Integrating Geochemical Characterization and Field Methods

Mitigating Potentially Acid-Generating Construction Materials in Northern MN

Mehgan Blair, Irvin Mossberger – Barr Engineering Company

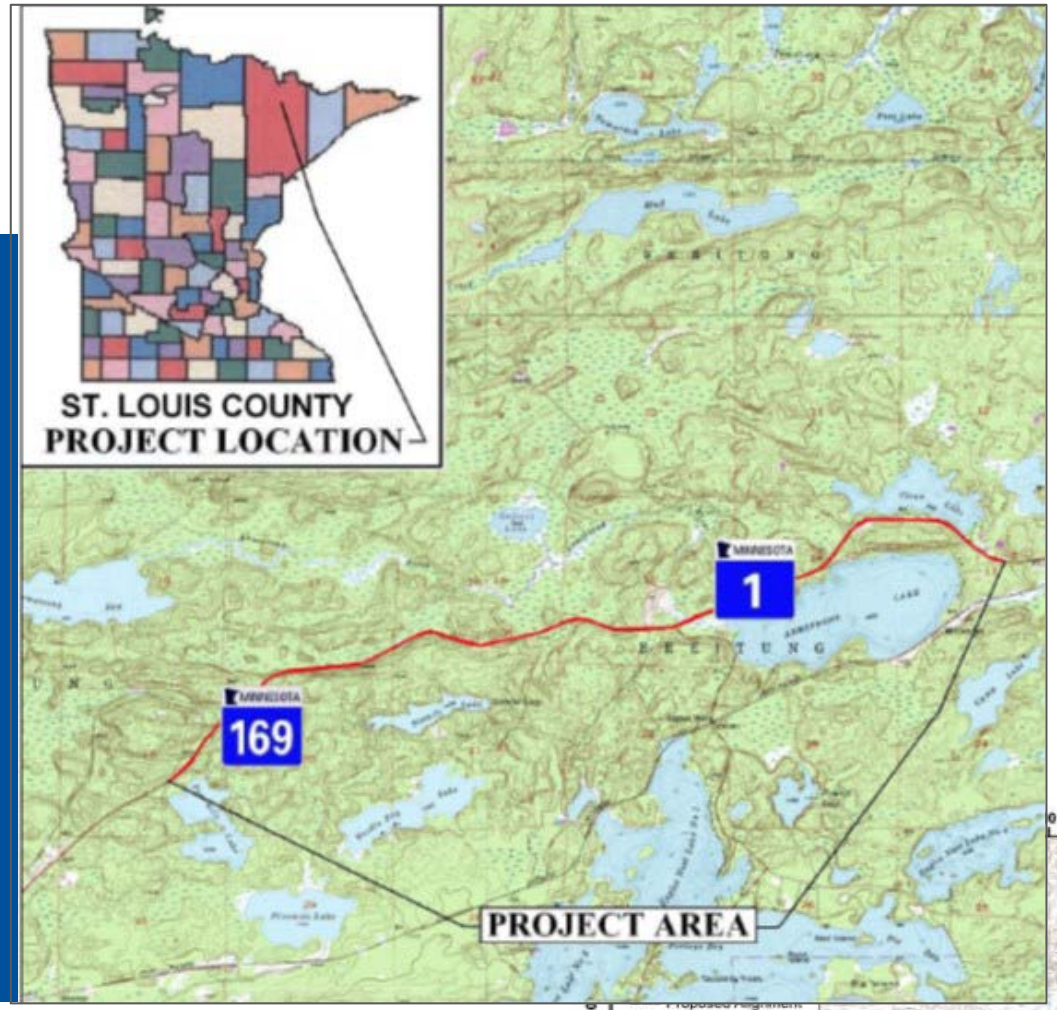
Jason Richter – MN Department of Transportation

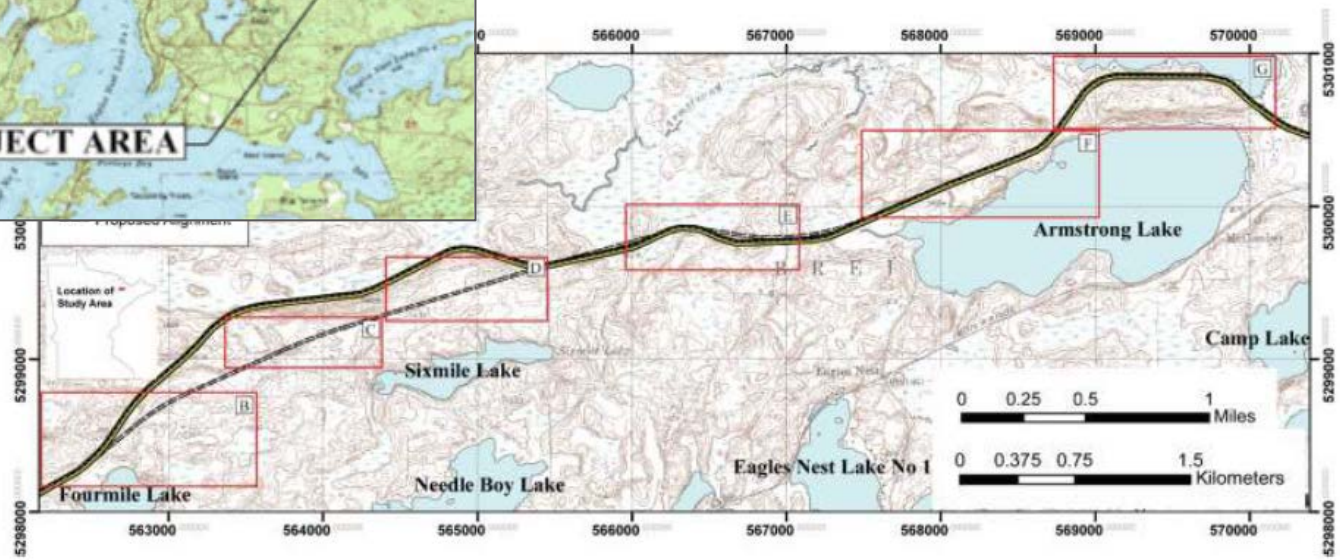
Presented at ASMR, 2018, St. Louis, MO

Outline

- Project and site background
- PAG rock mitigation plan elements and basis
- Implementation –
  - Comparing plan versus implementation
- Project challenges and status

MnDOT Hwy 169/1

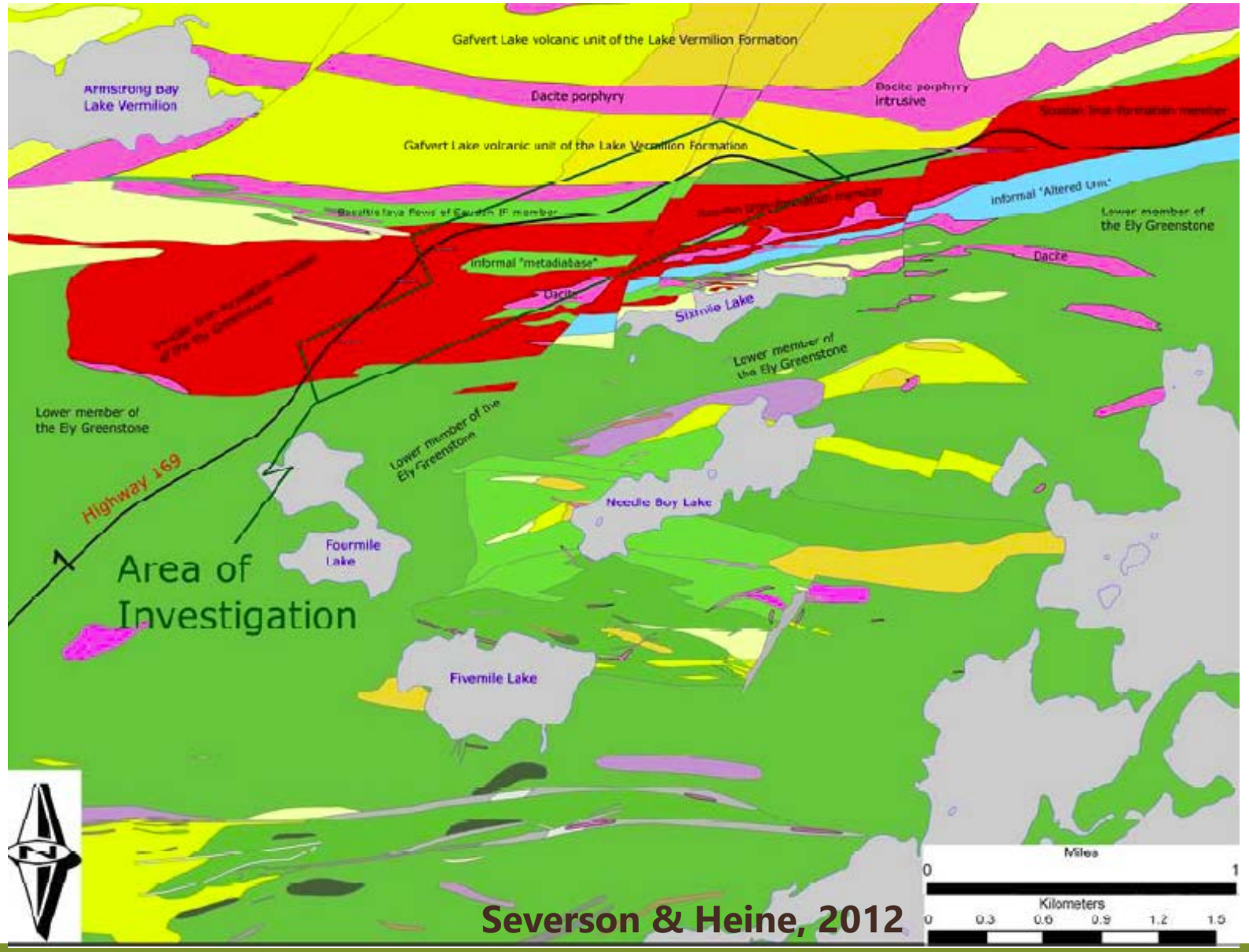




Project History

- Many serious and fatal accidents
- 2005: federal funding authorized
- 2010-16: NEPA review/EAW
  - technical panels, 18 alternatives vetted, studies
  - acid rock drainage concern
- 2016: potentially acid generating (PAG) mitigation plan completed

Site geology



Severson & Heine, 2012

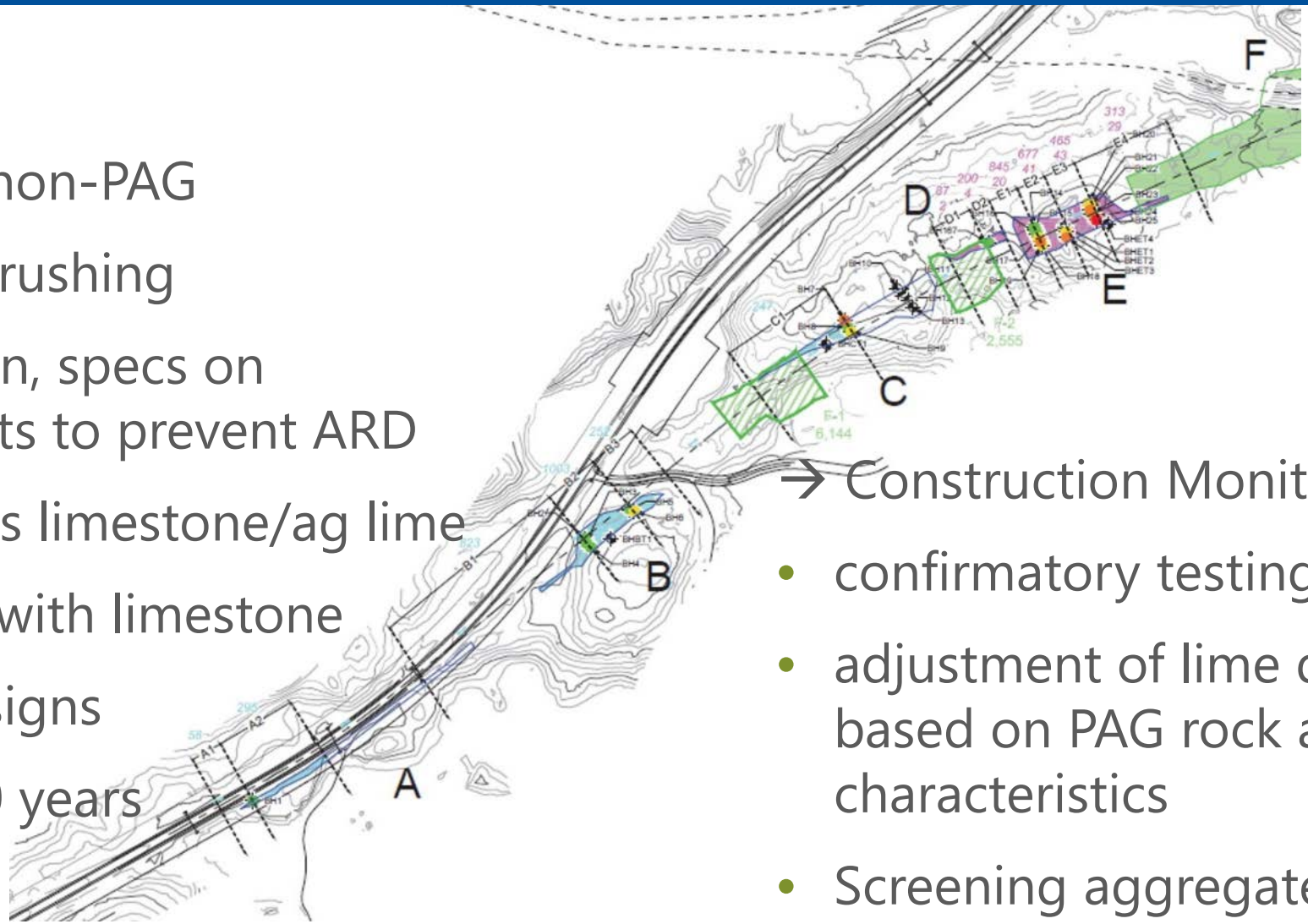
Mitigation Plan Methods

- Acid-base accounting:
  - total sulfur and carbon; speciated forms of sulfur
  - neutralization potential (by titration)
- Whole rock geochemistry
- Identified a design criteria for PAG rock of neutralization = 3x acid potential
- Preliminary lime demand for the project

PAG rock mitigation plan

Plan Protocols →

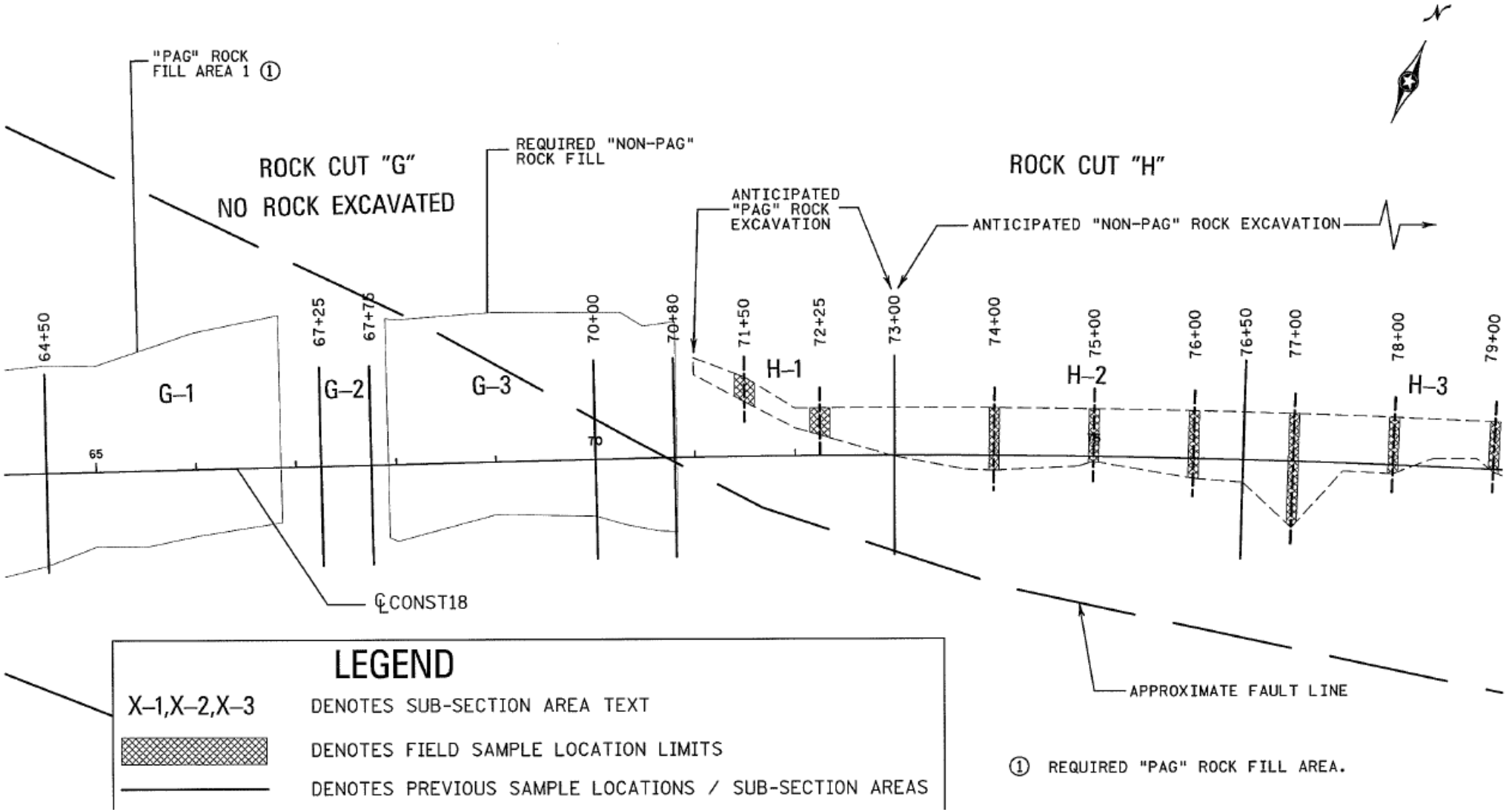
- Designated PAG/non-PAG
- Placed limits on crushing
- Consolidation plan, specs on neutralizing agents to prevent ARD
  - ID dosing rates limestone/ag lime
  - lining ditches with limestone
  - repository designs
- monitoring for 10 years



→ Construction Monitoring Needs

- confirmatory testing for sulfur
- adjustment of lime dose rates based on PAG rock and lime characteristics
- Screening aggregate sources

plans: pre-blast testing; planning for PAG fill



Lime "Mitigation"/Dosing; design criteria = **NPR ≥ 3**

- Net Potential Ratio = Neutralization Potential/Acid Potential
- "3" is a safety factor and is repository design criteria
- AP and NP were pre-determined to provide estimate of "mitigation" (augmentation of NP), to achieve NPR = 3

$$\mathbf{3} = \frac{\boldsymbol{NP}}{\boldsymbol{AP}}$$

- NP comes from rock AND from added lime "mitigation"

Dosing; design criteria = **NPR ≥ 3**

- **Revise AP** with additional sampling during construction, "on the fly"
- NPR≥ 3, Remembering **3 =** $\frac{NP}{AP'}$, so the "dosing equation" =

$$NP_{mitigation} = (3 \cdot AP_{revised}) - NP_{rock}$$

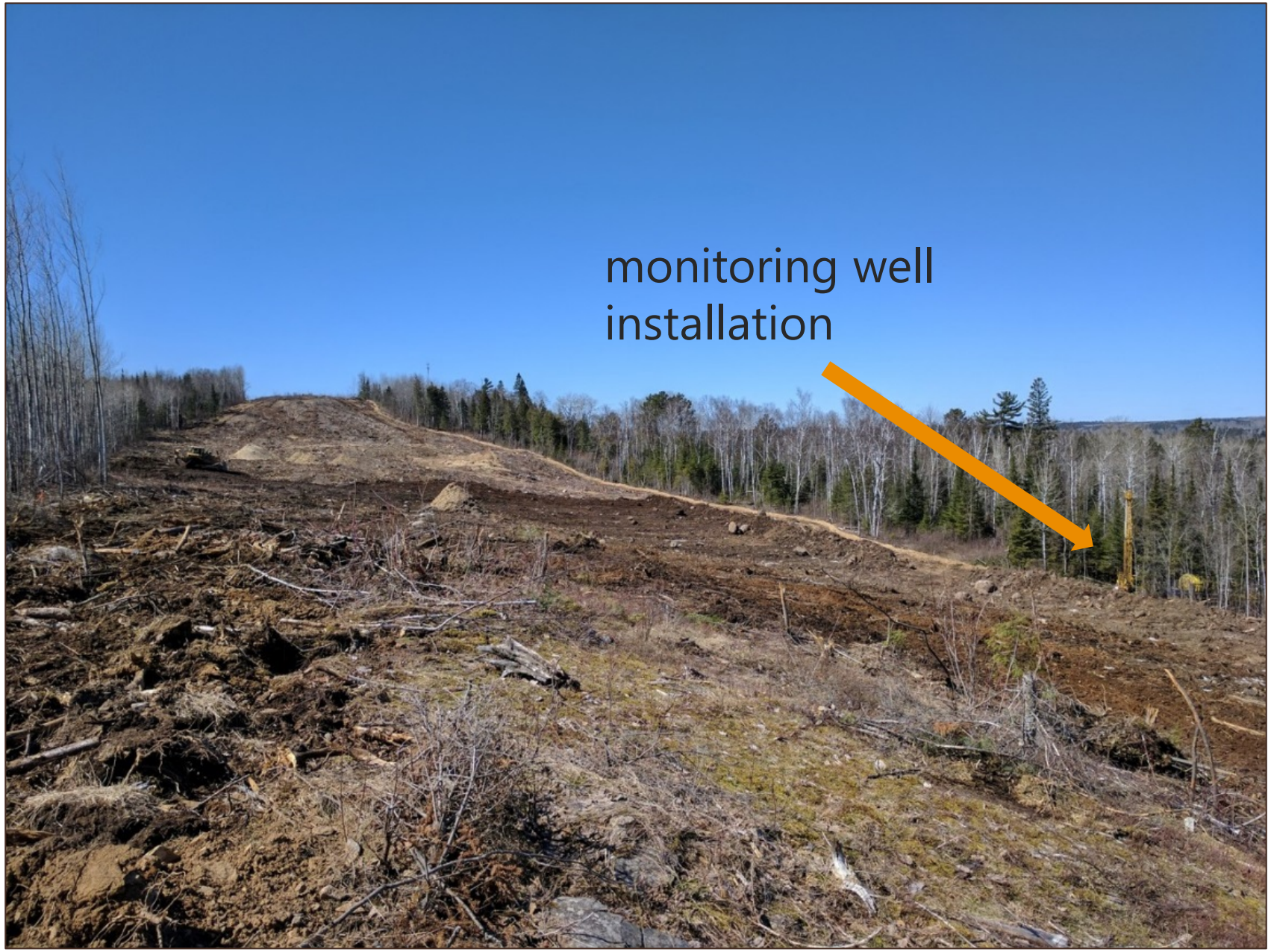
- NP expressed in tons $CaCO_3$/kt rock, so tell the contractor how many tons of lime (ag lime/limestone) to add.

Blasting the highs

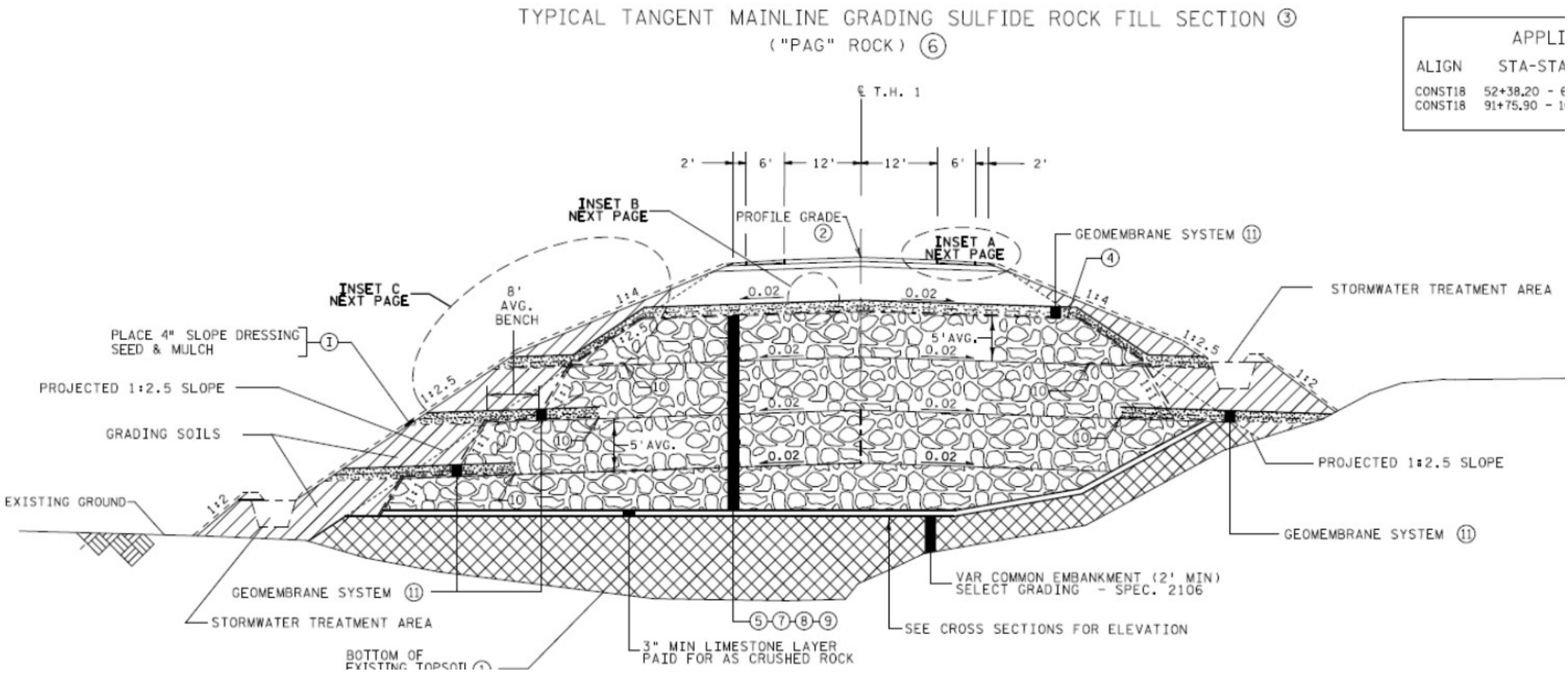
Filling the lows

- rock-cored highway

- 65’ high PAG rock landfill



plans: PAG fill/repository



Hauling, dosing, placing, grading

Building successive benches

Lots of equipment

- 20 side dumps
- 14 articulators
- 3 dozers
- 2 rollers
- 1 backhoe

Fast, intense pace, in restricted work area

Dose rates. . .

Rock Cut and Section Details				Results of Field			Limestone					Ag Lime				
Rock Cut	Rock Cut Section	STA to STA	Pre-construction Rock Cut Section Volume Estimate	Field Verified Rock Cut Section Volume	Revised Limestone Requirement (based on new %S and/or rock volume)	Truck Count Estimate	Total Corrected mass	Total corrected volume	Application Rate	Section Totals	Section Totals	Total Corrected mass	Total corrected volume	Application Rate	Sectioin Totals	Section Totals
Q	Q1	357+00-359+00	16	30	0	2	0.0	0.0	0.0	34.6	18.4	0.0	0.0	0.0	44.5	41.9
	Q2	359+00-36100	1,617	1,112	0	62	0.0	0.0	0.0			0.0	0.0	0.0		
	Q3	361+00-362+00	1,157	838	0	47	0.0	0.0	0.0			0.0	0.0	0.0		
	Q4	362+00-365+00	4,786	7,189	41	399	19.9	10.6	0.03			25.6	24.1	0.06		
	Q5	365+72-368+00	7,151	5,011	28	278	13.9	7.4	0.03			17.8	16.8	0.1		
	Q6	368+00-370+50	72	711	2	39	0.8	0.44	0.011			1.1	1.0	0.025		
R	R1	374+00-375+50	536	648	0	36	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.6	0.6
	R2	375+50-379+00	2,888	1,411	1	78	0.5	0.2	0.0031			0.6	0.6	0.0071		
	R3	379+00-382+50	0	0	0	-	0.0	0.0	#VALUE!			0.0	0.0	#VALUE!		
	R4	382+50-385+00	689	850	0	47	0.0	0.0	0.0			0.0	0.0	0.0		
	R5	385+00-386+00	299	13	0	1	0.0	0.0	0.0			0.0	0.0	0.0		
	R6	386+00-388+00	0	0	0	-	0.0	0.0	#VALUE!			0.0	0.0	#VALUE!		
		390+28.96-														

- Adjustments to preliminary dose rate on the fly:
  - Incorporate new sulfur values
  - Lime quality, moisture, CEC, etc.
  - Estimated volume of the trucks and of backhoe bucket, etc.

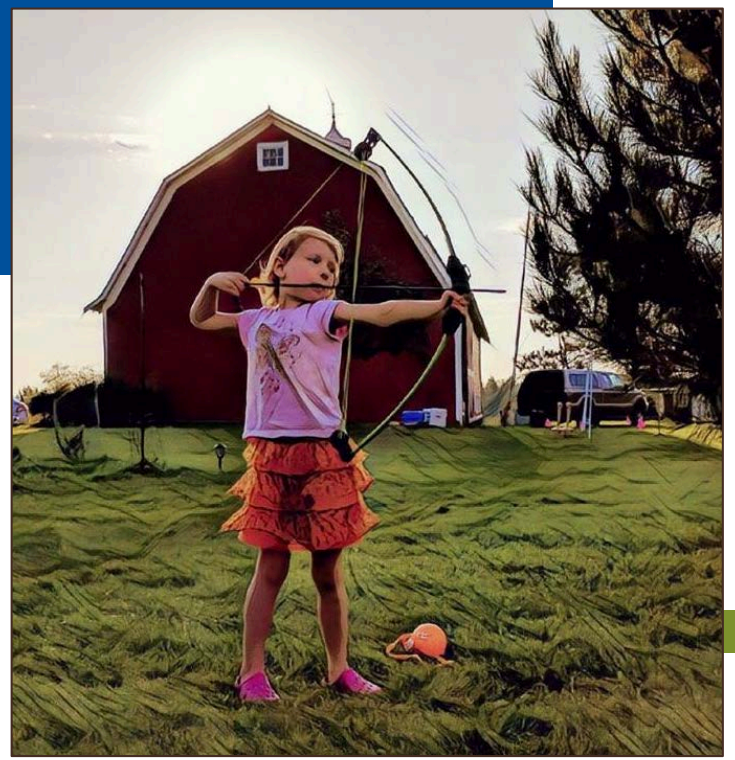
Ideal blending

Fabrics and covers

Plan versus execution

- TAT too long
  - Confirmatory testing “on the fly”/ another pre-construction program
- Blending impractical at low dose rates
  - Combined blending and layering
- “Examination of saturated hydric soils”- PAG/non-PAG?
  - Reactive secondary sulfides
  - field leach test, odor after HCl,

Many arrows in our geochemical methods quiver!



Consider suitability for use in

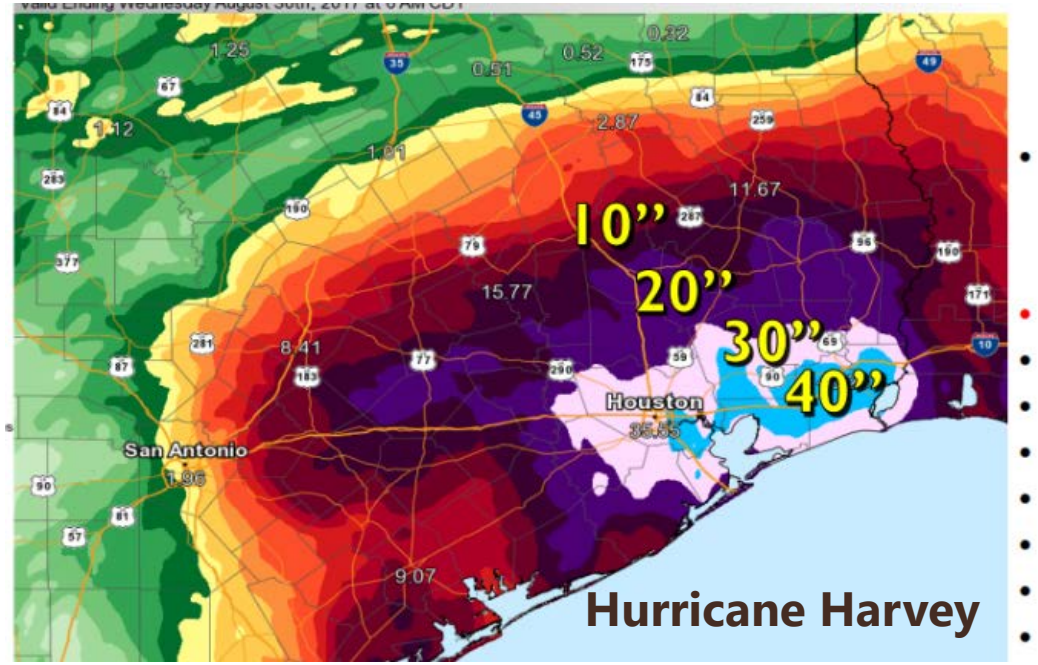
- plan development:
  - Comprehensive for risk assessment
  - Customized to rock type

versus

- construction monitoring:
  - Quick turn-around
  - Cost-efficient
  - Interpretable
  - Executable

additional project challenges

- Rain
- Snow
- Hurricane



Project stats

>200 sulfur samples added

6.5 miles of new road

60,000 cy PAG rock managed

Project status

- Final bituminous – summer 2018
- Ongoing groundwater monitoring
- Development of MnDOT guidance

Questions?