Geofoam Lightweight Fill - Lessons and Applications in Colorado

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Colorado

- Known for?
  - *Traffic*. Crippling, mind numbing, *WTF?!* recreational traffic.

c/o Denver Post

Colorado

- Known for?
  - Mountains and snow

Colorado

- Geotechnical impacts?
  - Slope stability: rockfall, slides, debris flows

Colorado

- Geotechnical impacts?
  - Vertical bedding and structural impacts
  - Fluctuating groundwater and saturated conditions
  - Clay

Geofoam?

- Defined by ASTM D6817/D6817M
- Expanded Polystyrene Fill (EPF)
- CDOT Item 203-00840 (EPF in cubic yard [CY]) and 203-00850 (EPF Complete In Place in CY)

Geofoam Properties

- Lightweight and rigid material (D6817, Table 1)
  - Density range: 0.7 pcf – 3.0+ pcf
  - Compressive strength: 2.2 psi – 40.6+ psi
  - Flex strength: 10 psi – 100+ psi

CDOT Use of Geofoam

- 1993 - SH 14 Cameron Pass Slide
- 2004 - U S160 Montoya Slide
- 2005 - US 160 Slides
- 2007 - Kit Carson Bridge
- 2008 - CO 13 Rio Blanco Slide
- 2010 - US 50 Cerrro Slide
- 2011 - SH 14 Cameron Pass Slide
- 2012 - US 50 Cerrro Slide
- 2012 - US 50 Blue Ck
- 2014 - US 287 over BNSF
- 2019 - US 36 Wall Repair
- 2022 - Bridge Repair (Multiple)
- 2023 - US 6 Newcastle Intersection

Costs of Geofoam

Year	CY	CY Cost	Subtotal
1993	1,230	$55.00	$67,650.00
2004	6,250	$72.00	$450,000.00
2005	7,700	$80.00	$616,000.00
2007	68	$450.00	$30,600.00
2008	5,500	$80.00	$440,000.00
2010	22,087	$56.39	$1,245,485.93
2011	8,000	$60.00	$480,000.00
2012	13,848	$129.92	$899,791.84
2014	4,523	$85.00	$384,455.00
2019	50,107	$119.04	$3,096,155.60
2022	9	$1,300.00	$11,167.00
2023	6	$365.00	$2,190.00
Total	**119,328**	**$64.73**	**$7,723,495.37**


When to use Geofoam Fill?

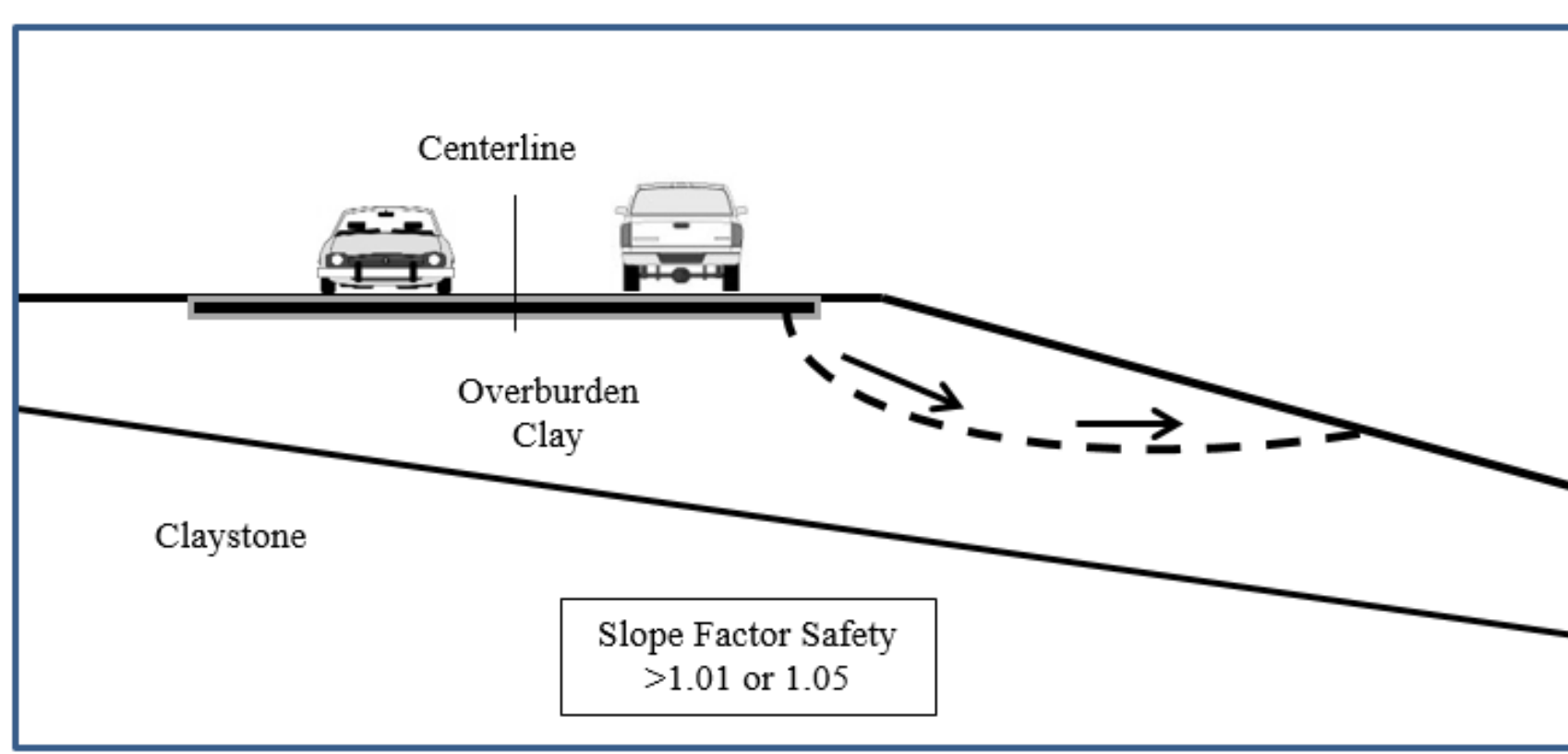
When to use Geofoam Fill?


Is it growing?
I swear it is growing??

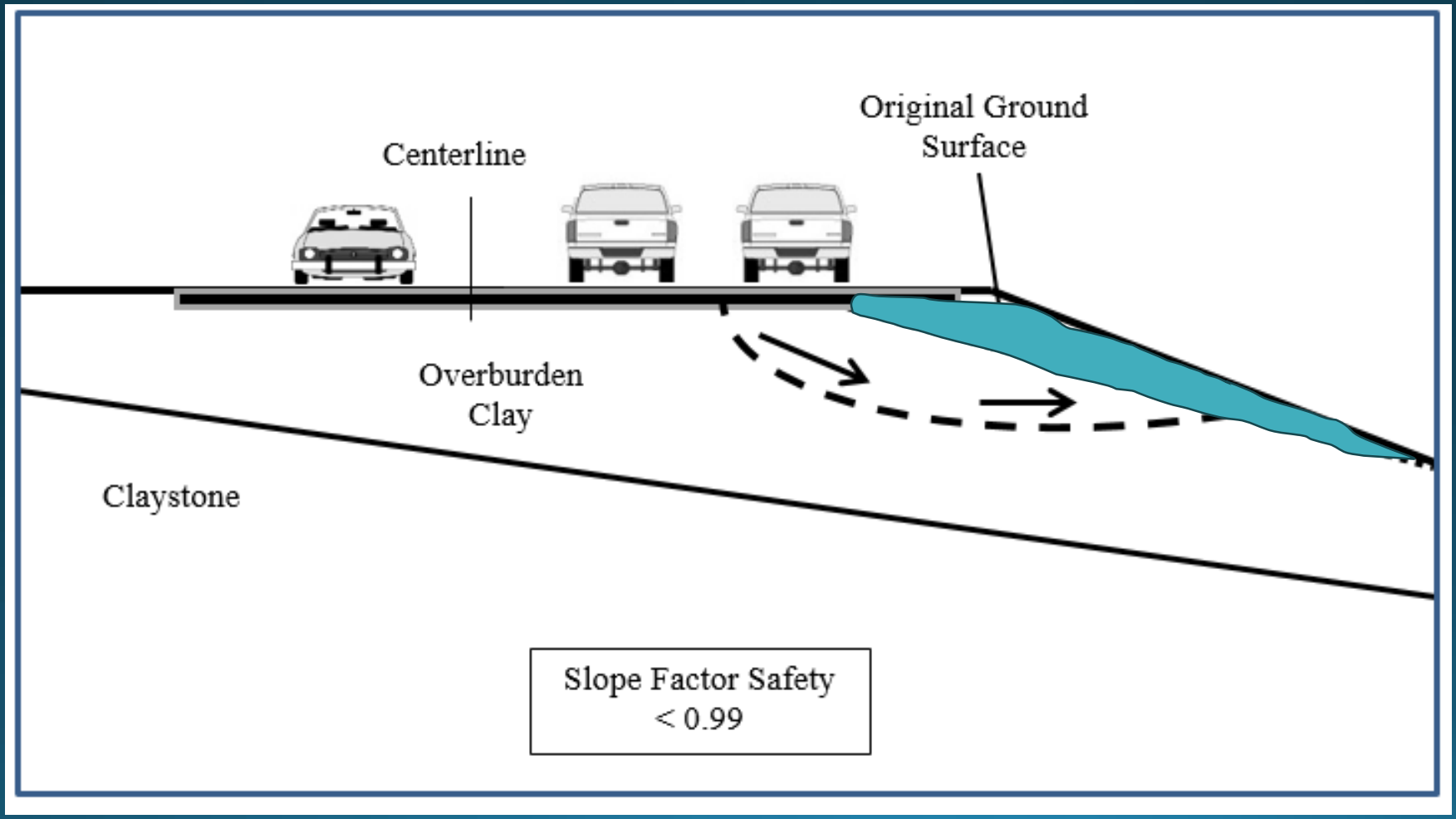
Why want to use Geofoam Fill?

- Really lightweight (1.15 pcf).
- 100 times lighter than what material is currently.
- Can be a great mitigation option (tool in the toolbox for landslide and embankment mitigation).

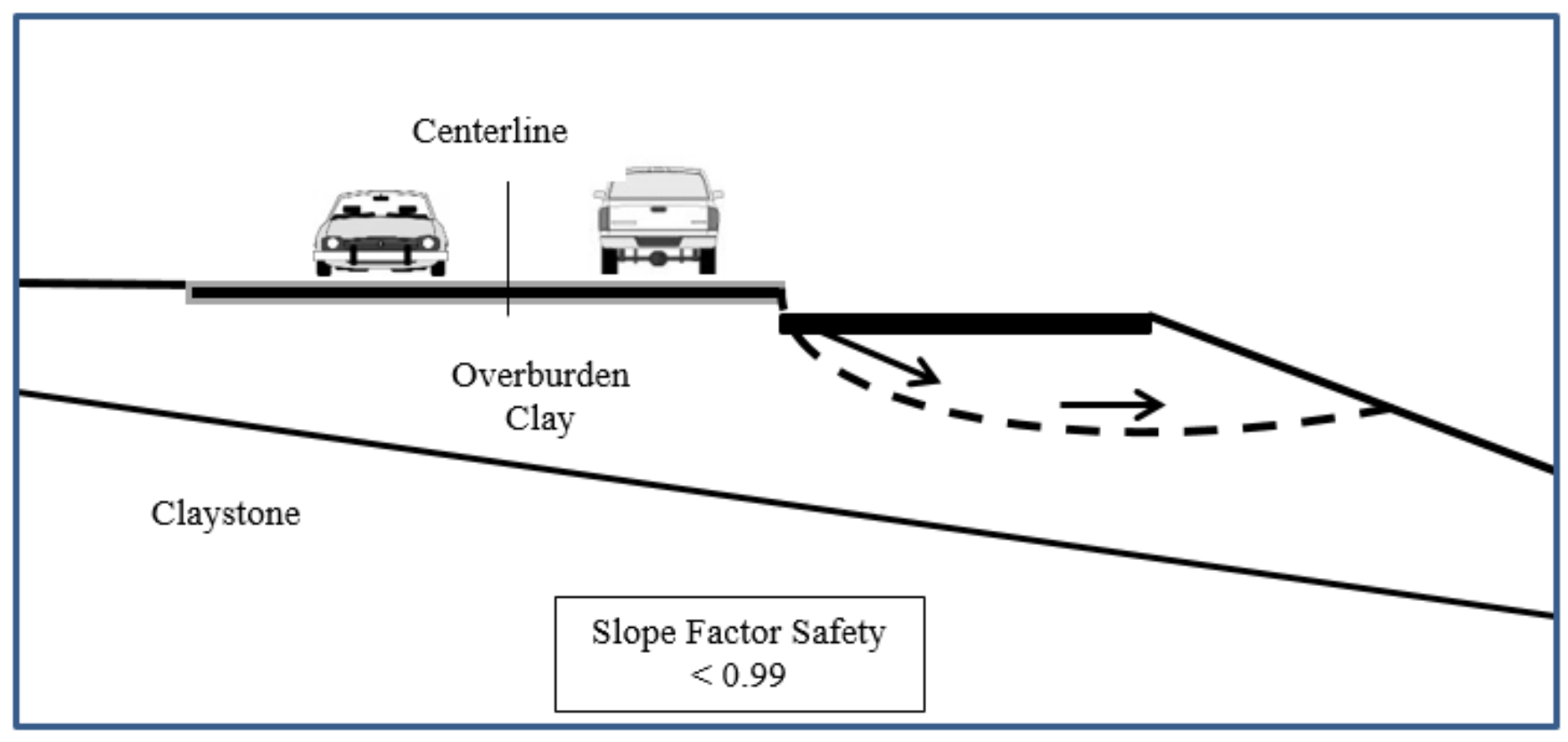
Many Instances - Existing Roadway with low strength embankments.



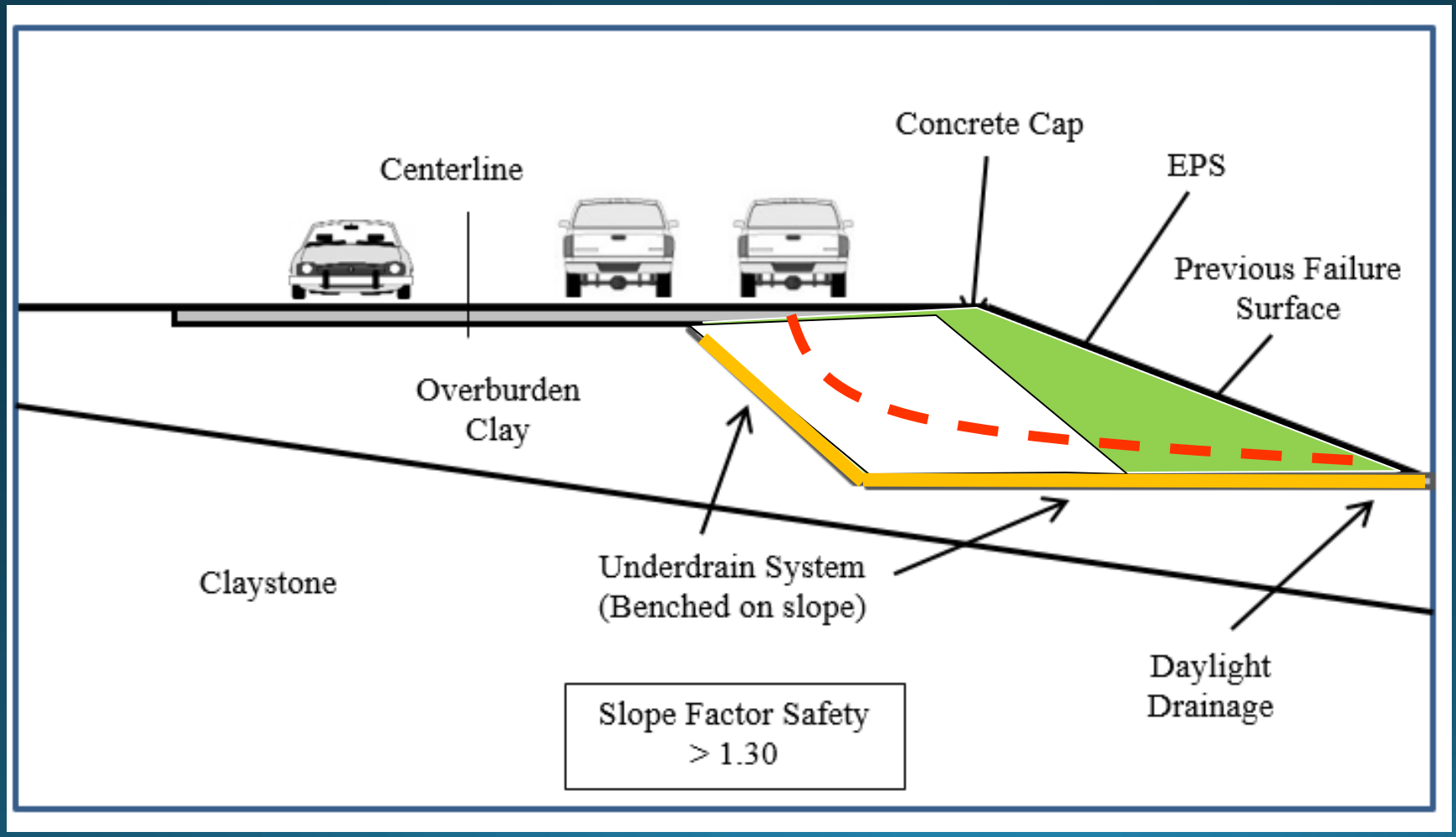
DOT or Agency builds out to add a lane.



Get a high precipitation year and…. Voila!



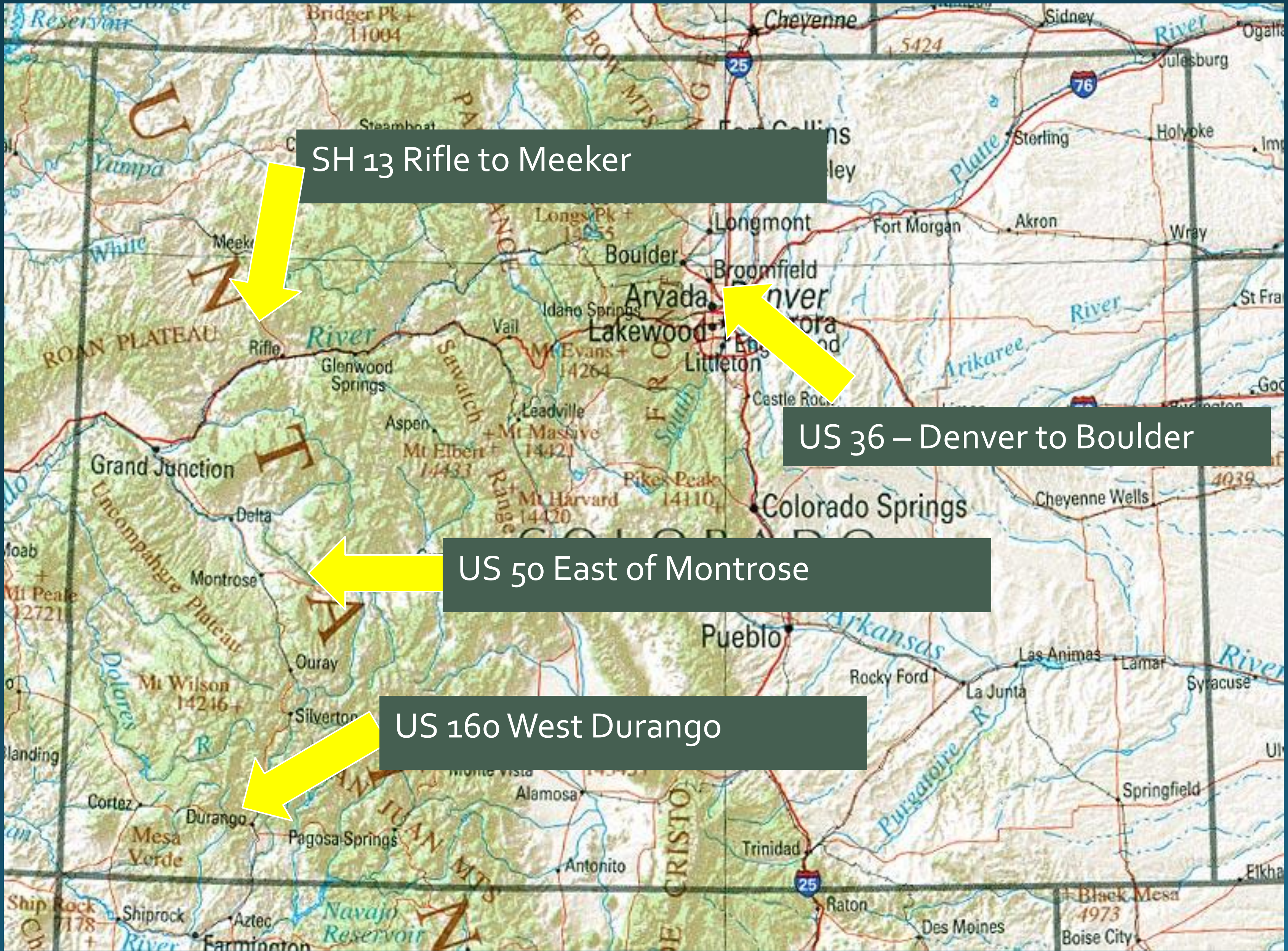
Have our failure how can we go about mitigating the failure?



EPS Design Considerations

1. EPS block characteristics
   - 0.7 to 3.0 PCF
2. Earth pressure and global stability effects
   - Active vs Passive.
   - Where does failure surface intersect blocks?
3. Groundwater and surface water
   - EPS floats

Colorado


SH 13 Rifle to Meeker
US 36 – Denver to Boulder
US 50 East of Montrose
US 160 West Durango
Cheyenne
Sidney
Julesburg
Fort Collins
Sterling
Holyoke
Longmont
Fort Morgan
Akron
Wray
Boulder
Broomfield
Arvada
Denver
Lakewood
Littleton
Castle Rock
Meeker
Rifle
Glenwood Springs
Vail
Aspen
Leadville
Grand Junction
Delta
Montrose
Ouray
Silverton
Colorado Springs
Cheyenne Wells
Pueblo
Rocky Ford
La Junta
Las Animas
Lamar
Syracuse
Springfield
Cortez
Durango
Pagosa Springs
Alamosa
Antonito
Trinidad
Raton
Des Moines
Boise City
Shiprock
Aztec
Moab

Site Conditions Colorado

- Sandstones and shales of the Mesaverde Group and Mancos Shale
- Highway embankments and fills exhibit low shear-strength properties when wetted and are prone to landslides and embankment failures.
- Overall the subject sites consisted of approximately 15 to 25 feet of low to medium plasticity clays underlain by weathered to unweathered shale/claystone bedrock.


US 50


US 50


US 50


US 50


US 160 – Previous
Sawdust Fill


US 160


US 160


US 160


US 160


SH 13
BARRIER

SH 13


SH 13

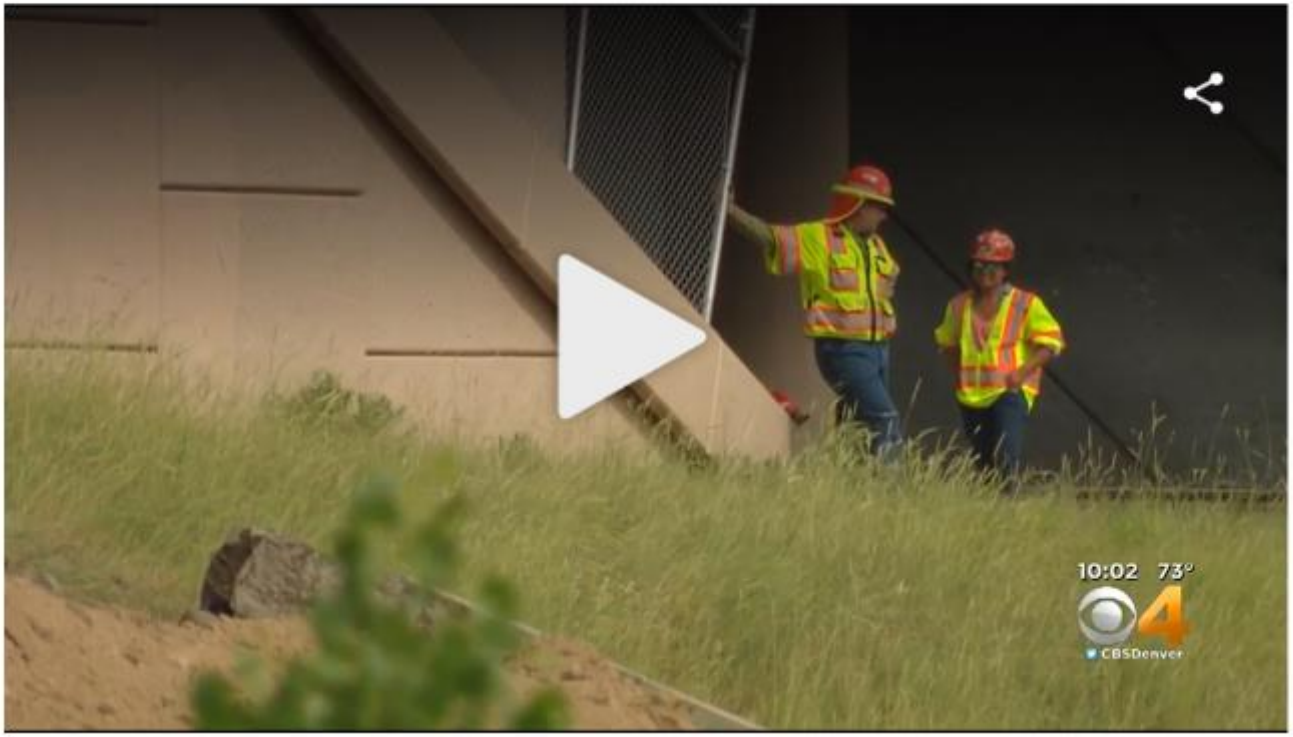

SH 13


SH 13


SH 13

‘A Giant Hole In The Highway’: Engineers Work To Fix U.S. 36

By Kelly Werthmann July 15, 2019 at 10:00 pm **Filed Under:** Colorado Department of Transportation, Highway U.S. 36, Westminster News



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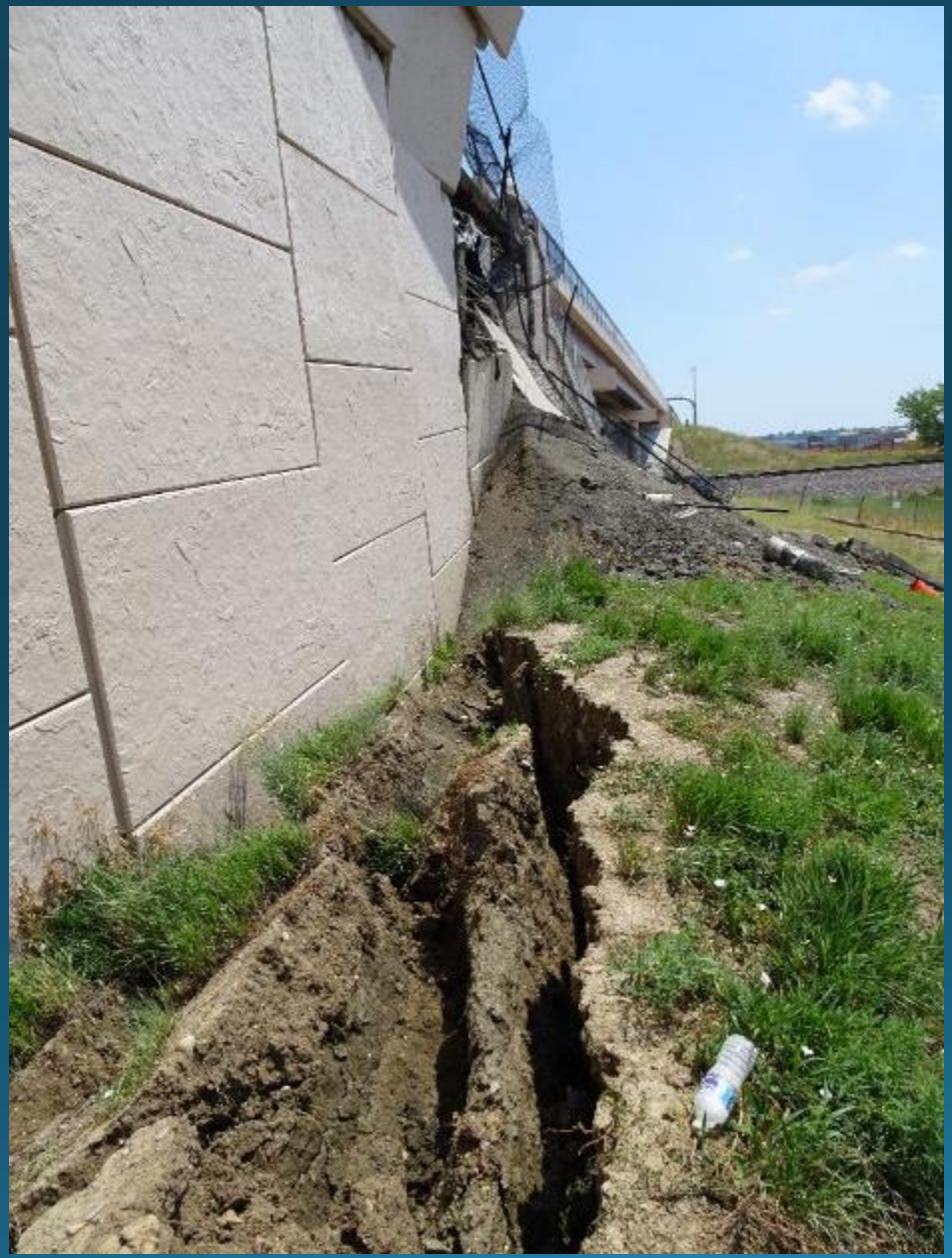
July 18, 2019

July 18, 2019

July 22, 2019



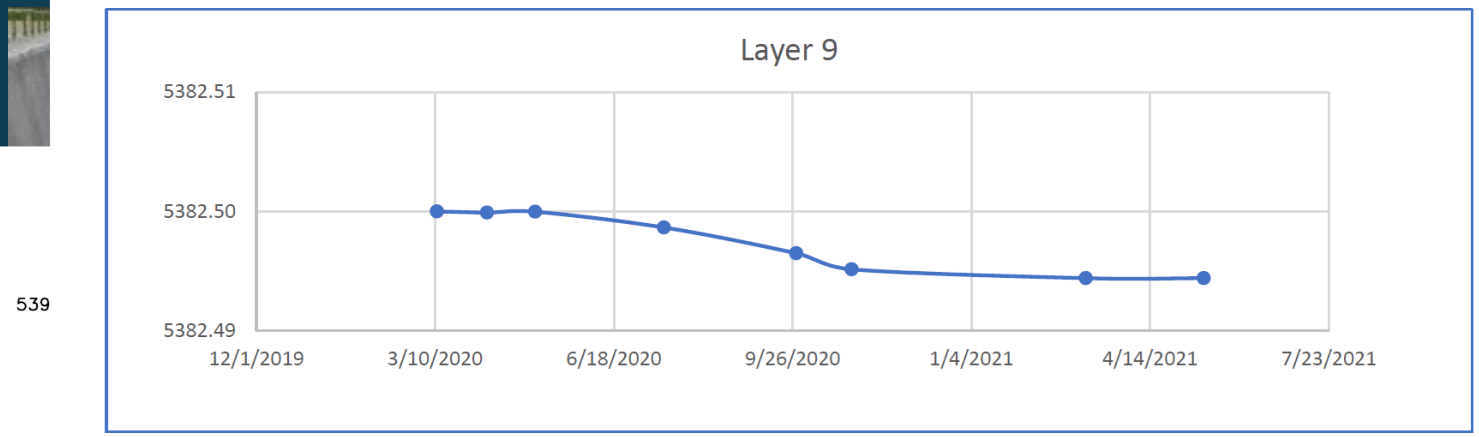
August 16, 2019

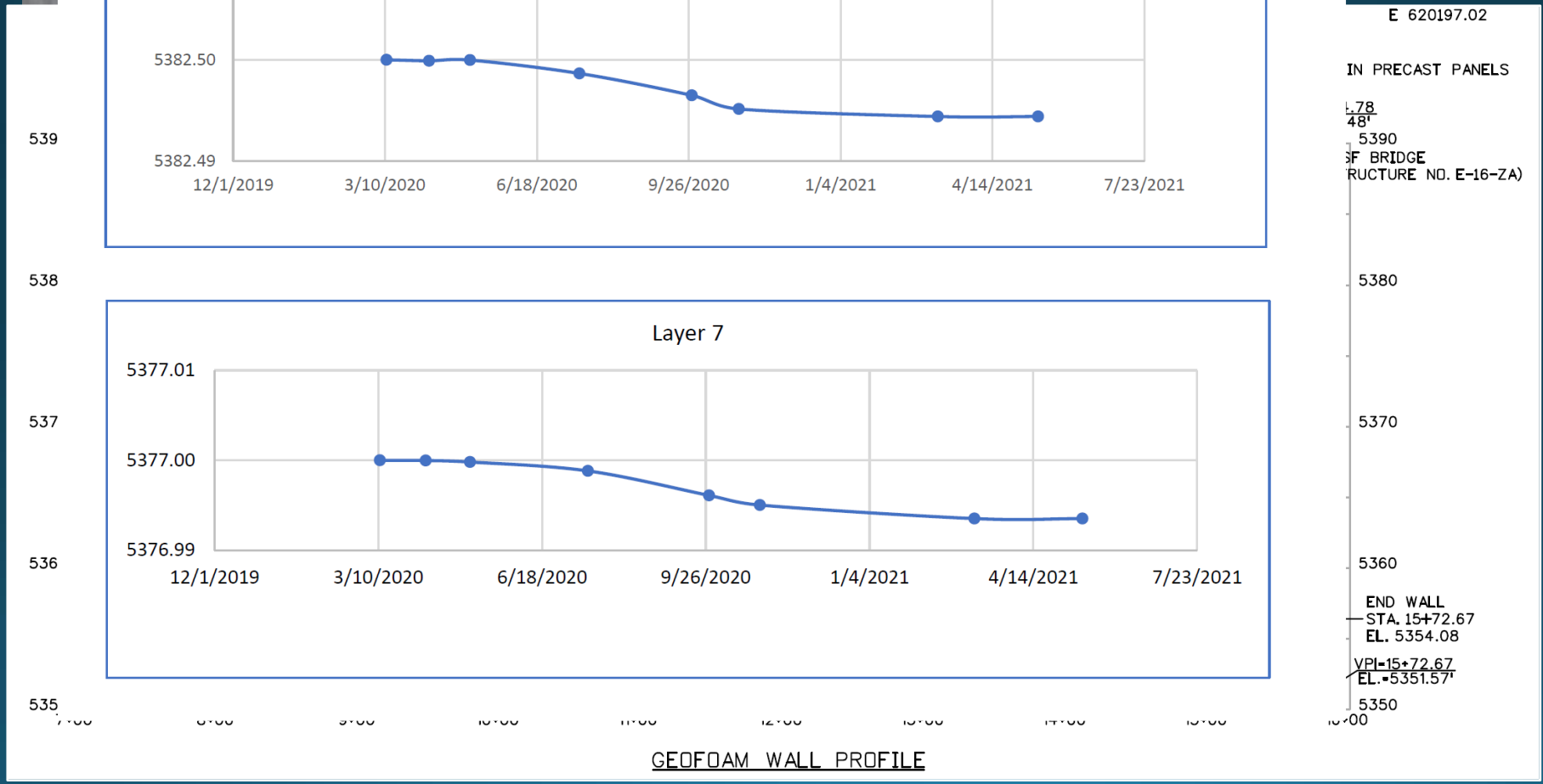
August 26, 2019

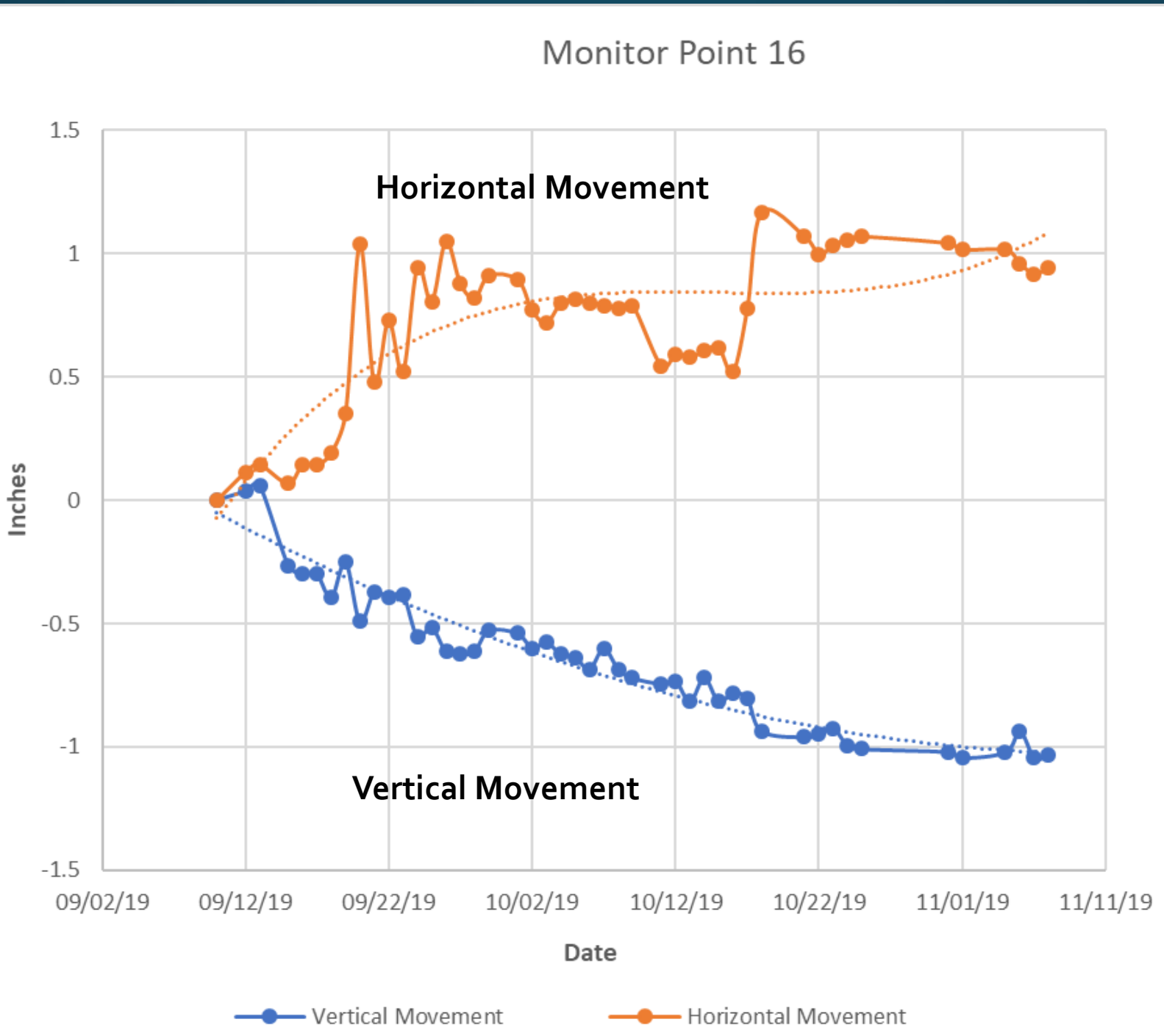
September 13, 2019

September 13, 2019

Installation of Extensometer Instrumentation






Monitor Point 16
Horizontal Movement
Vertical Movement
Inches
1.5
1
0.5
0
-0.5
-1
-1.5
09/02/19
09/12/19
09/22/19
10/02/19
10/12/19
10/22/19
11/01/19
11/11/19
Date
Vertical Movement
Horizontal Movement

ASCE Publication April 2021

Published April 2021 for ASCE Rocky Mountain (Geo-Conference)

EPS Lightweight Fill

Reoccurring Construction Issues:

1. *Careful handling of blocks to avoid damage!*
2. *Earth pressure effects on geofoam – either shoring or 1:1 or flatter cutslope!*
3. *Layout…….layout……..layout!*
4. *Acceptable gaps between blocks (1/4" to ½")!*
5. *Accommodating short term settlement prior to paving!*
6. *Grippers ineffective – foam in contact foam is best.*
7. *Quick Geofoam Characteristic – Deformation is vertical and horizontal!*

Conclusions

As with all geotechnical and geotechnical design projects the success of the project is dependant on the involvement of the Designer of Record.

It is important to have close communication between the Owner, Contractor and Designer to provide the best quality product.