BI-ANNUAL GRMP REVIEW MEETING NORTH CENTRAL REGION: ATHABASCA DISTRICT

MARCH 7, 2018

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Kehiwin Lake Landsides, Hwy 41:23 Near Elk Point, Alberta (NC24): Remedial Measures and Challenges

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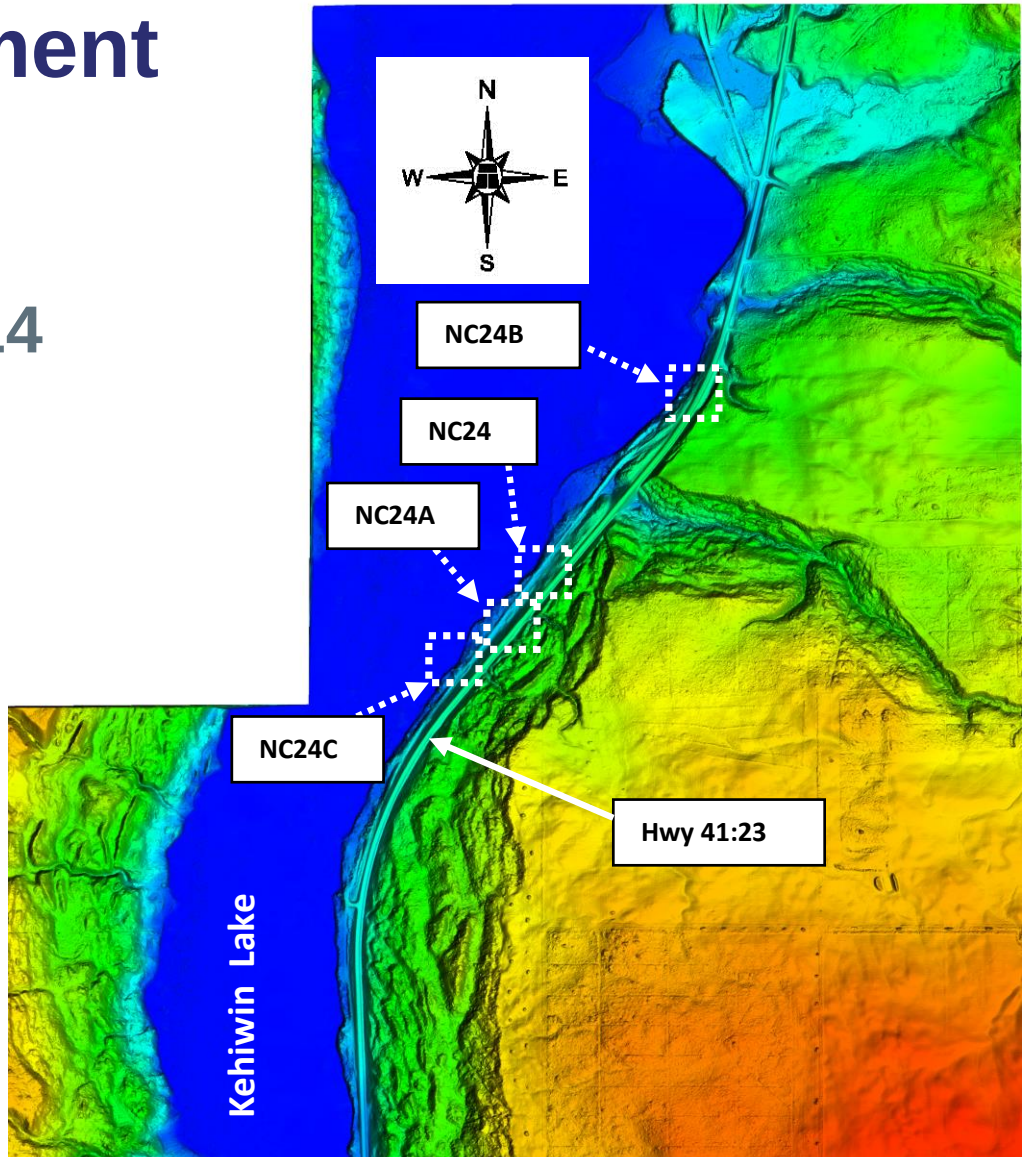
Historical Development of Landslides

- **Five Landslides between 2001** and **2014**
- **NC 24- 2001-2009**
- **NC24A- 2010-2011**
- **NC 24B- 2010-2011**
- **NC24C-2011- 2017**
- **NC24D-2014-2017**

Shaded Relief Plan Showing Landslide Sites



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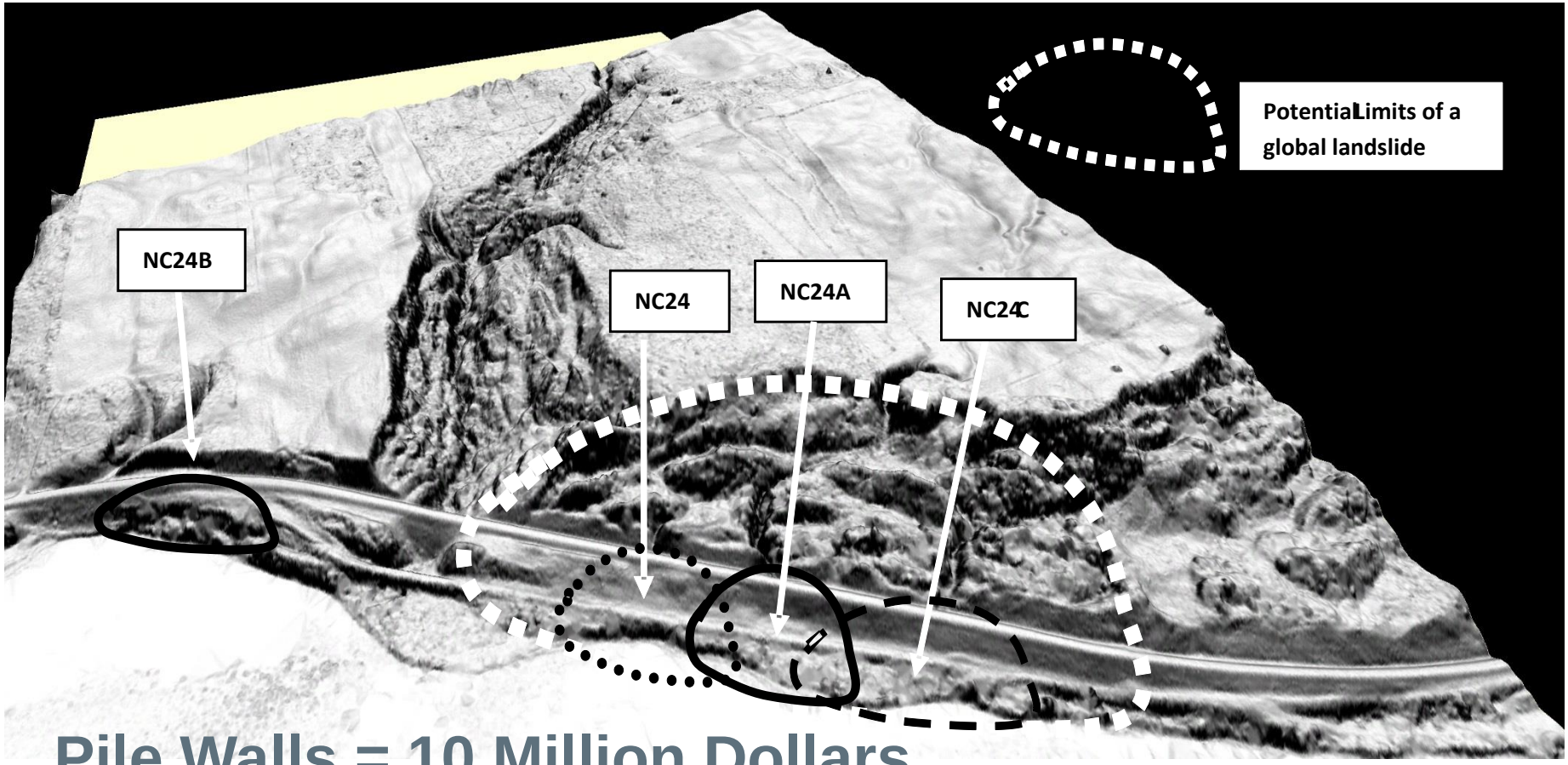

Pile Walls = 10 Million Dollars

A 3D rendering image along the highway alignment at the landslide sites

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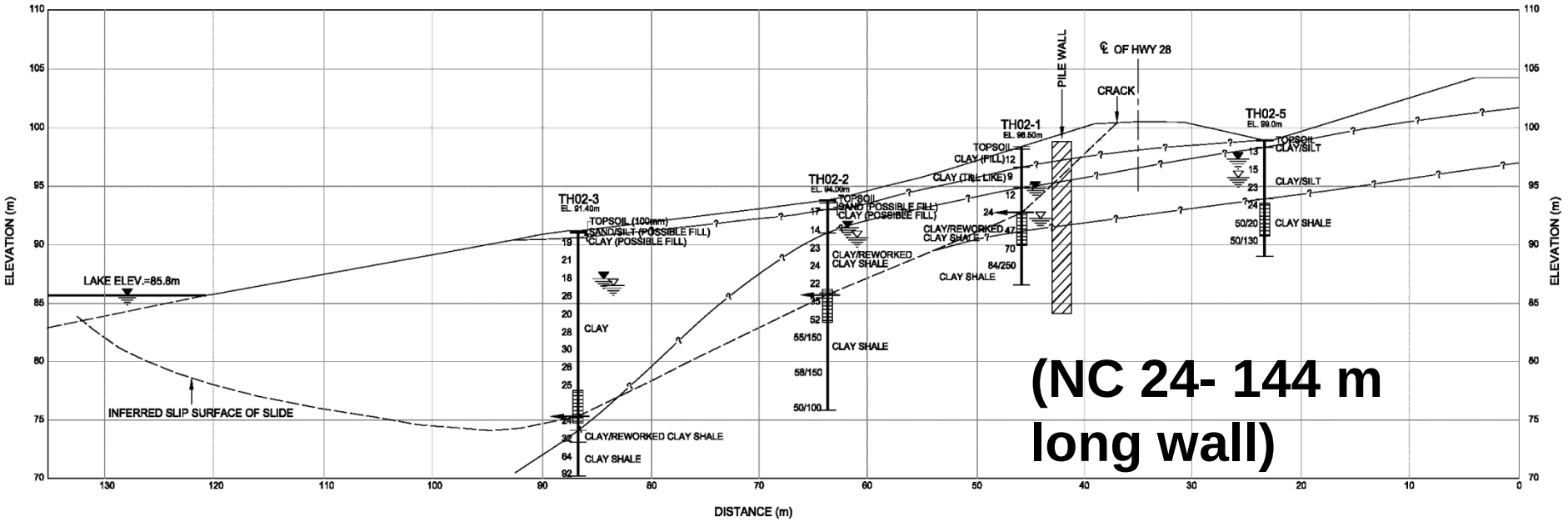

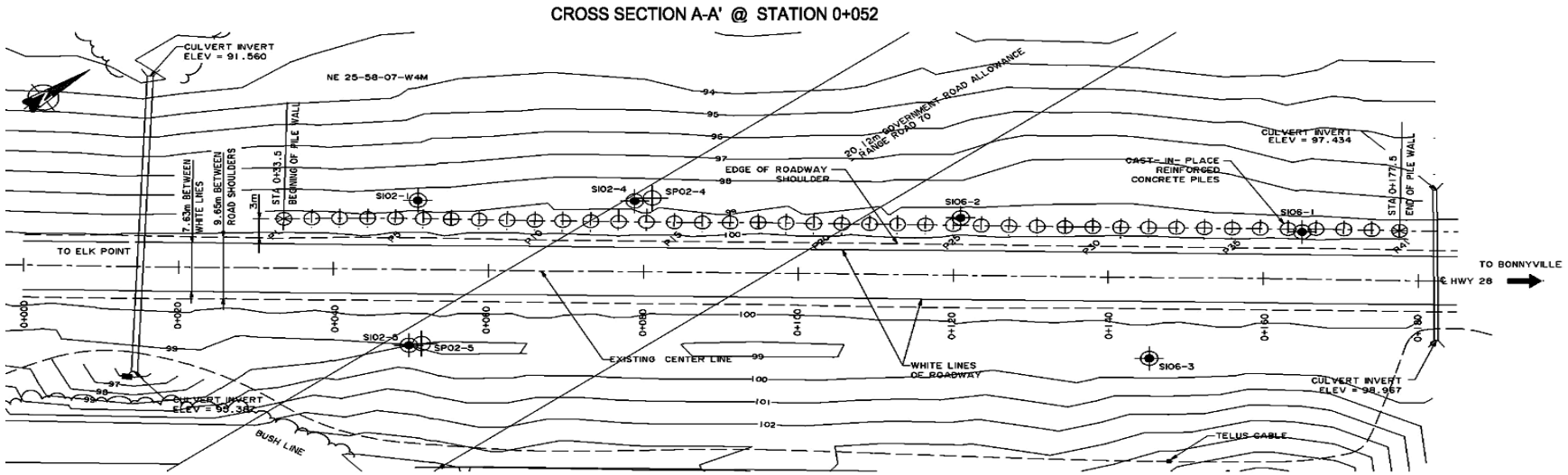

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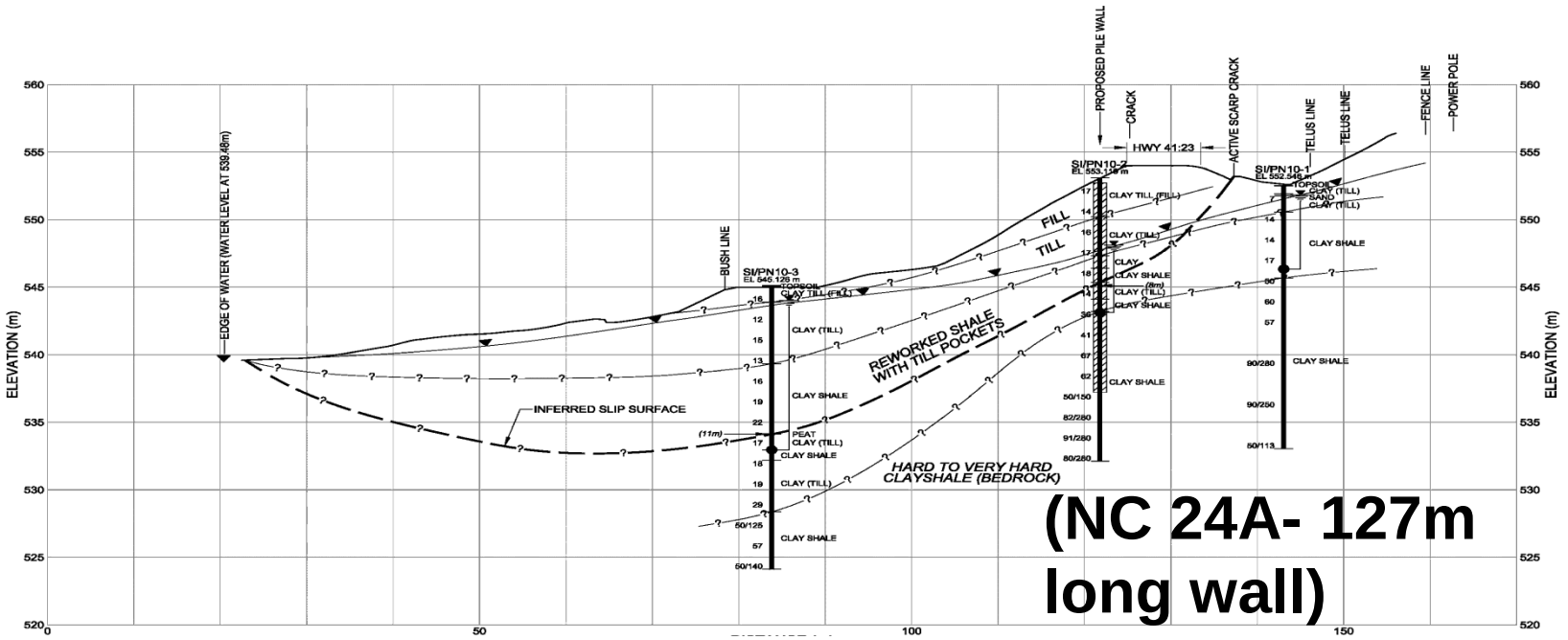
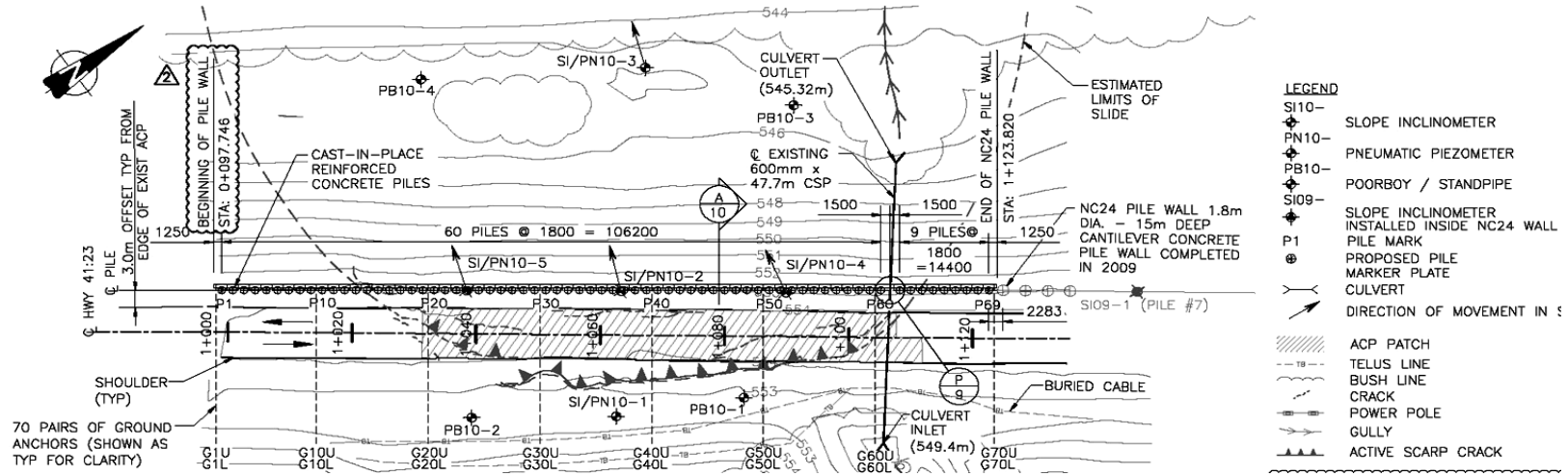


(NC 24A- 127m long wall)



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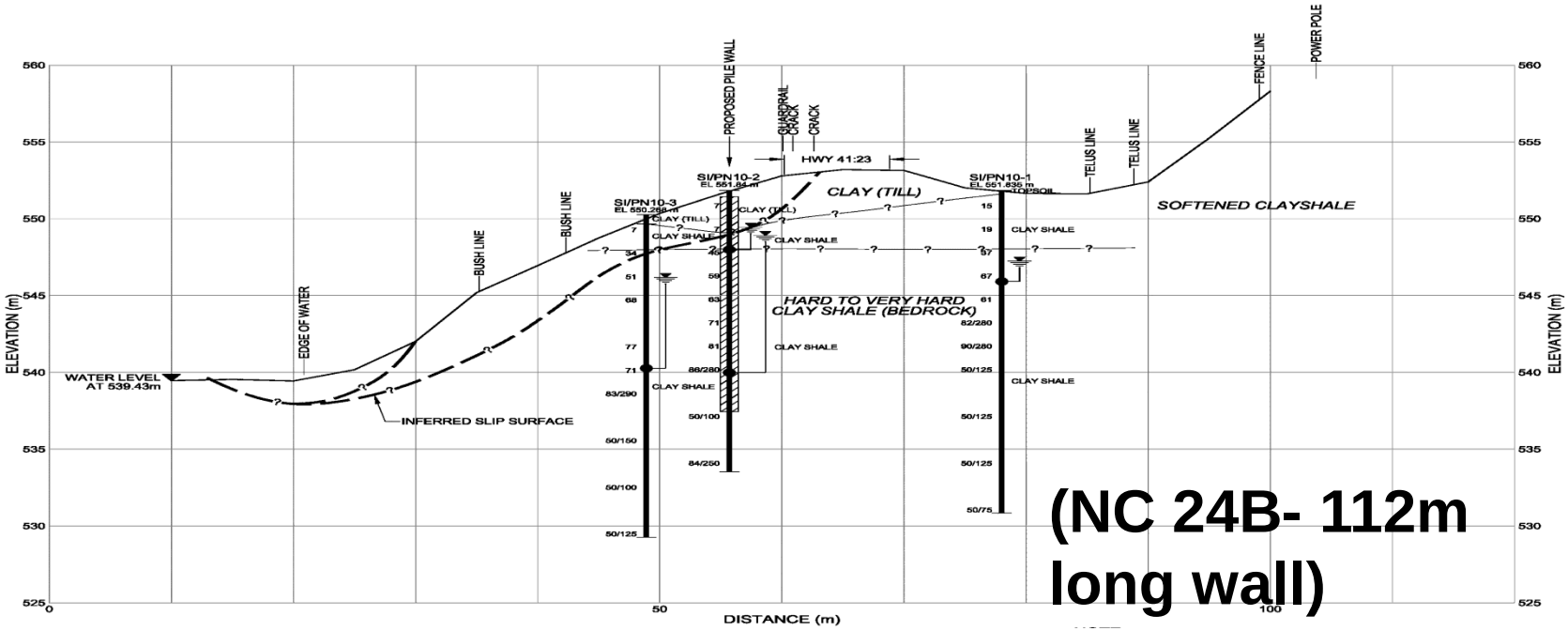
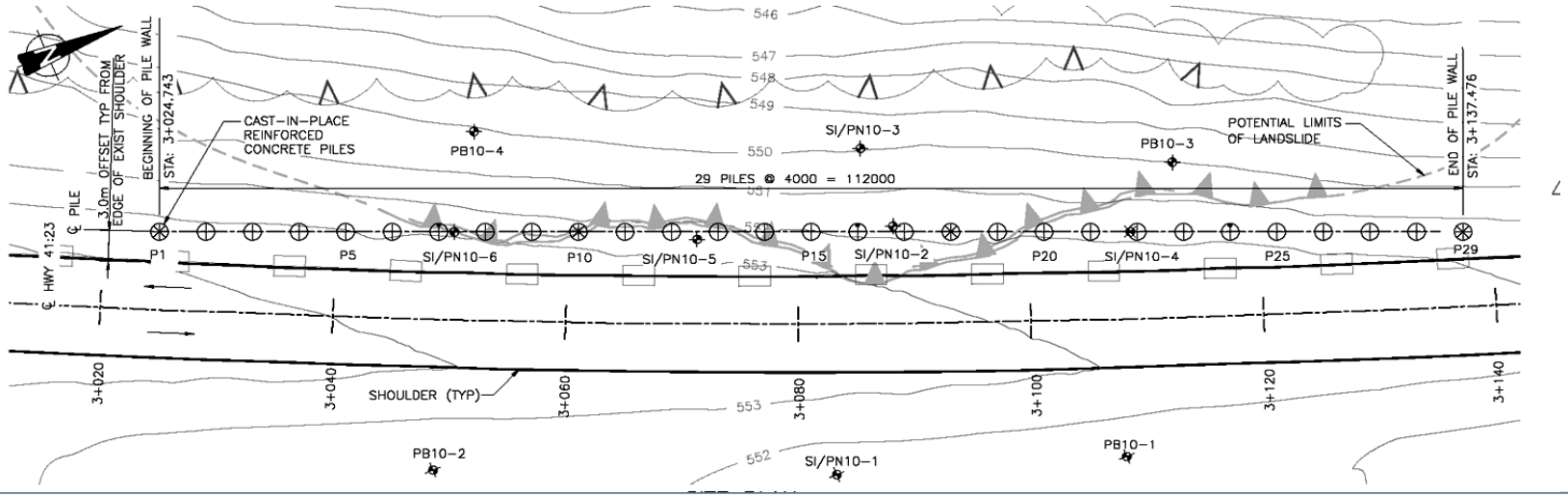


(NC 24B- 112m long wall)



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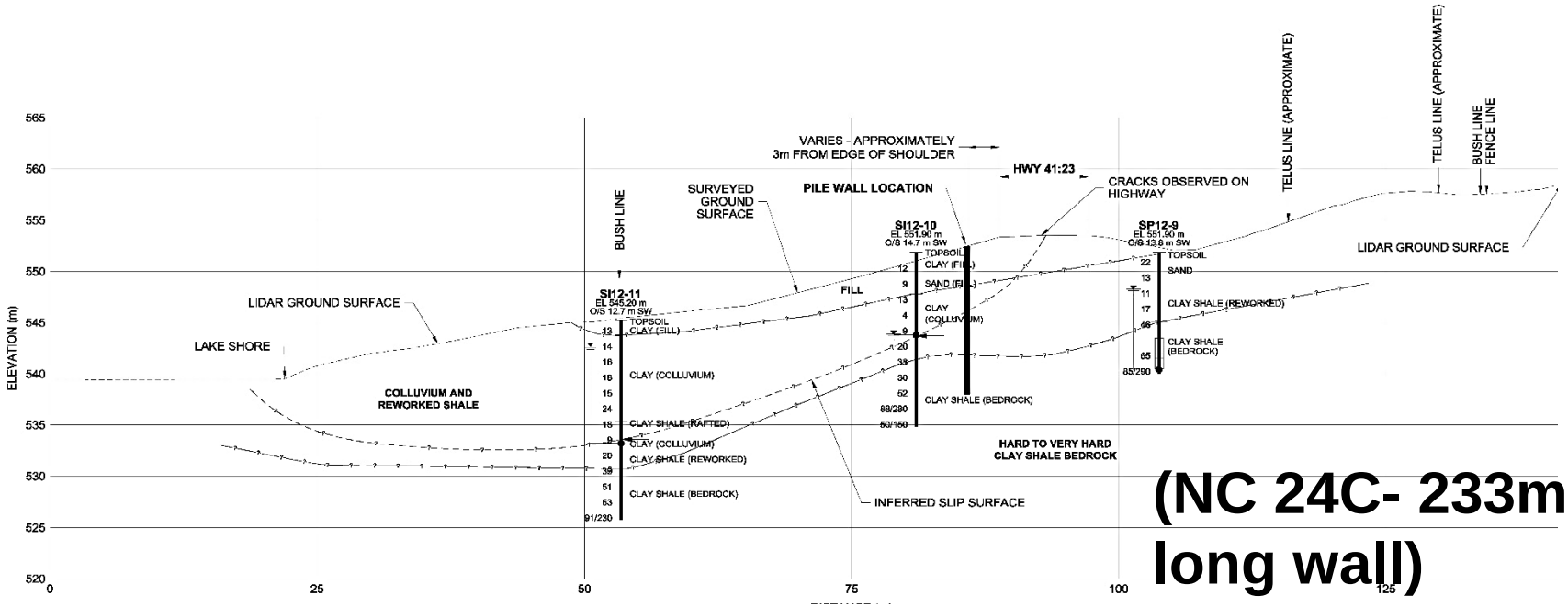
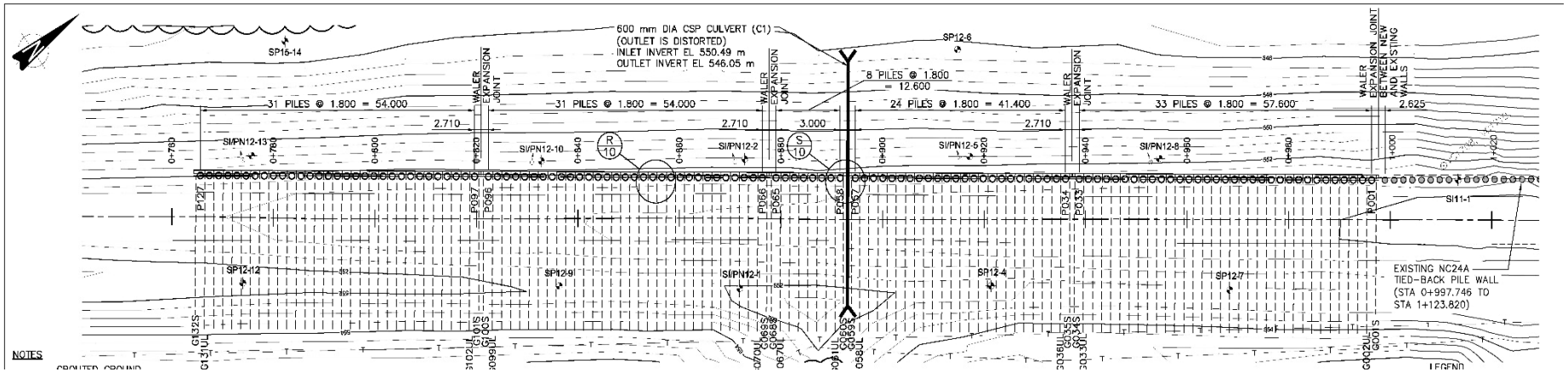


(NC 24C- 233m long wall)



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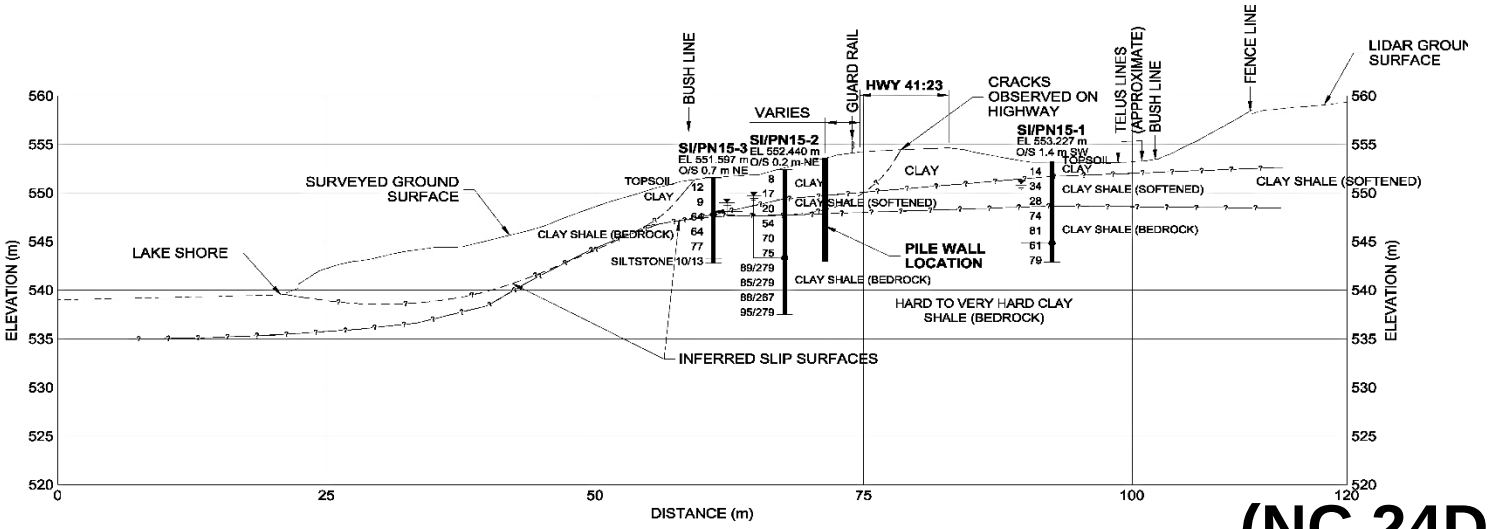
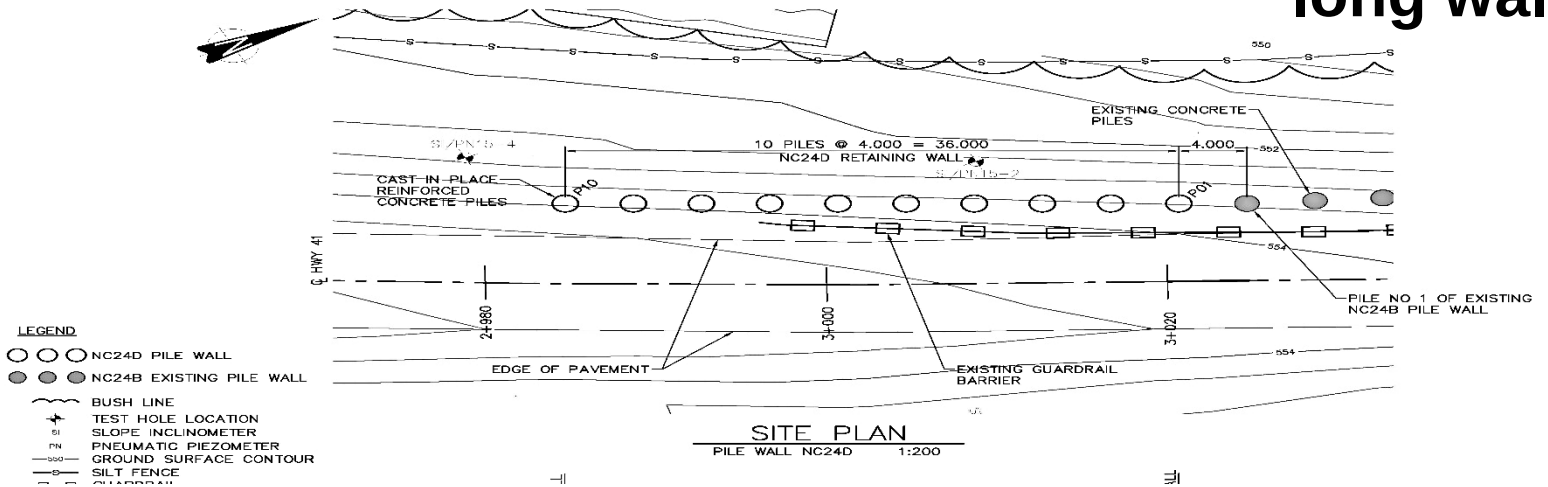


(NC 24D- 40m long wall)



SITE PLAN
PILE WALL NC24D 1:200

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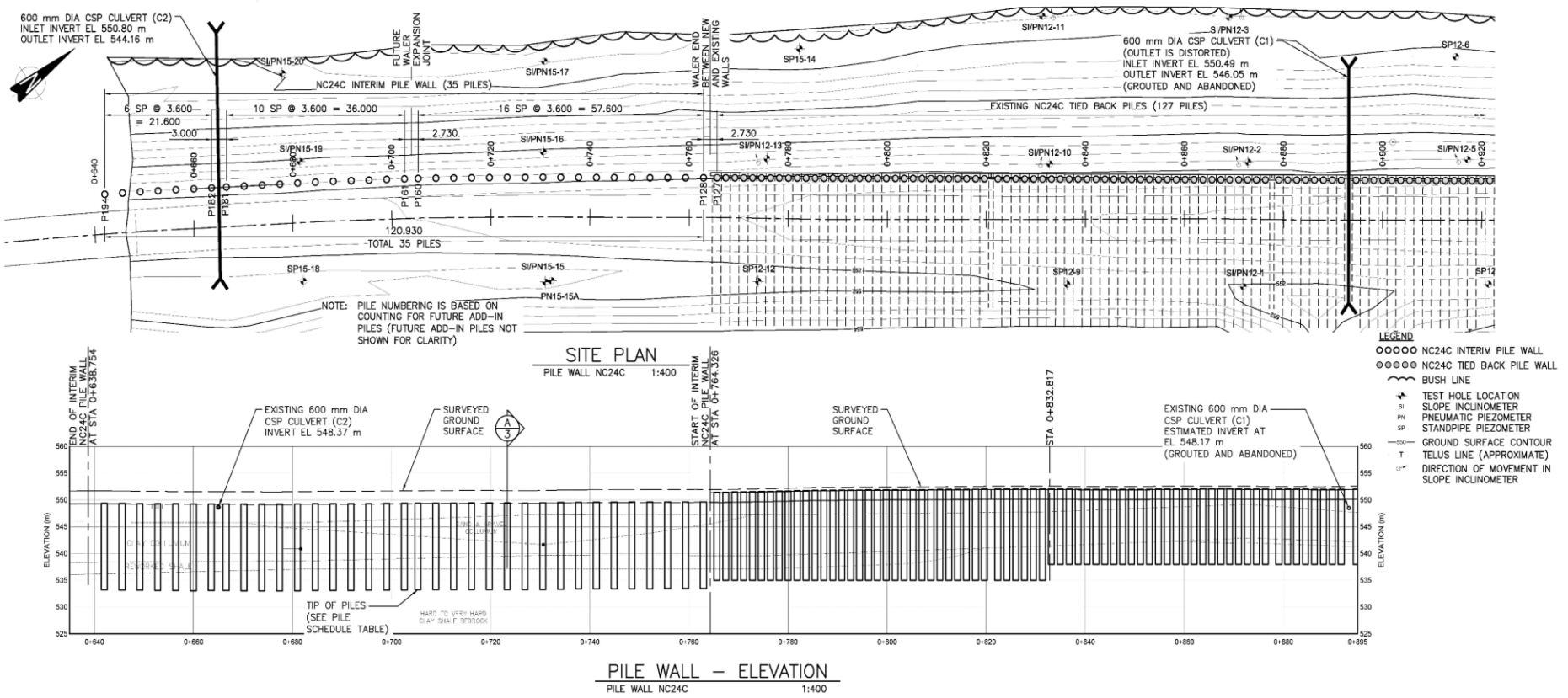
(NC 24C Pile Wall Extension- 100 m long)



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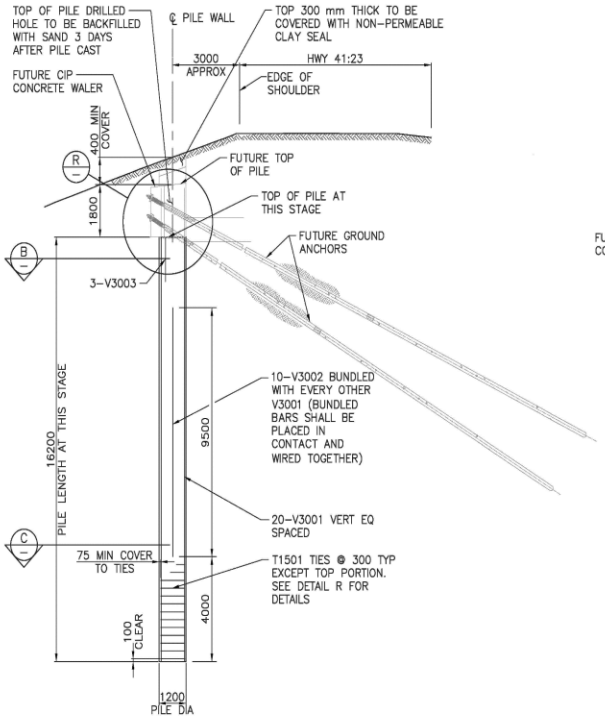

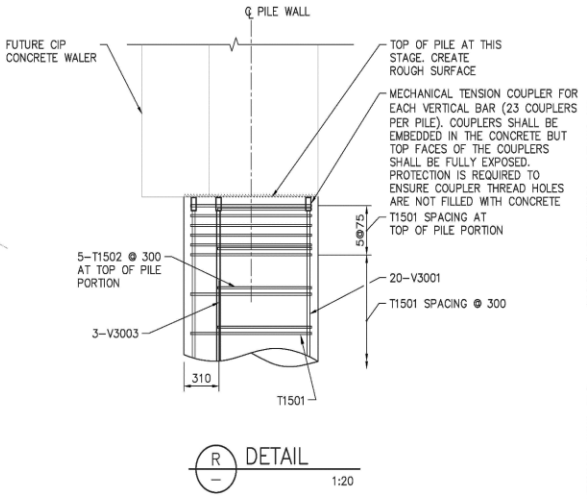

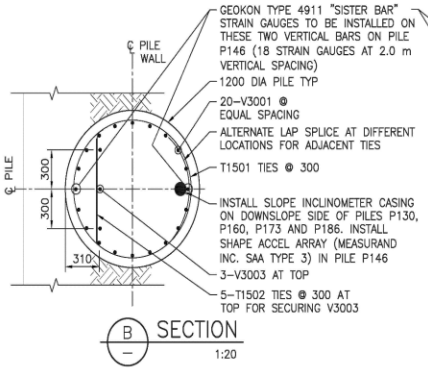

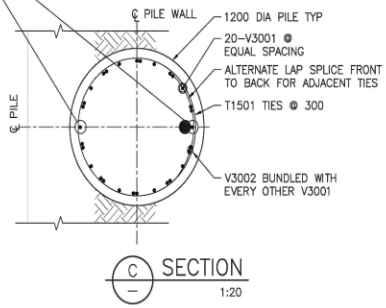

DESIGN:

- THE INTERIM PILE WALL OF THIS STAGE IS DESIGNED TO TAKE ONLY 67% OF THE FULL EARTH LOAD AS SHOWN ON THE LOADING DIAGRAM. THE TIME TO BUILD FINAL PILE WALL SHALL BE PROPERLY SCHEDULED TO ENSURE THE WALL WILL BE COMPLETED BEFORE PILE WALL DEFLECTION (BY CONTINUOUSLY MONITORING) REACHES THE FOLLOWING SUGGESTED CONTROL DEFLECTION VALUE:

MONITORING LOCATION	DESIGN DEFLECTION AS SLS (mm)	SUGGESTED CONTROL DEFLECTION (mm)	SUGGESTED WARNING DEFLECTION THRESHOLD VALUES (mm)*
TOP OF GROUND AT PILE WALL	29	24	20
TOP OF PILE (AT THIS STAGE)	21	16	12

- PILE REBAR CALCULATED STRAINS AND THE WARNING THRESHOLD VALUES FOR BUILT PERMANENT PILE WALL ARE LISTED IN THE BELOW TABLE:

REGIONS	AT PILE MOMENT RESISTANCE CAPACITY **	AT 70% PILE MOMENT RESISTANCE CAPACITY **	SUGGESTED WARNING THRESHOLD VALUES *
20-30M TYPICAL VERTICAL BARS WITH 10-30M, 9.5 m LONG ADDITIONAL VERTICAL BARS ADDED	0.00086 (COMPRESSION SIDE) 0.00297 (TENSION SIDE)	0.00048 (COMPRESSION SIDE) 0.00134 (TENSION SIDE)	0.00043 (COMPRESSION SIDE) 0.00120 (TENSION SIDE)
20-30M TYPICAL VERTICAL BARS	0.00060 (COMPRESSION SIDE) 0.00257 (TENSION SIDE)	0.00042 (COMPRESSION SIDE) 0.00145 (TENSION SIDE)	0.00035 (COMPRESSION SIDE) 0.00100 (TENSION SIDE)

NOTE: * SUGGESTED WARNING THRESHOLD VALUES ARE BASED ON CURRENT EARTH MOVEMENT RATE (i.e. 2-5 mm PER YEAR) IT MAY CHANGE WITH TIME
** STRAINS PROVIDED BASED ON ASSUMPTIONS IN THE BEAM FLEXURE THEORY

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NC24C EXTENSION CONSTRUCTION CHALLENGES

- Contractor mobilized three different rigs to drill piles (SR50, SR65, SR80).. Eventually decide to use SR80 and Segmental Casing.... Liebherr 24 used for the original wall

- Decided to use SR80 and Segmental Casing; will case the holes for the entire depth (do we have to?) ; worried about seepage near bottom

- Rig broke down; segmental casing in the ground filled with concrete; took almost 1 week to drill through the rebar and concrete to retrieve casing

- Operator quit; resumed drilling but casing got stuck again; could not retrieve the casing from the ground… Clay is too sticky

- Can not finish the piles without an oscillator; need a new pad and will sit perpendicular to the highway; need a detour

- AT paid for the detour to get the project going; salvaged gravel hauled to AT nearby pit

- Rate of production increased from 1 pile per two weeks to almost 1 pile per day

- Contractor assembled all cages and placed them for a long duration on the slope; parked a heavy crane at one location for a long duration; rate of movement accelerated; worried about losing the highway

- Had to extend the completion date from July 31, 2017 to September 30, 2017. The construction of 35 piles took 2.5 months (originally bid 21 days).

- Applied 3 days of Liquidated damages and 50 days of site occupancy penalties

- Contractor to file a claim for different /difficult soil conditions; mobilization/remobilization of different rigs, mob/demob and operation of oscillator; additional concrete, and for delays for the requirement to remove rebar cages from site

NC04 Erosion Issues, Hwy 55:10 & 813:02 in Athabasca, Alberta: Remedial Measures

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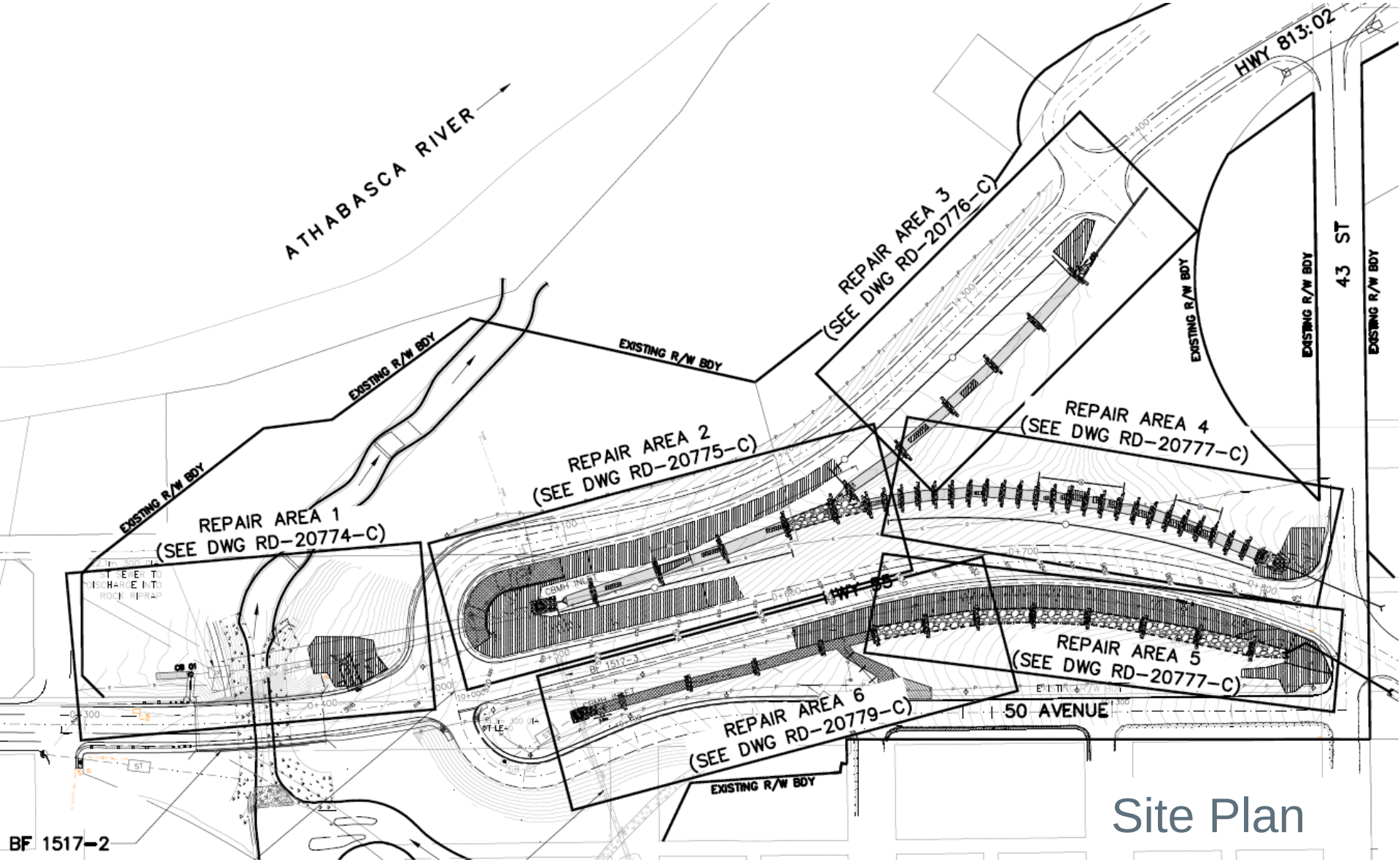

Site Plan

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Erosion Issues - Cause

- Concentrated runoff flowing over bare slopes
- Bare slopes possibly due to excessive salting of the hill
- Soils in area are sandy and susceptible to erosion
- Gabion weirs at the bottom are space far apart

Innovation

- Flexamat was used as an option for riprap
- A trial seed mix that is more resistant to salt

The Team

COMPANY	NAME	ROLE
OWNER		
Alberta Transportation (Athabasca)	Paula Campbell Arthur Kavoluk Ron Hilligas	Project Sponsor Project Administrator Maintenance Contract Inspector
CONTRACTOR		
Brock White Canada ULC (Calgary, Alberta)	Craig Felzien Alex Lowe Kris Lyons	Construction Superintendent Project Manager Foreman
CONSULTANT		
Thurber Engineering Ltd. (Edmonton, Alberta)	Tarek Abdelaziz Don Stefanyk Ken Froese Luis Cortez Mohamed Hossein	Review Principal Senior Materials Engineer Project Manager Construction Inspector Construction Inspector
GeoMetrix Group Engineering (Edmonton, Alberta) (Sub-Consultant to Thurber)	Zichao Wu Wayne Stewart	Structural Engineer (designer of concrete troughs) Structural Engineer (site inspection)
WSP Canada Inc. (Athabasca, Alberta) (Sub-Consultant to Thurber)	Brad Grant Renaud Marchand Dylan Evans	Survey

Hwy 55 south ditch: poor vegetation growth with resulting erosion

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Hwy 55 north ditch: undercutting of gabion splash pad

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50 Avenue: sediment accumulation in channel added after runoff flooded electrical box

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Hwy 813: salt flat

Hwy 55 NE corner of bridge: erosion encroaching

Hwy 55 NW corner of bridge – undercutting trough

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Hwy 55 NW corner of bridge – catch basin at toe

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Solution

Regrade ditches and line with combination of Flexamat (rolled concrete blanket) and Class 1M riprap

Compost blanket everywhere else; high-stress areas also covered with permanent TRM

Seed mix was unique blend suggested by Nilex as more salt-resistant than typical AT blends

Add drain trough at NE side of bridge

Widen NW trough and add settling basin

Approx. $400,000

NE corner – new drain trough with dissipation bowl

NW corner – widened inlet taper, added settling basin

50 Ave: Flexamat placement

Flexamat Standard: beveled concrete blocks approx. 165 mm on each side and 57mm bonded to high-strength bi-axial geogrid with Curlex II ECB – up to 4.9m wide x 15m long

Flexamat Plus: adds Recyclex TRM-V on bottom side for additional erosion protection - $75/m^2 installed v $65/m^2 for RR

Anchoring and overlapping Flexamat

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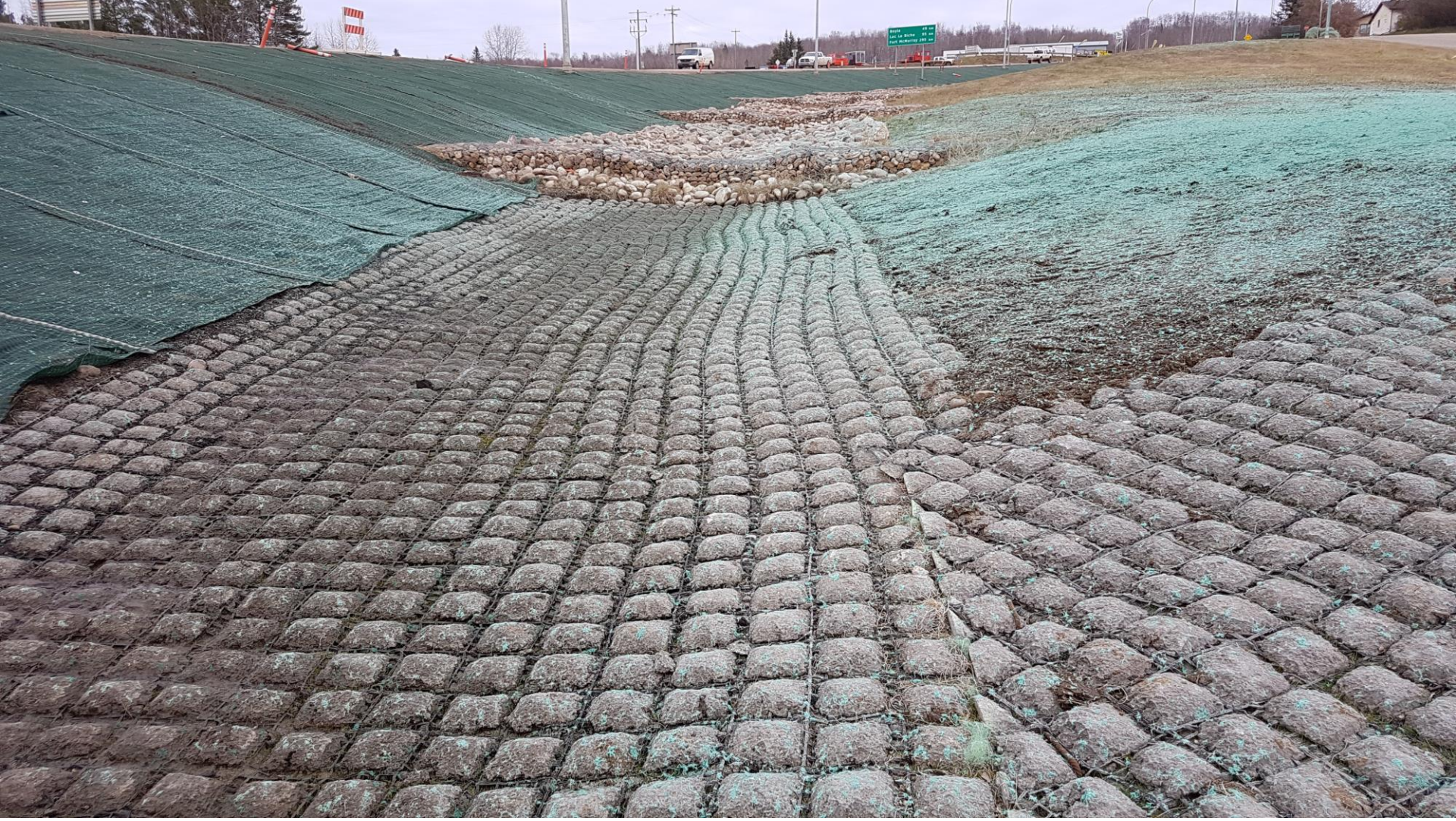

Hwy 55 south ditch: Flexamat in lower portion, riprap in upper, compost blanket with TRM on slope

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Hwy 55 south ditch: Flexamat and hydroseed

Hwy 813: Flexamat, compost sock, compost blanket, and hydroseed

Flexamat: early seed growth

Acknowledgments

- Roger Skirrow, Rocky Wang, Rishi Adhikari, Alberta Transportation Geotechnical and Materials Section
- Paula Campbell, Arthur Kavulok, Brandon Sandford, Edie Yuill (AT Athabasca Office)
- Gord Wolters, Calvin Kissel, Sola Akapo, Ron Hilligas, Brent Churla (AT Athabasca Region Local MCIs)

Thank you !