 2: Place wire mesh sheet.

Step 3: Tie wire mesh properly.

Step 4: Place and tie continuous waler bar.

Step 5: Place bearing plate, beveled washer, and collar nut.

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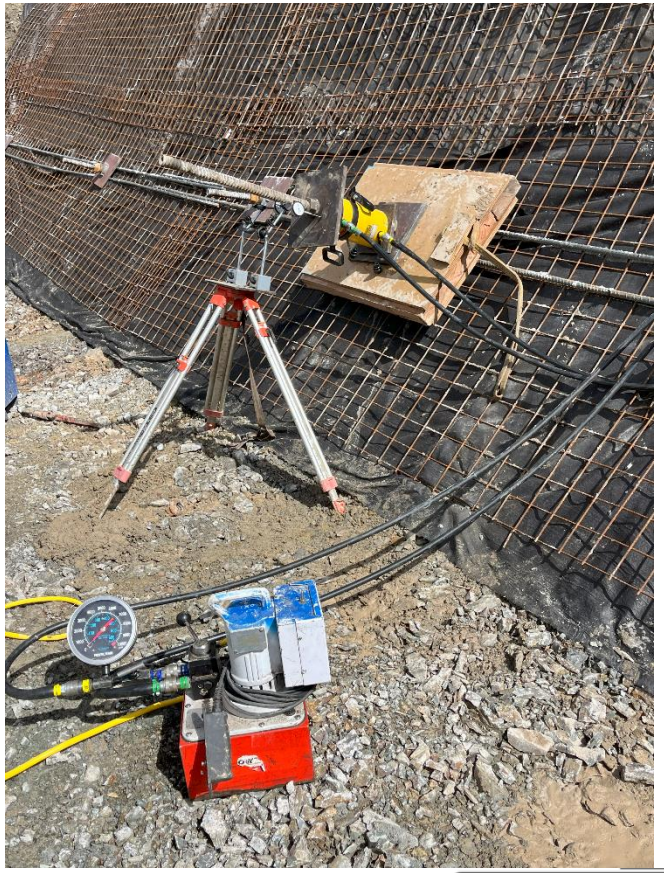
Excavation

- GC Ames Construction had excavation crews working day and night.
- Utilized a conveyor belt, 3 excavators, and 1 dozer to move soil.

1 Test Nail per Lift

Soil Nails Testing



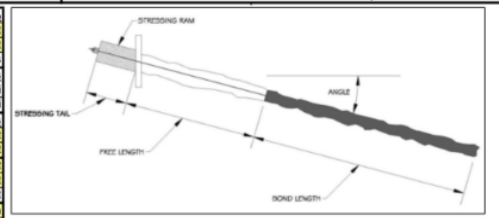
- **Each test satisfied the creep test criteria at a load equal to 1.5 Design Load (DL), and each nail adequately held in excess of 2.0 DL.**

Keller North America, Inc.
5775 Eudora Street
Commerce City, CO 80022

Soil Nail Report
Verification Test
Nail Number: T8 between F-35 and F-36
SoilType: Fill
Tested Ultimate Bond Stress: 38 psi

KNA Job Number:	15311409
Job Name:	Grand Teton Landslide
Job Location:	Wilson, WY
Date:	8/30/24
User:	JA

Allowable Design Load (DL) @ 100%	
Soil DL (kips/ft bond):	1.89 kip/ft
Rock DL (kips/ft bond):	0.00 kip/ft
Pullout Design Load:	18.9 kips
Allowable Bond Stress	
Soil Bond Stress:	12.54 psi
Rock Bond Stress:	0.00 psi
Grouted Bond Lengths	
Soil Bond Length (BLs):	10 ft
Rock Bond Length (BLr):	0 ft
Free Length (FL):	20 ft
Stressing Tail (T):	2 ft
Total Stressing Length (L):	22 ft
Drill Hole Dia.:	4.0 in
Nail Area (A):	1.13 sq. in.
Modulus of Elasticity (E):	28,500 ksi
Nail Type:	40/20 bar
Yield Strength:	96.7 kips
90% Yield Strength:	87.0 kips

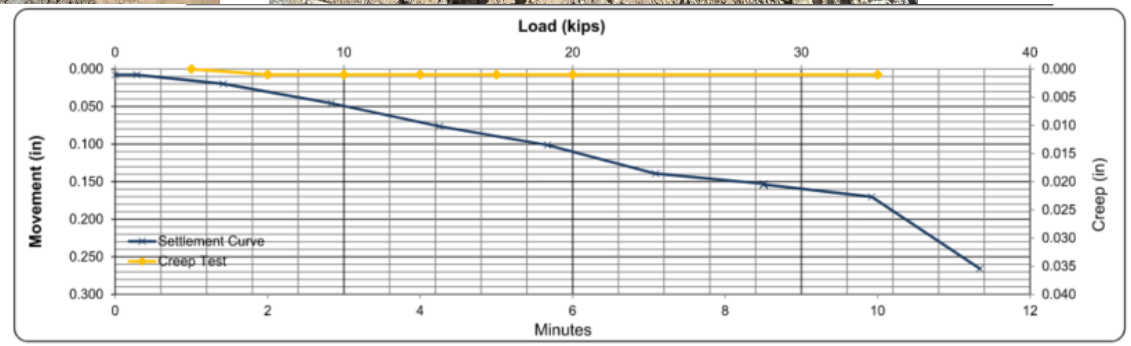


Anchor Elongation Calculations
Alignment Load (AL): 5.0% 0.9 kips
Theoretical Δ at AL (PL/AE): 0.008 in
Adjust Actual Elongations for AL (Add
Theoretcal Δ at AL to Actual) Y or N? Y

Ram No:	100-51
Ram Capacity (Ton):	100
Gage (A or B):	A
Calibration Date:	2-Jul-24

Test Load (Kips)	Gage (psi)	Ram Factor (psi/kip)
17.78	1000	0.00
37.41	2000	53.46
57.21	3000	52.44
77.00	4000	51.95
96.46	5000	51.83
116.09	6000	51.68
136.05	7000	51.45
156.13	8000	51.24
175.90	9000	51.17

	Time	Pullout Load (%)	Nail Load (k)	Jack Pressure (psi)	Actual Elongation Left (in)	Actual Elongation Right (in)	Adjusted Elongation (in)	Comments
Hold Time		0.0%	0.0	0			0.008	
1 min		5.0%	0.9	50	0.000	0.000	0.008	
10 min		25.0%	4.7	250	0.009	0.015	0.020	
10 min		50.0%	9.5	500	0.029	0.047	0.046	
10 min		75.0%	14.2	750	0.050	0.087	0.076	
10 min		100.0%	18.9	1000	0.065	0.122	0.101	
10 min		125.0%	23.6	1250	0.099	0.164	0.139	
Creep Test 1 min		150.0%	28.4	1475	0.112	0.178	0.153	
2 min		150.0%	28.4	1475	0.113	0.179	0.154	
3 min		150.0%	28.4	1475	0.113	0.179	0.154	
4 min		150.0%	28.4	1475	0.113	0.179	0.154	
5 min		150.0%	28.4	1475	0.113	0.179	0.154	
6 min		150.0%	28.4	1475	0.113	0.179	0.154	
10 min		150.0%	28.4	1475	0.113	0.179	0.154	If movement from 1 to 10 min is greater than 0.040 run extended creep test, then continue
Extended Creep Test 20 min		150.0%	28.4	1475				
30 min		150.0%	28.4	1475				
50 min		150.0%	28.4	1475				
60 min		150.0%	28.4	1475				
10 min		175.0%	33.1	1725	0.129	0.196	0.170	
10 min		200.0%	37.8	1975	0.221	0.295	0.266	
10 min		250.0%	47.3	2450	0.256	0.327	0.299	
10 min		300.0%	56.7	2950	0.369	0.451	0.418	
10 min		350.0%	66.2	3425				



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Teton Pass Temporary Shoring
Completed in 5 weeks working 24/7

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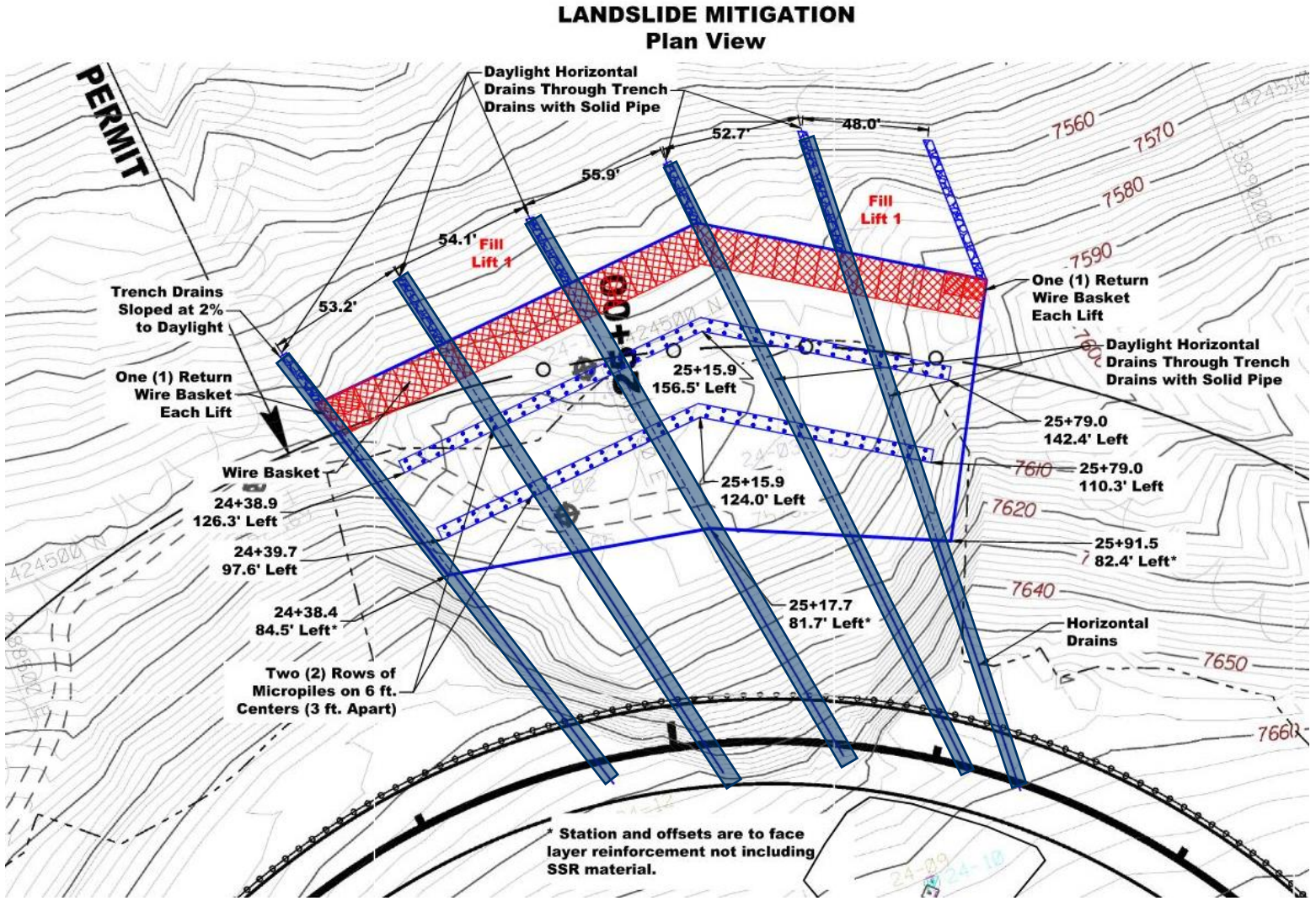
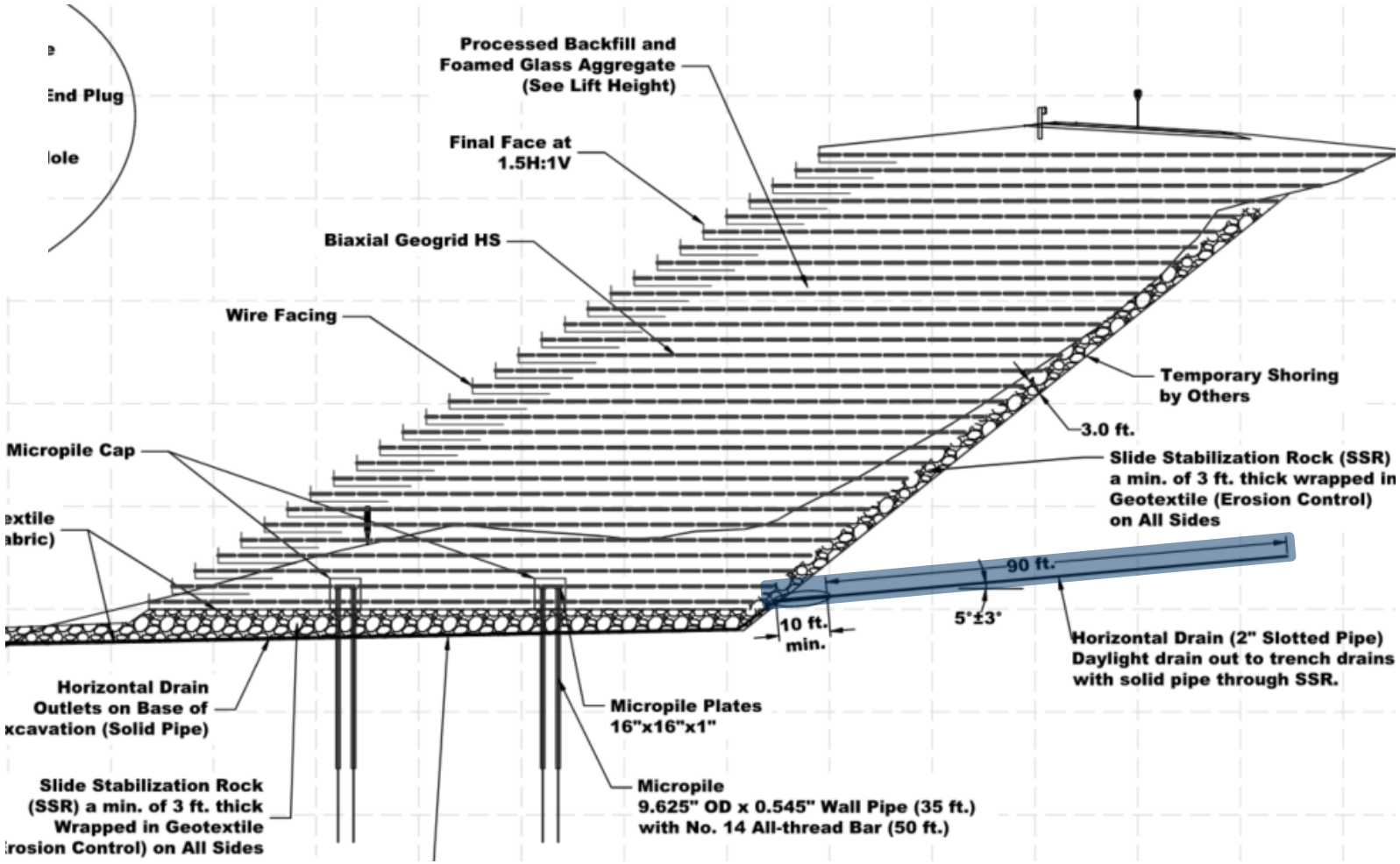
Horizontal Drains

- 5 Horizontal Drains Installed after Soil Nailing by Jensen Drilling



Horizontal Drains

- 2 inch diameter slotted pipe
- Drilled 90 ft
- 10 ft riser section
- 5 degrees upward



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Horizontal Drain Drilling

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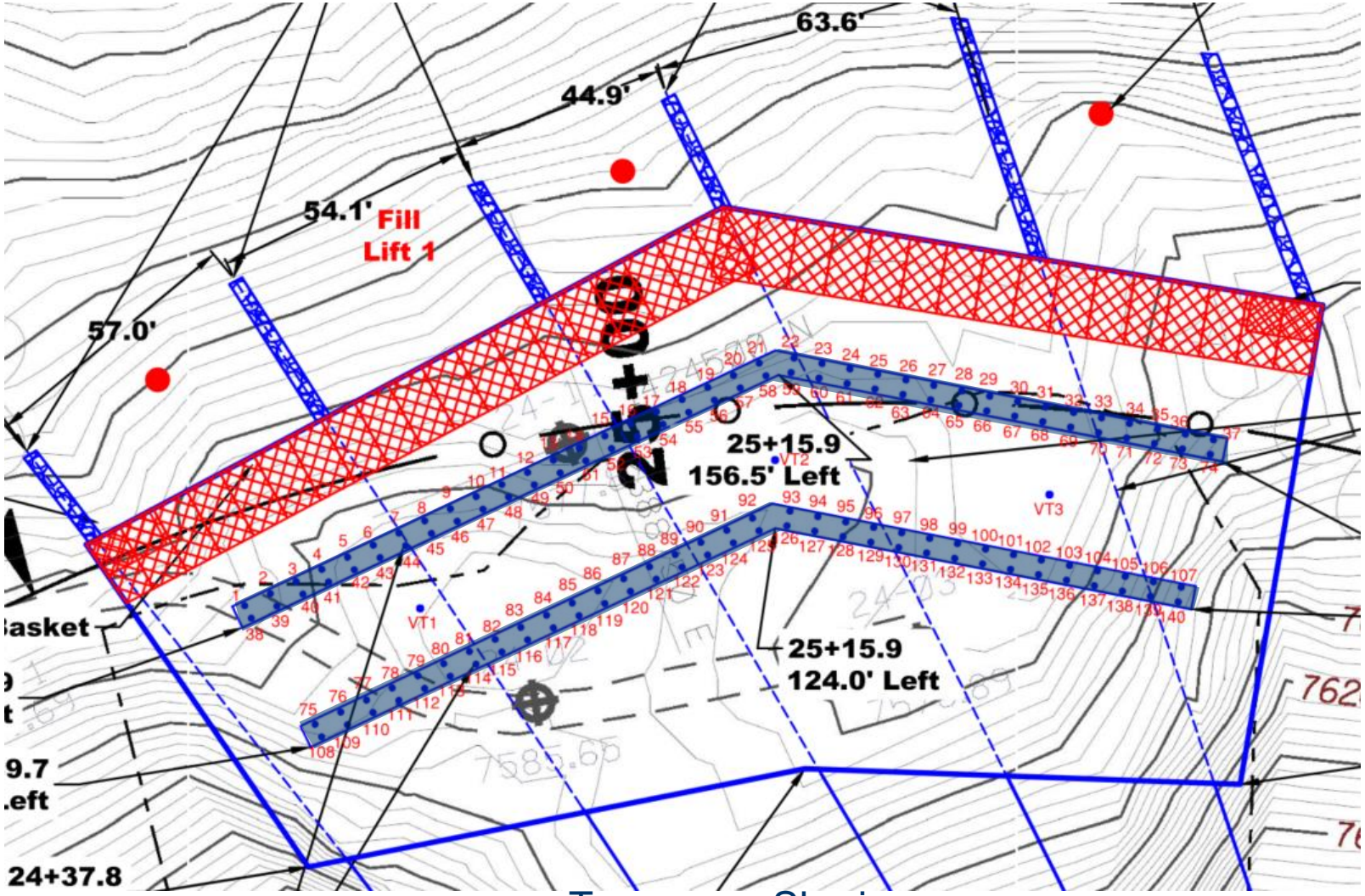
Permanent Slope Stability Micropiles

- Keller installed 140 permanent micropiles for base stabilization in front of the shoring
- 9-5/8 inch diameter cement grouted steel pipes and bars
- 2 groups of coupled micropiles with 2 rows in each group
- RJ Engineering design for WYDOT

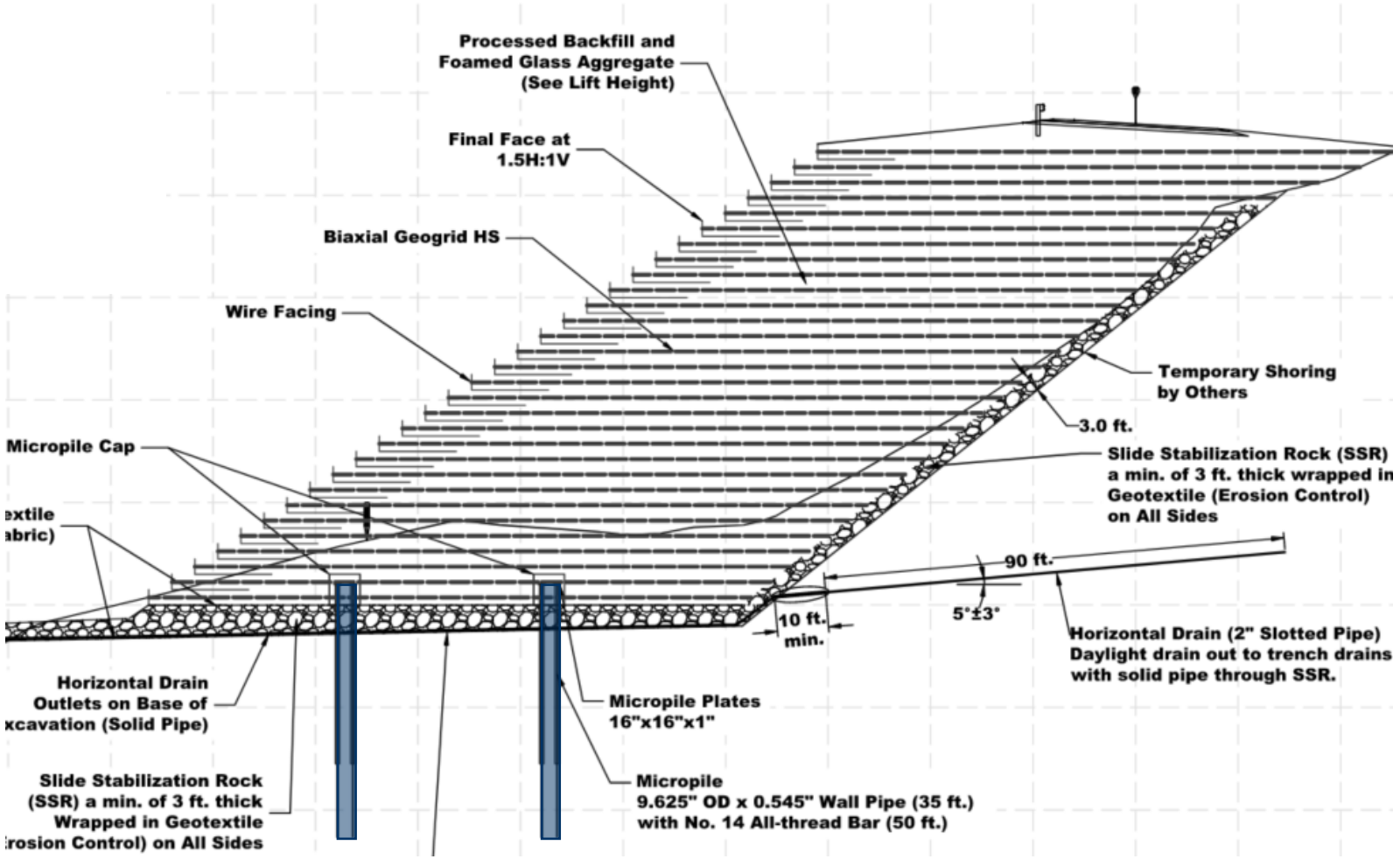


Temporary Shoring

KELLER

Permanent Slope Stability Micropiles

- Approx. 8 ft of pipe was left sticking up from the ground
- Micropiles connected to the future reinforced backfill slope by Ames
- Ames to install a leveling pad with rock (up to 6 in.) to the bottom of pier cap.
- Reinforced lightweight foamed glass aggregate backfill with biaxial geogrid up to the previous highway elevation



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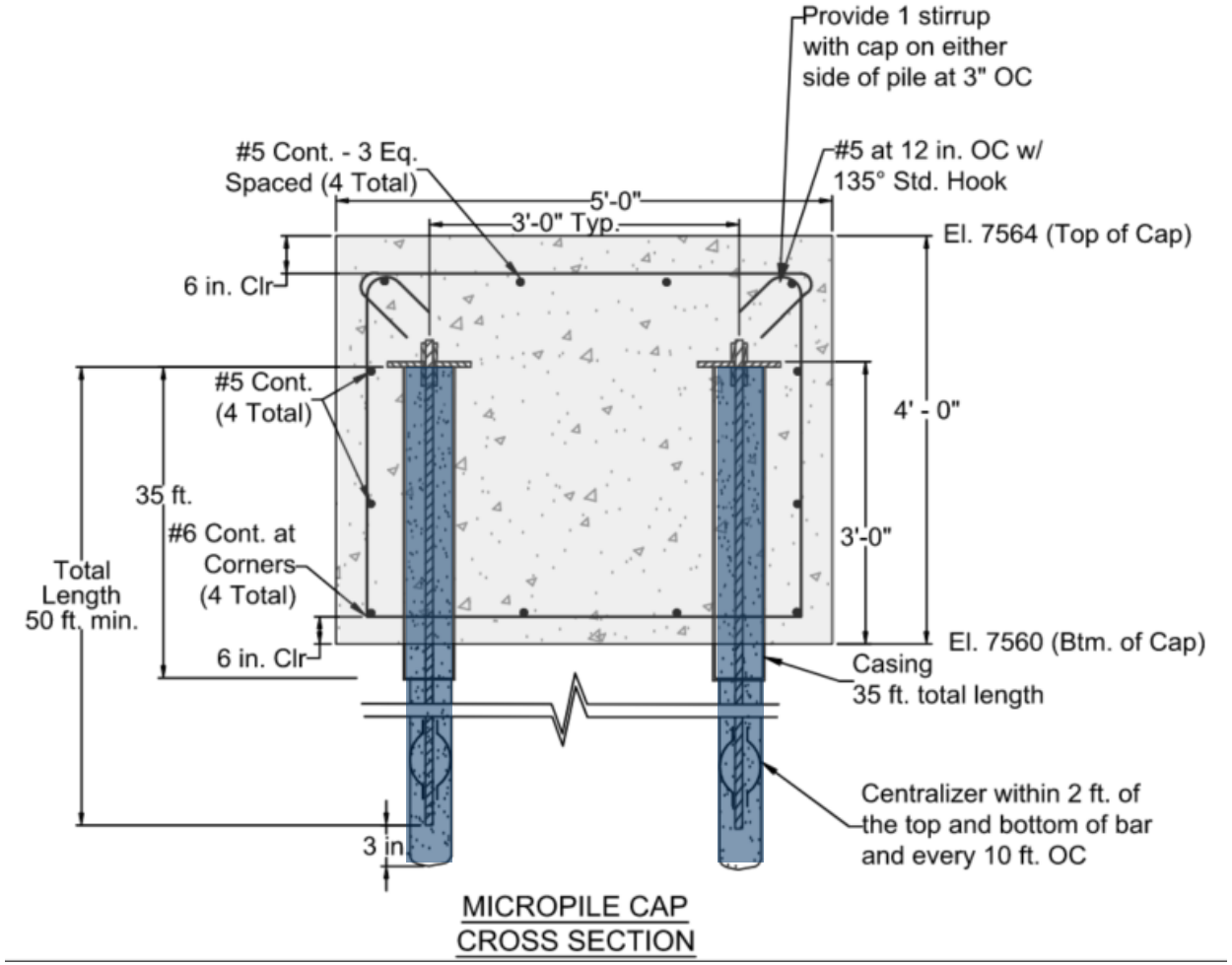
Permanent Slope Stability Micropiles

- Micropiles in each group are connected by a 5ft x 4ft pile cap
- MP Total length: 50 ft minimum
- Steel Pipe (9-5/8in): 35 ft
- 10 ft C-C spacing on pairs
- Rock Socket (8in): 15 ft minimum
- #14 – 75 ksi threadbar in the center
- Test Pits confirmed conditions after soft clay encountered in drilling



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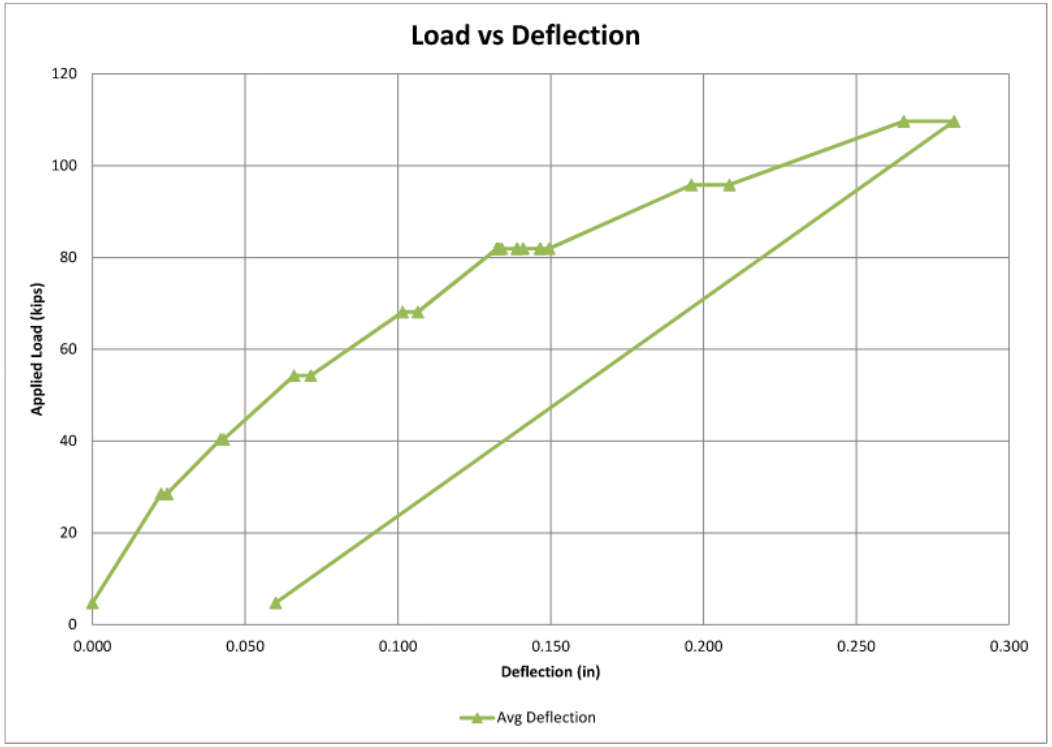
Micropile Installation

Micropile Testing

- 3 tension tests performed on sacrificial piles constructed using the same means and methods as for the production piles.
- 110 Kip Test Load; 55 Kip Design Load



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Permanent Slope Stability Micropiles

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Permanent Slope Stability Micropiles
Completed in 3 weeks with 2 crews/2 rigs
Working 1 long shift 6 days/week

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Conditions at Site as Keller Demobilized

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Conditions at Site as GC Ames Construction placed Lightweight Fill

December Conditions at Site – Weather Halted Project

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2025 Completion of Project

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Finishing the project – US Forest Service required covering of wall with soil to be grassed

Jackson Hole News&Guide

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End