NORTH CAROLINA
Department of Transportation

Resiliency Planning: Documenting and Managing Geotechnical Assets
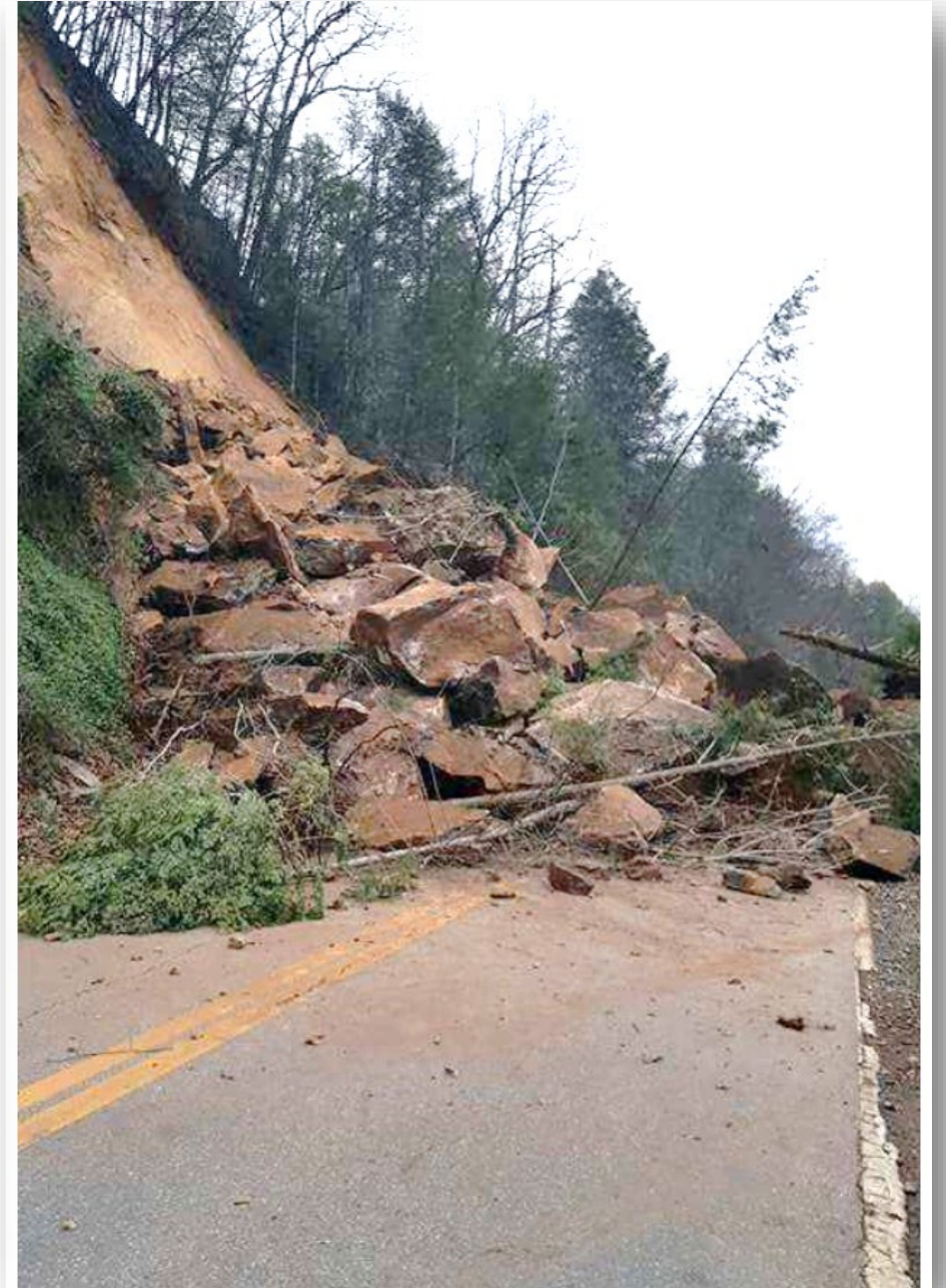
Crystal D. Johnson, L.G.

WRO Geotechnical Unit

October 31, 2023

Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

Clay for Scale

Geotechnical Asset Management

Geotechnical Assets are:

- "physical and independent assets that are within the right-of-way and an integral part of a transportation corridor" – Anderson, Schaefer and Nichols (2015)

North Carolina Assets that impact corridors:

- Rockfall
- Rockslide
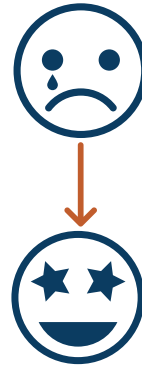- Landslide
- Embankment
- Debris Flow

A rating system that suits our needs:

Sites with failure anticipated

Institutional knowledge

Focus on disruption to facility

Each of 12 categories is assigned numerical value based on characteristics

Final calculation produces asset score

Assumptions and Considerations:

•   Geologic structure information is known

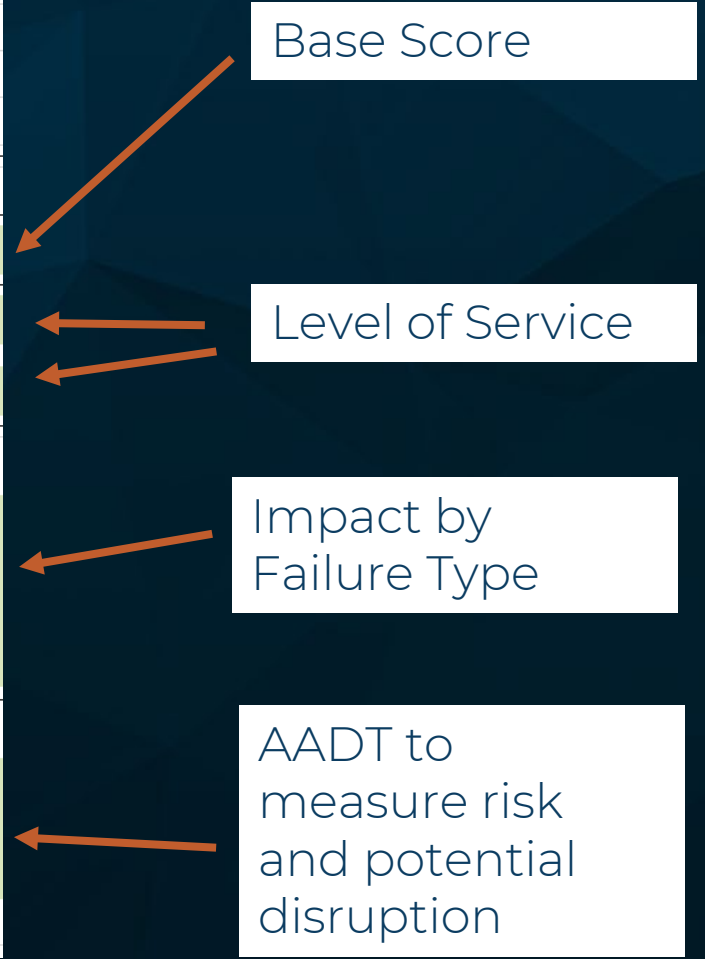•   Final scores are compared to each other only and are empirical

ASSET MANAGEMENT - SLOPES

Date:	**Field Geologist:**	**Division:**	
County No.:	**Latitude:**	**Northing:**	
County Name:	**Longitude:**	**Easting:**	
Route No.:	**Common Name:**		

			Score:
1. Route Type:			N/A
2. Detour Factor:	*A. Type of Detour:*		Select Detour
	B. Detour Length:		Select Length

3. Failure Type & Volume

Type:	Volume (yd^3)	
Rockfall		Select Quantity
Rockslide		Select Quantity
Landslide		Select Quantity
Embankment		Select Quantity

4. Average Vehicle Risk (AVR)

$$AVR = \frac{ADT * Slope\ Length\ (miles)}{Speed\ Limit\ (mph)} * 0.01$$

AADT =		
Slope Length (miles) =		
Speed Limit (mph) =		
AVR:	Traffic Info Needed	

5. Roadway Impedence:		Select Imp.
6. Pavement Damage:		Select Damage
7. Secondary Roadway Impact:		Select Impact
8. Failure Frequency:		Select Freq.

9. Precipitation Amount (Effect anticipated in 24 hrs):

Type:	Precipitation (in):	
Rockfall		Select Precip.
Rockslide		Select Precip.
Landslide		Select Precip.
Embankment		Select Precip.

10. Maintenance Required:		Select Maint.

11. Groundwater (Seepage):

Type:	Seepage Presence:	
Rockfall		Select GW Seep.
Rockslide		Select GW Seep.
Landslide		Select GW Seep.
Embankment		Select GW Seep.

12. Previous Remediation:		Select Rem.
13. Total Score:		Please fill out each category

Nantahala Gorge (2020)

ASSET MANAGEMENT - SLOPES

Date:	**Field Geologist:**	**Division:**
County No.:	**Latitude:**	**Northing:**
County Name:	**Longitude:**	**Easting:**
Route No.:	**Common Name:**	

1. Route Type:

2. Detour Factor: *A. Type of Detour:*

B. Detour Length:

3. Failure Type & Volume   *Type:*   *Volume (yd^3)*

Rockfall

Rockslide

Landslide

Embankment

4. Average Vehicle Risk (AVR)

AADT =

$$AVR = \frac{ADT * Slope\ Length\ (miles)}{Speed\ Limit\ (mph)} * 0.01$$

Slope Length (miles) =

Speed Limit (mph) =

AVR: **Traffic Info Needed**

Base Score

Level of Service

Impact by Failure Type

AADT to measure risk and potential disruption

5. Roadway Impedence:			
6. Pavement Damage:			
7. Secondary Roadway Impact:			
8. Failure Frequency:			
9. Precipitation Amount (Effect anticipated in 24 hrs):		*Type:*	*Precipitation (in):*
		Rockfall	
		Rockslide	
		Landslide	
		Embankment	
10. Maintenance Required:			
11. Groundwater (Seepage):		*Type:*	*Seepage Presence:*
		Rockfall	
		Rockslide	
		Landslide	
		Embankment	
12. Previous Remediation:			
13. Total Score:			Please fill

Level of Service Disruptors

Water causes chaos!!

How many other entities will it affect

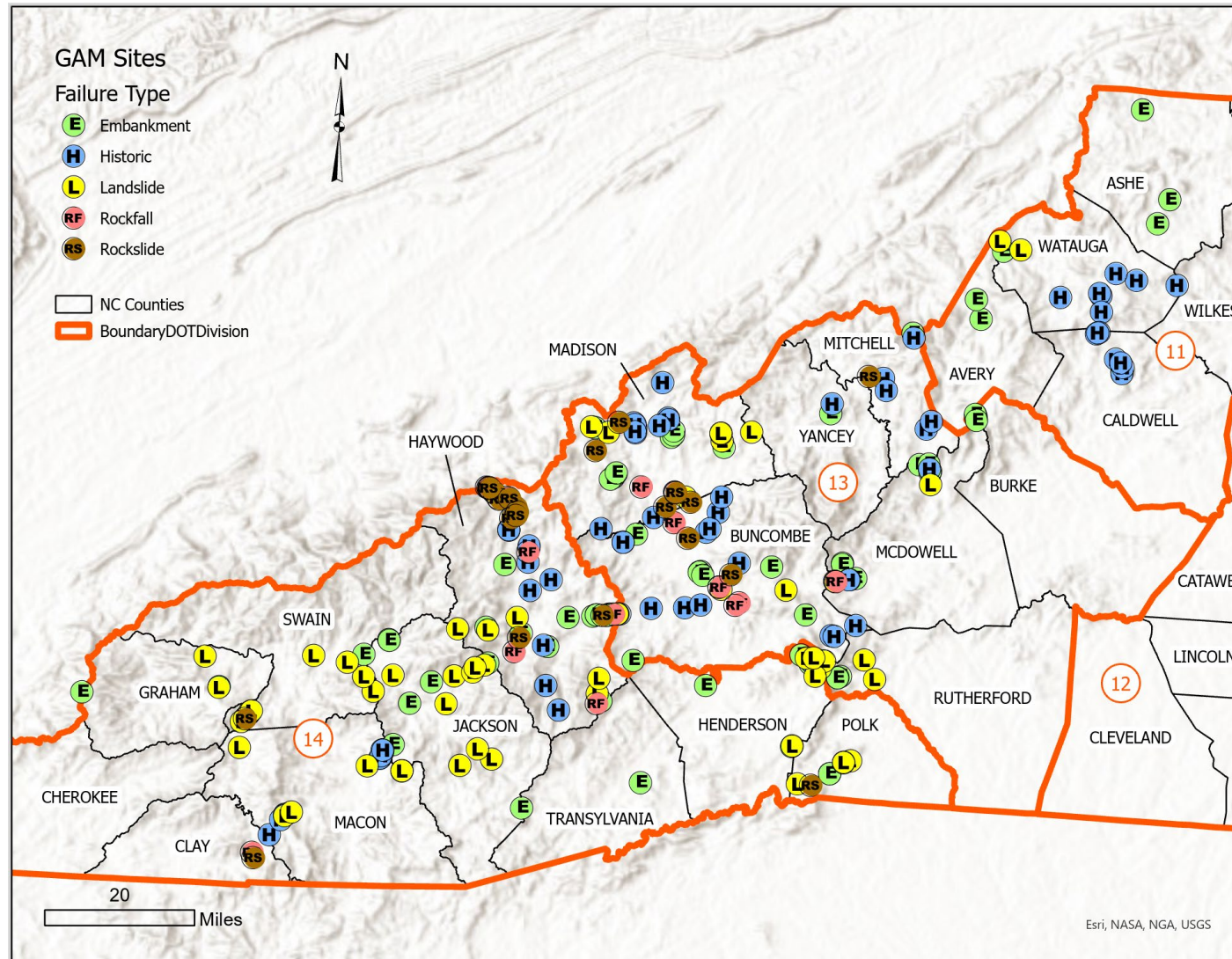Usually knocks score down

2010

2012

Tiny Jody for scale

2023 Google

2021 SCORE: 1031

ASSET MANAGEMENT - SLOPES

Date: 6/22/2021	**Field Geologist:** CDJ	**Division:** 14	
County No.: 43	**Latitude:** 35.739315	**Northing:** 748248	
County Name: HAYWOOD	**Longitude:** -83.027273	**Easting:** 805214	
Route No.: I-40	**Common Name:** MM7-SITE6		

				Score:
1. Route Type:			Interstate	100
2. Detour Factor:		*A. Type of Detour:*	Equal or better	1
		B. Detour Length:	> 25 miles	2
3. Failure Type & Volume		*Type:*	*Volume (yd^3)*	
		Rockfall		
		Rockslide	2k-50k	100
		Landslide		
		Embankment		
4. Average Vehicle Risk (AVR)				
$AVR = \frac{ADT * Slope\ Length\ (miles)}{Speed\ Limit\ (mph)} * 0.01$		ADT =	25000	
		Slope Length (miles) =	0.196	
		Speed Limit (mph) =	60	
		AVR:	0.816667	
5. Roadway Impedence:			Full	100
6. Pavement Damage:			Severe	10
7. Secondary Roadway Impact:			Long Term	3
8. Failure Incidence:			>2 times	2
9. Precipitation Amount (Effect anticipated in 24 hrs):		*Type:*	*Precipitation (in):*	
		Rockfall		
		Rockslide	>5in	1.1
		Landslide		
		Embankment		
10. Maintenance Frequency:			More than once per year	2
11. Groundwater (Seepage):		*Type:*	*Seepage Presence:*	
		Rockfall		
		Rockslide	Present	1.1
		Landslide		
		Embankment		
12. Previous Remediation:			Stabilized	0.2
13. Total Score:				1030.92

2023 SCORE: 138

ASSET MANAGEMENT - SLOPES

Date: 5/8/2023	**Field Geologist:** CDJ	**Division:** 14	
County No.: 43	**Latitude:** 35.739315	**Northing:** 748248	
County Name: HAYWOOD	**Longitude:** -83.027273	**Easting:** 805214	
Route No.: I-40	**Common Name:** MM7-SITE6		

				Score:
1. Route Type:			Interstate	100
2. Detour Factor:		*A. Type of Detour:*	Equal or better	1
		B. Detour Length:	> 25 miles	2
3. Failure Type & Volume		*Type:*	*Volume (yd^3)*	
		Rockfall		
		Rockslide	100-2k	125
		Landslide		
		Embankment		
4. Average Vehicle Risk (AVR)				
$AVR = \frac{ADT * Slope\ Length\ (miles)}{Speed\ Limit\ (mph)} * 0.01$		AADT =	26500	
		Slope Length (miles) =	0.196	
		Speed Limit (mph) =	60	
		AVR:	0.865667	
5. Roadway Impedence:			Shoulder	25
6. Pavement Damage:			None	0
7. Secondary Roadway Impact:			One Day	1.1
8. Failure Frequency:			Ravelly (continuous)	1.3
9. Precipitation Amount (Effect anticipated in 24 hrs):		*Type:*	*Precipitation (in):*	
		Rockfall		
		Rockslide	>5in	1.1
		Landslide		
		Embankment		
10. Maintenance Required:			Once every 1-5 years	1.3
11. Groundwater (Seepage):		*Type:*	*Seepage Presence:*	
		Rockfall		
		Rockslide	Present	1.1
		Landslide		
		Embankment		
12. Previous Remediation:			Stabilized	0.2
13. Total Score:				137.8163763

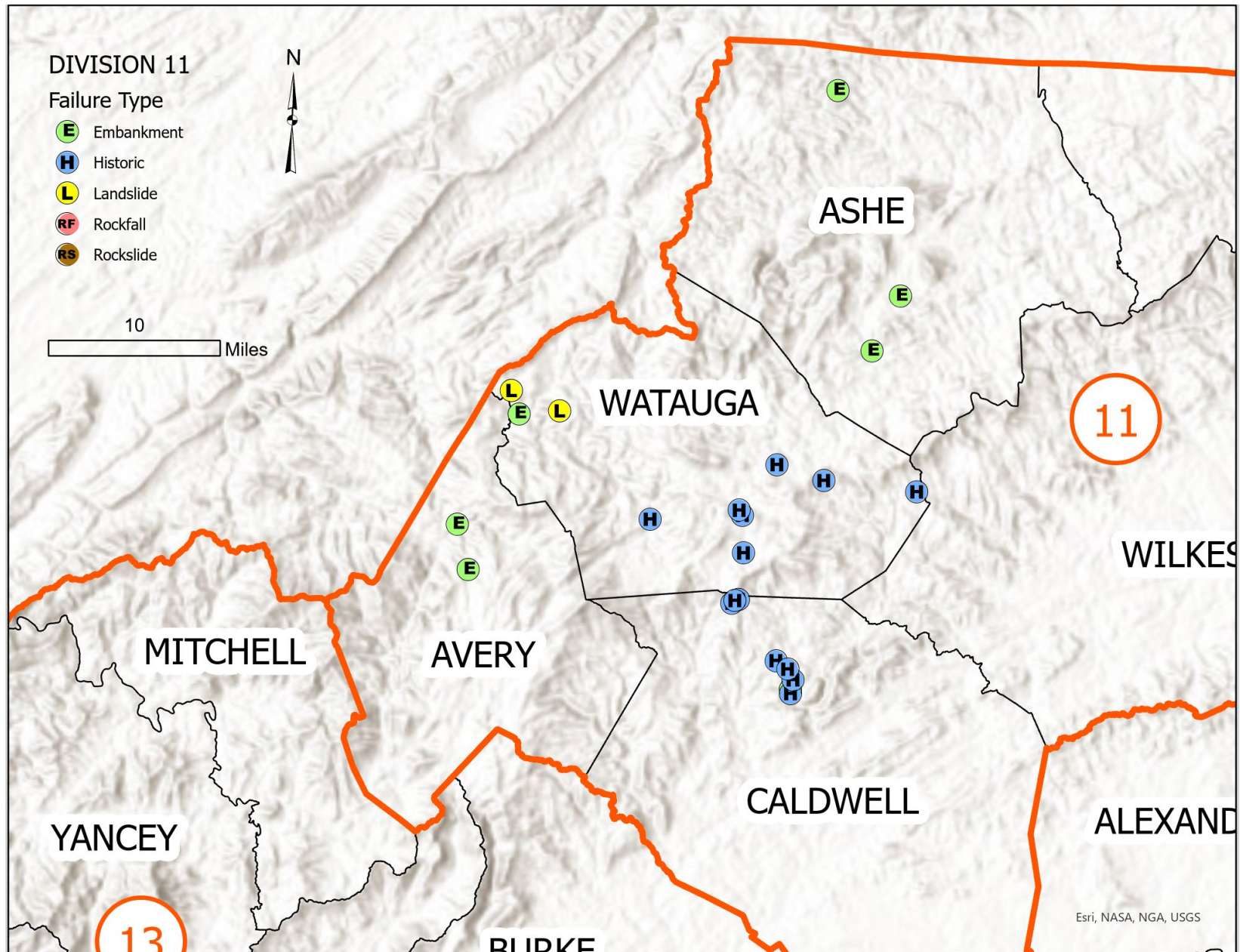Overview of NCDOT Geotechnical Asset Management Sites

Landslides by Division

254 landslides recorded in WNC
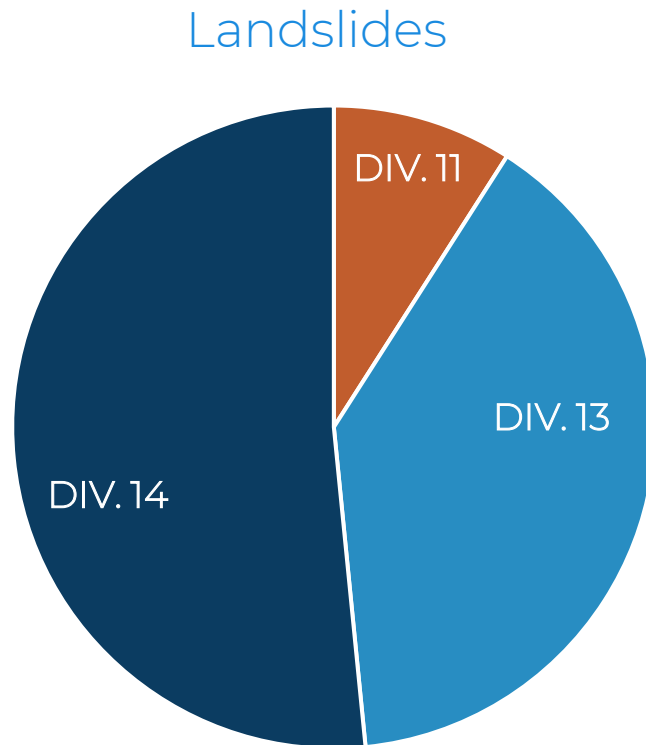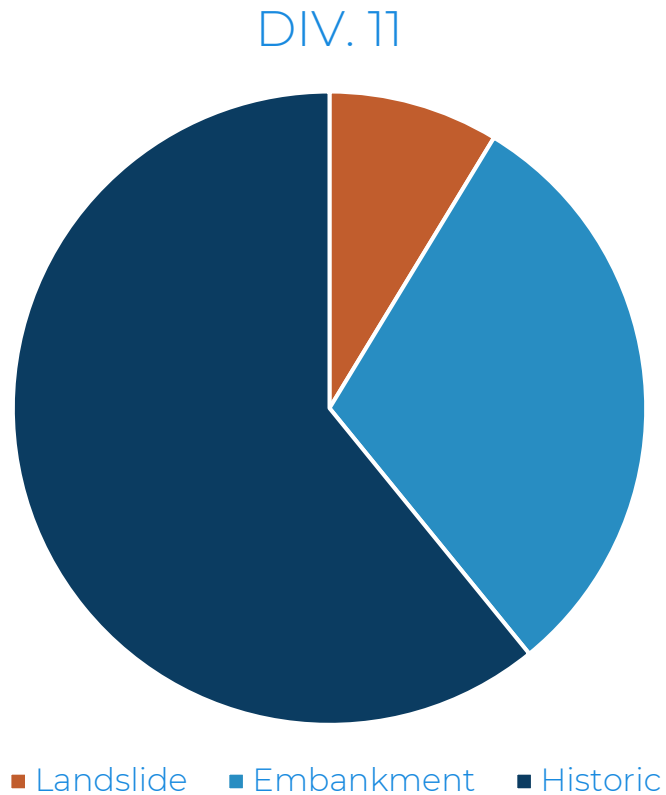
Landslides

Landslides in WNC

- Division 11 – 23 landslides

- Division 13 – 100 landslides

- Division 14 – 131 landslides

Division 11 GAM Sites

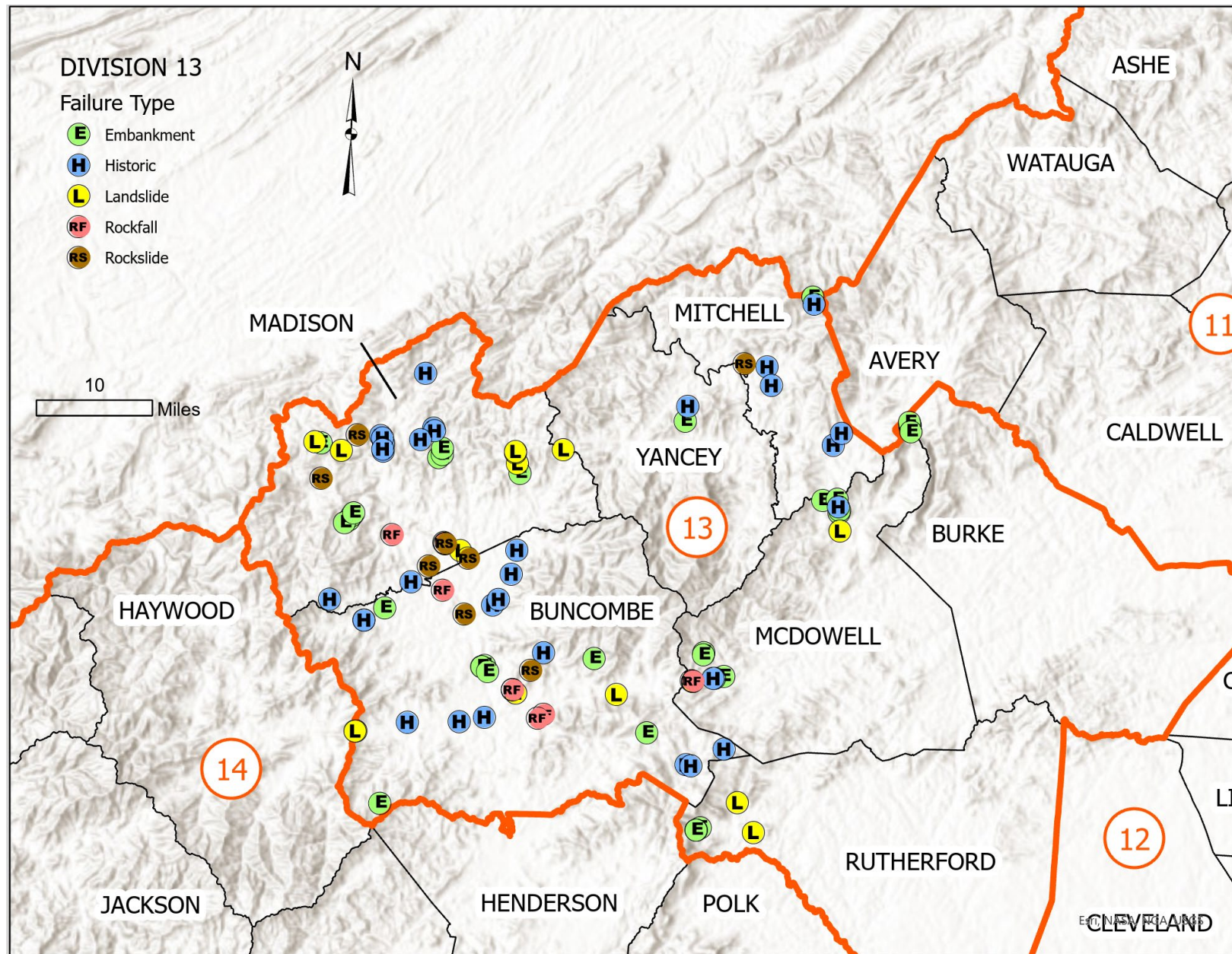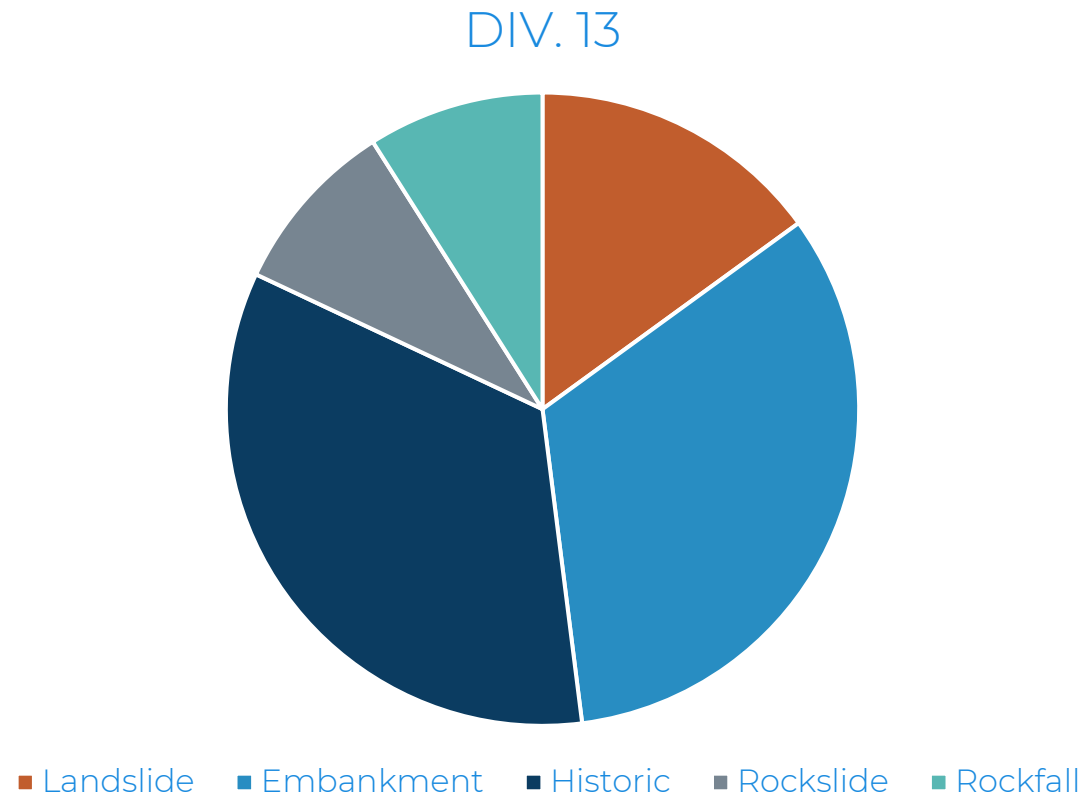# Types of Landslides in Division 11
23 failures recorded

DIV. 11

■ Landslide   ■ Embankment   ■ Historic

Failure Type in Division 11

- Landslide – 2
  - Movement of a mass of rock, debris or earth down a slope
- Embankment – 7
  - Failure of built slopes
- Historic – 14
  - Slopes that failed during construction, but have since been stabilized
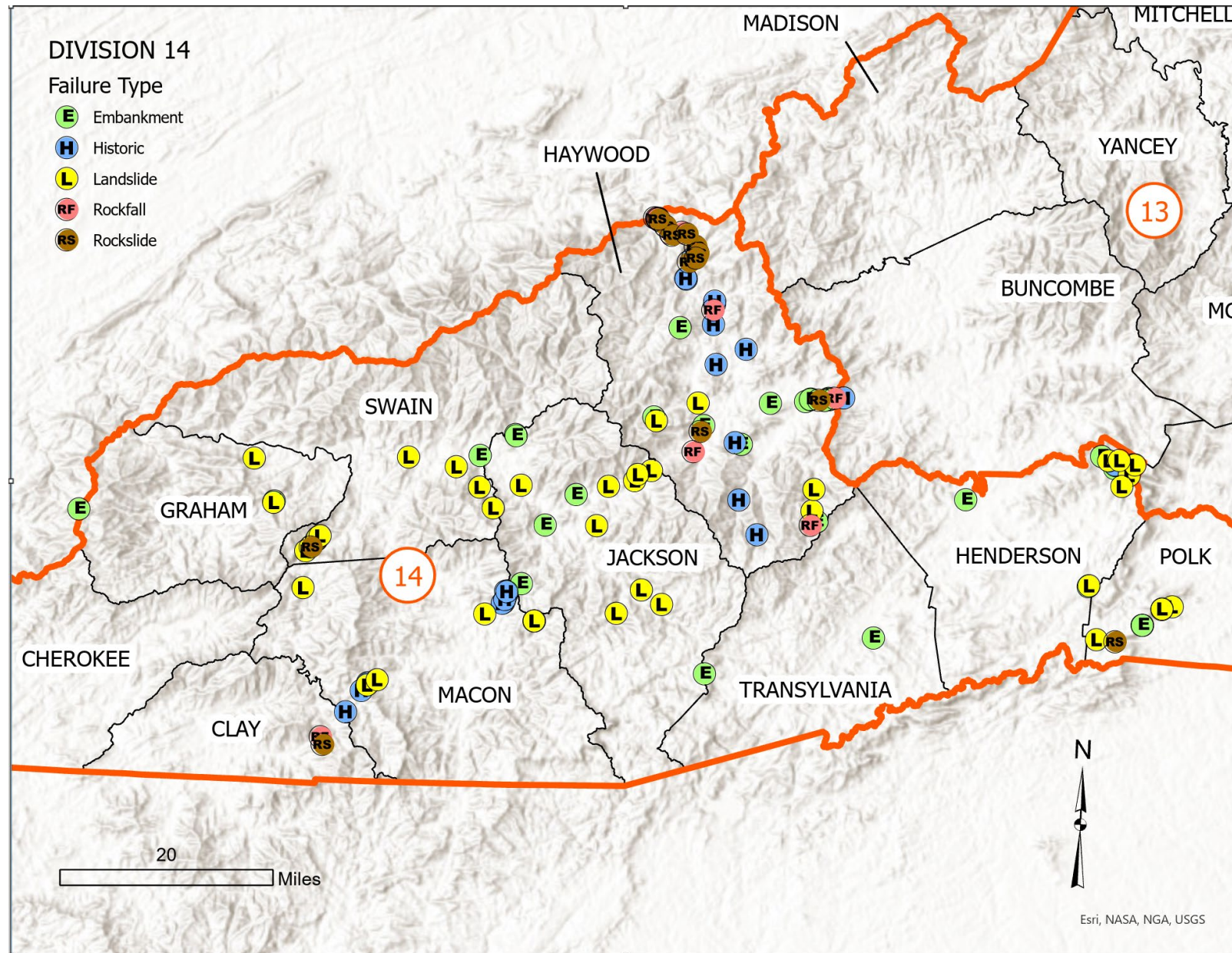- Debris Flow – Coming Soon 2023!!

ncdot.gov

Division 13 GAM Sites

Types of Landslides in Division 13
100 failures recorded

DIV. 13

■ Landslide ■ Embankment ■ Historic ■ Rockslide ■ Rockfall
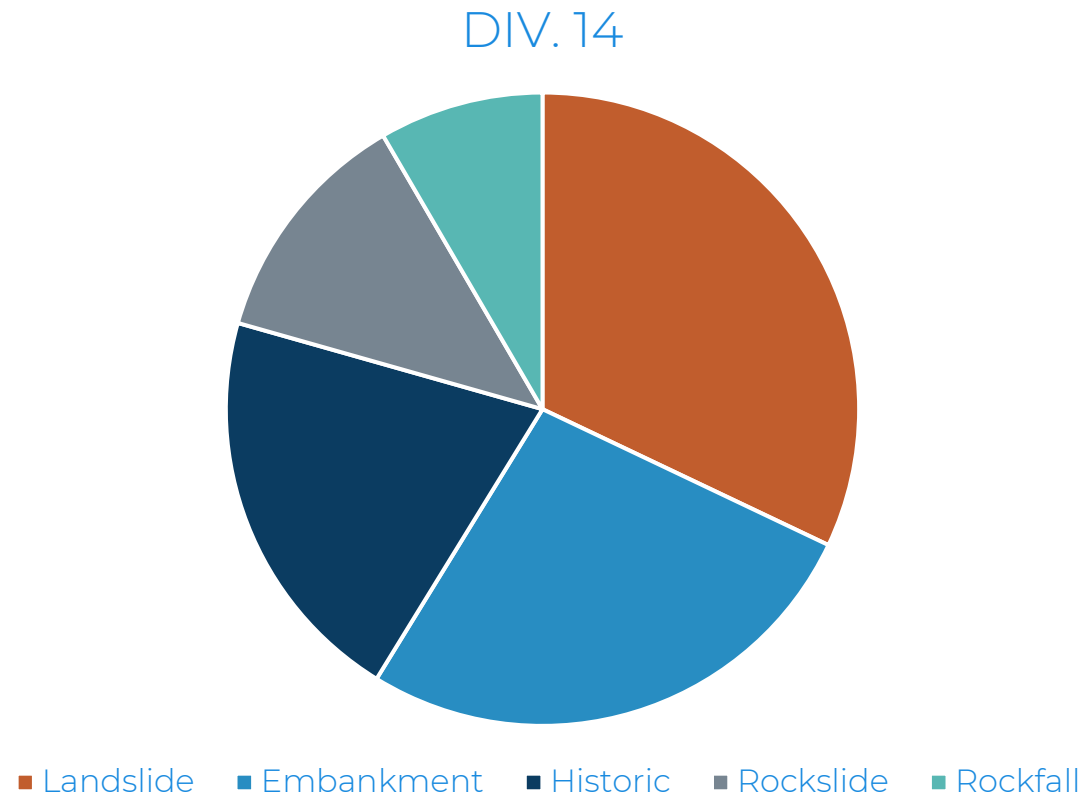
Failure Type in Division 13

- Landslide – 15

- Embankment – 33

- Rockslide – 9

- Rockfall – 9

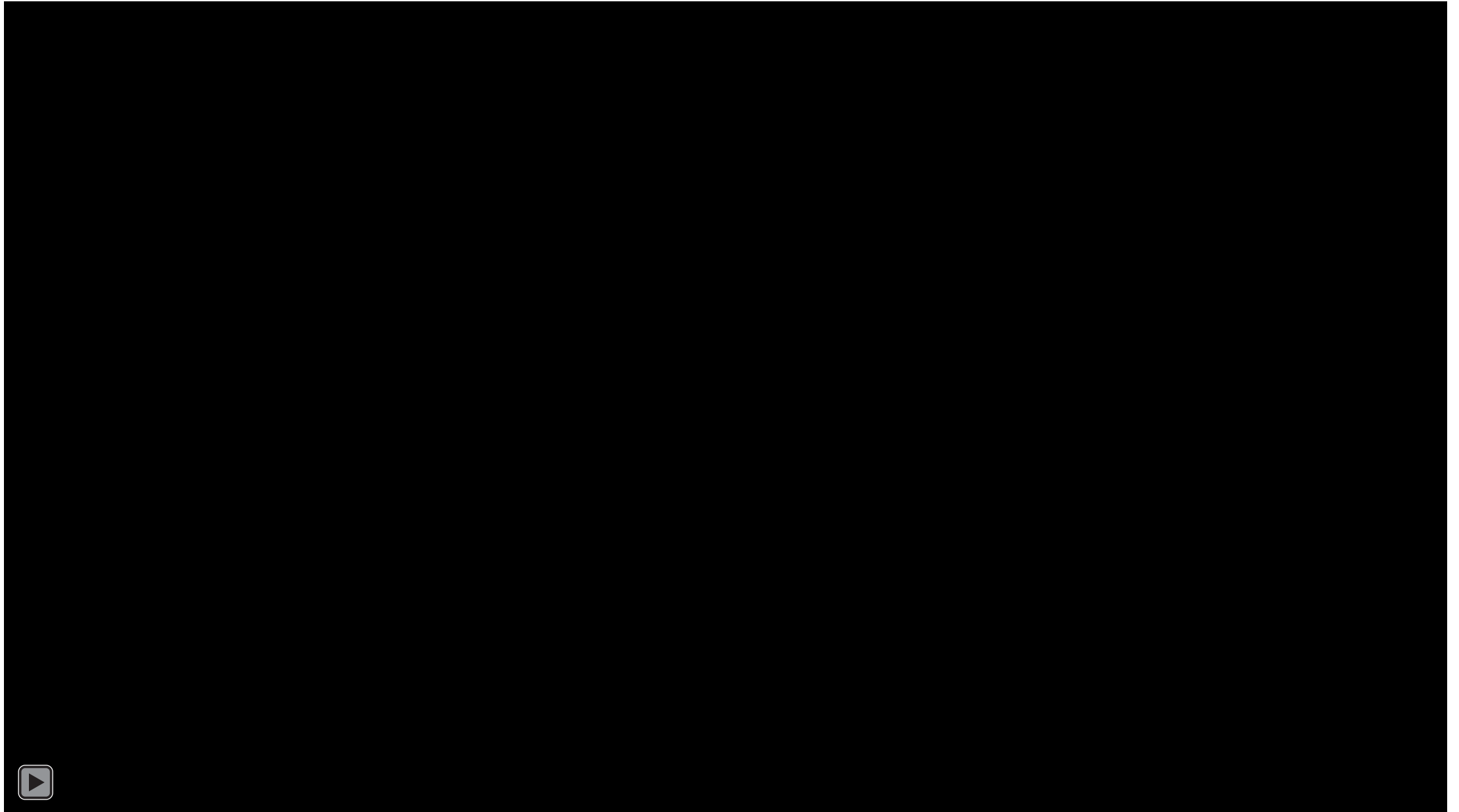- Historic – 34

- Debris Flow – Coming Soon 2023!!

ncdot.gov

Division 14 GAM Sites

Types of Landslides in Division 14

131 failures recorded

DIV. 14

■ Landslide ■ Embankment ■ Historic ■ Rockslide ■ Rockfall

Failure Type in Division 14

- Landslide – 42

- Embankment – 35

- Rockslide – 16

- Rockfall – 11

- Historic – 27

- Debris Flow – Coming Soon 2023!!

Contact Us

Crystal Johnson

cdjohnson8@ncdot.gov

Clay Elliott

dcelliott@ncdot.gov

@NCDOT

@NCDOT

NCDOT

ncdotcom

NCDOTcommunications

ncdot_comm