

# Geosynthetics Reinforced Railway Twinning Project

## Canadian National Railway

### Aurora, ON



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## CN Rail Track Map & Project Location



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### Project Overview

- CN Bala Subdivision runs between Toronto & Capreol in Ontario
- Major part of transcontinental link between Southern Ontario & Western Canada
- Very busy route
  - Heavy CN rail
  - Several weekly Via Rail trains
  - Weekday GO rush hour trains
- Two-kilometre rail line twinning completed in 2017 – Aurora, ON



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### Project Overview



My Home

6 km

Project Location

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## Project Overview

- Site characterized by deep pockets of muskeg/bog
- Concerns with settlement of existing track
- Several geosynthetic solutions in original design
  - Multi-layered geosynthetic reinforced raft
  - Geosynthetics reinforced embankment surcharge
- Problematic area required pile supported platforms with geosynthetic reinforced soil beam



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## Site Conditions Between Mileage 29.2 & 29.5

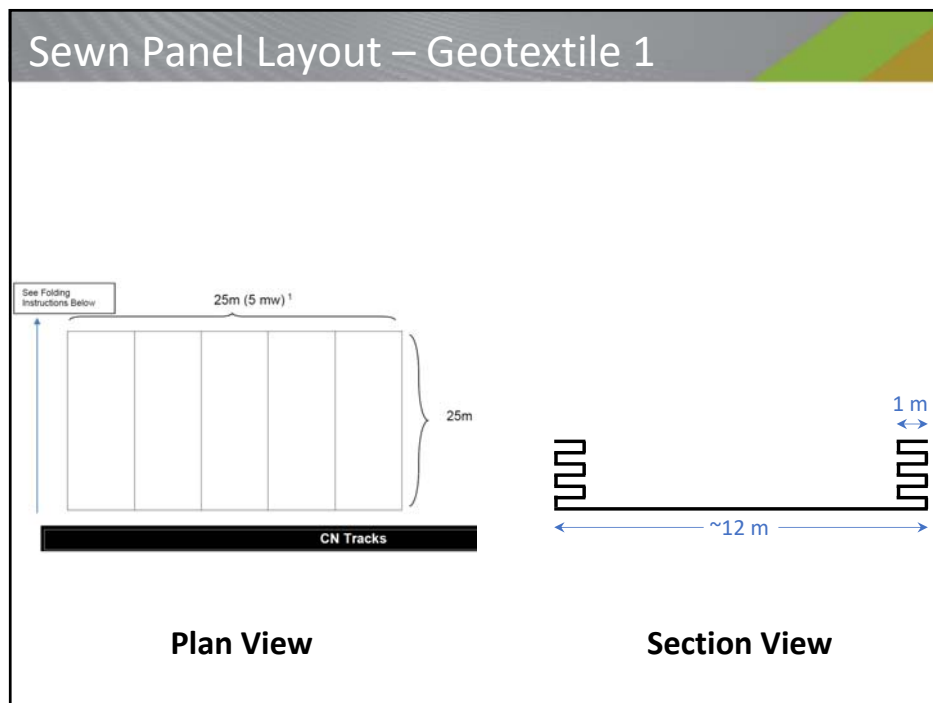


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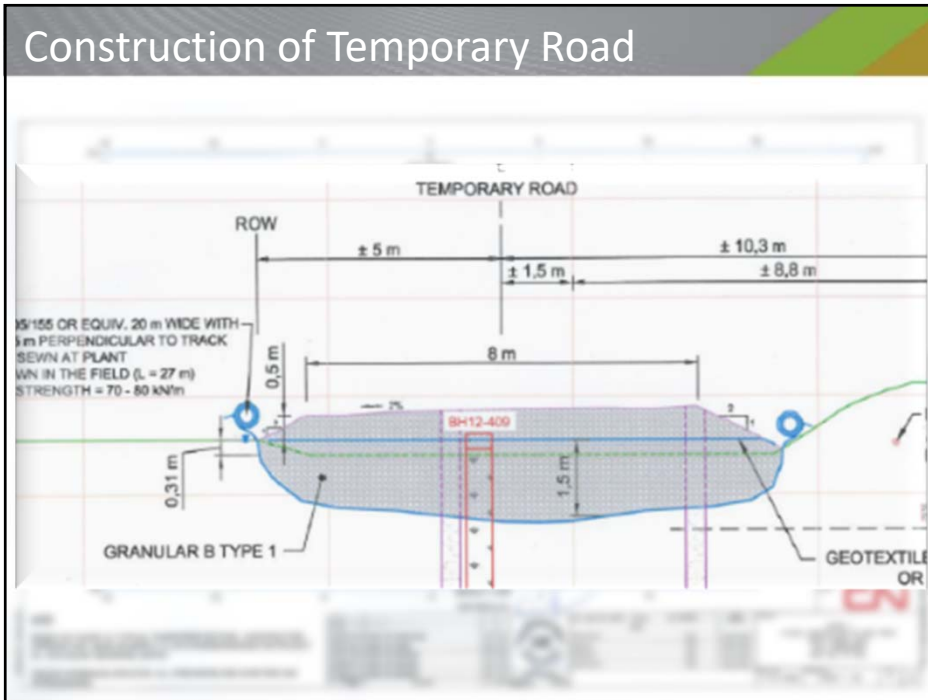
### Geosynthetics Used for Access Road

	High Modulus PP Woven Geotextile 1 (Base of Raft)		High Modulus PP Woven Geotextile 2 (Within Raft)		Uniaxial PET Geogrid (Temporary Surcharge)
	MD	XD	MD	CD	
Tensile Strength @ Ultimate (kN/m)	105.0	155.0	52.5	47.3	51.1
Tensile Strength @ 5% Strain (kN/m)	21.9	78.8	21.9	22.8	15.4
Seam Strength (kN/m)	N/A	82.5	N/A		N/A
Long Term Design Strength (kN/m)	N/A		N/A		30.5

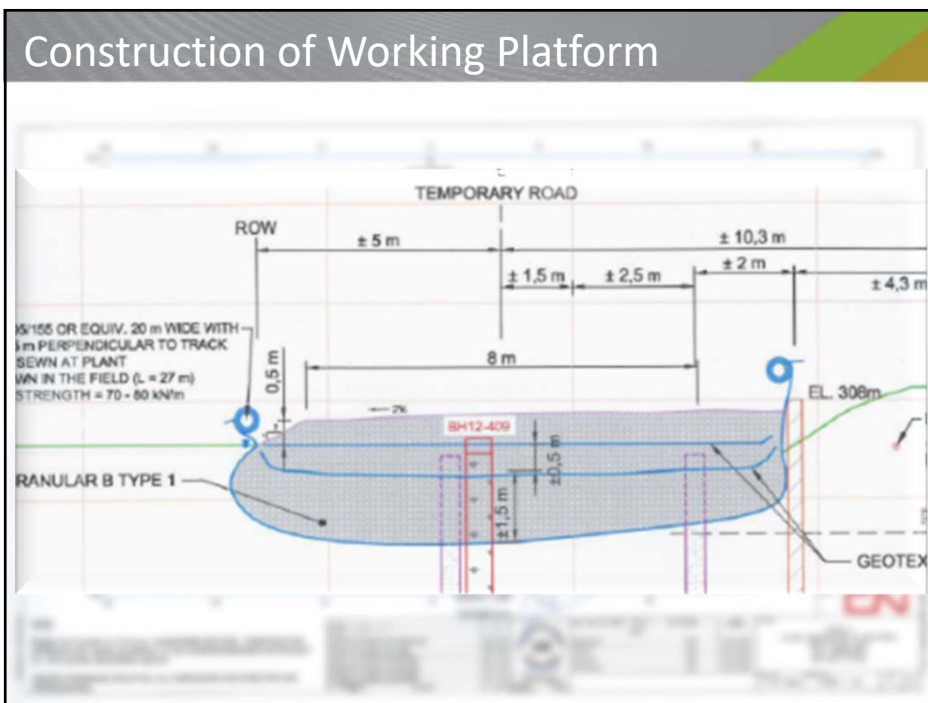
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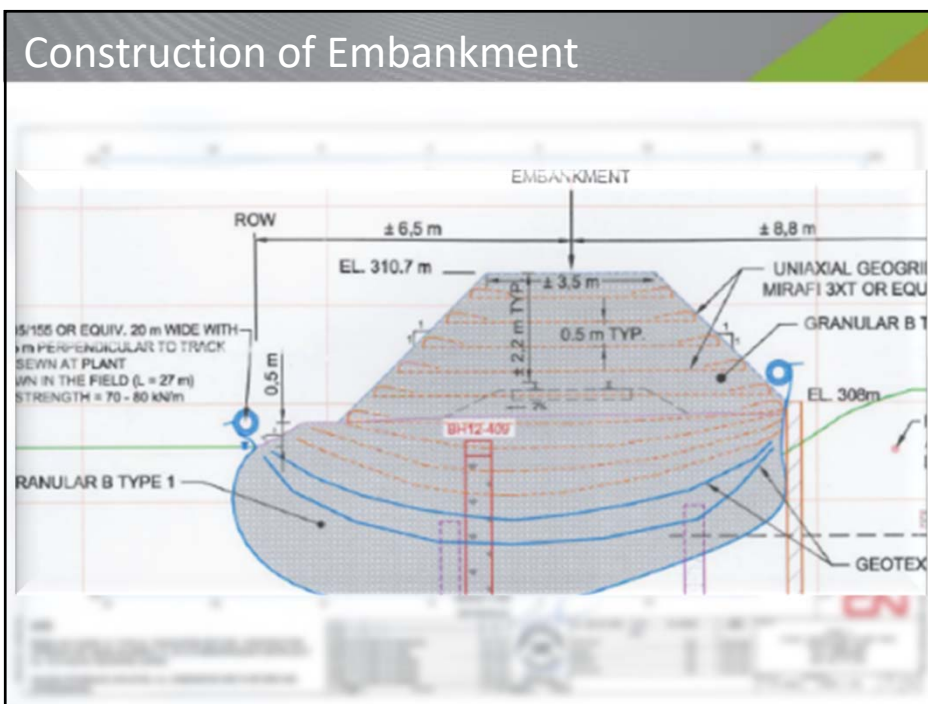


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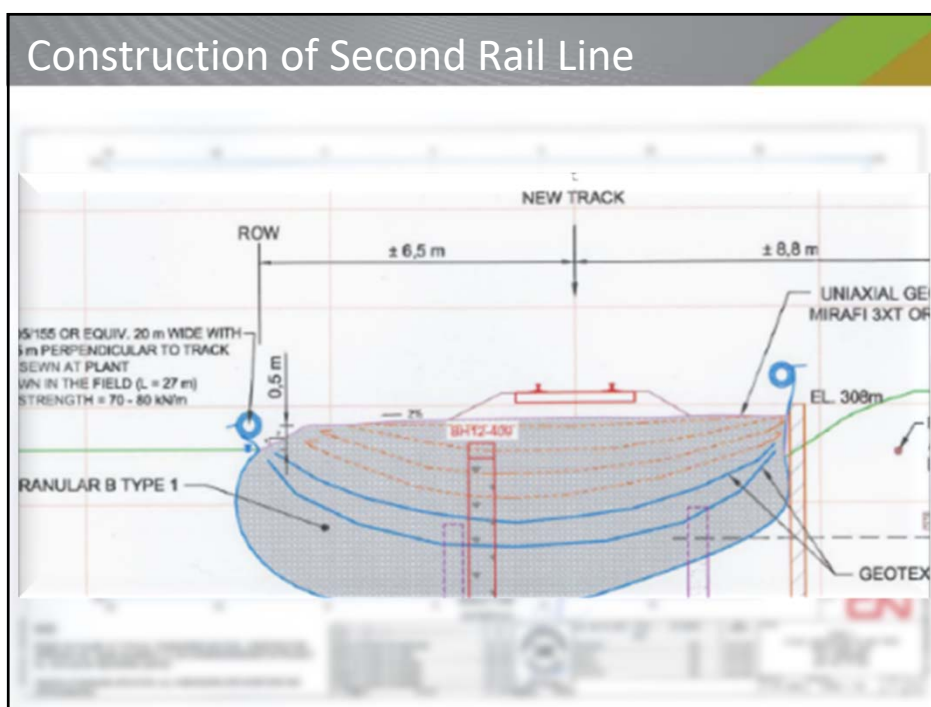


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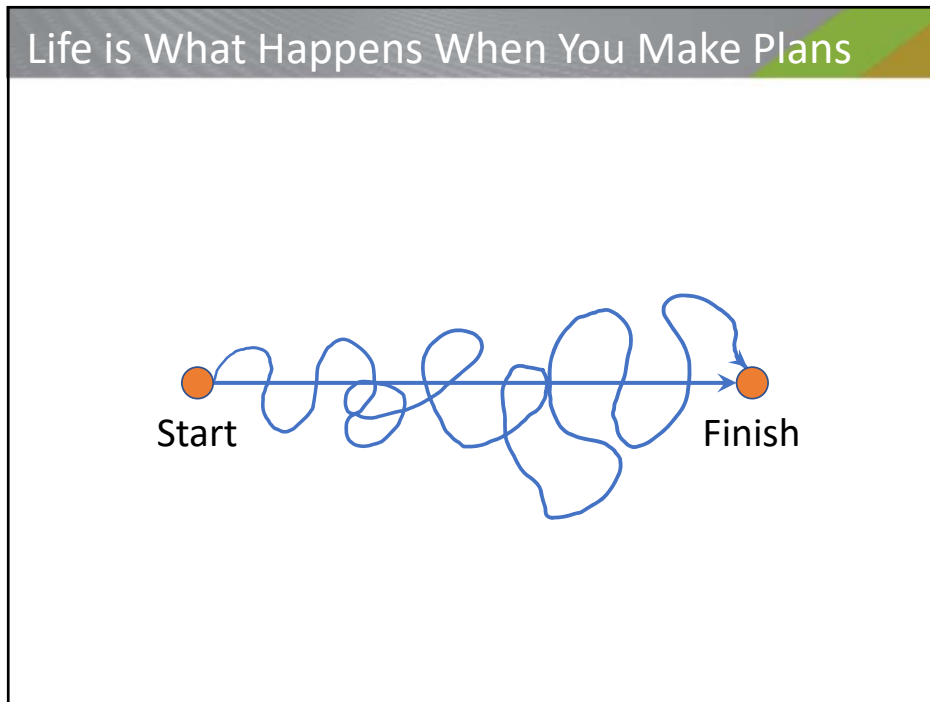


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### Unexpected Site Challenge

- Peat > 6 m thick unable to support initial fill loads
- Excessive settlement to existing track in these areas
- Two locations
  - 47+310 – 47+375 (65 m)
  - 47+425 – 47+525 (100 m)
- Piles needed to stabilize existing track and reinforce new mainline



The photograph shows a red locomotive on a railway track. The locomotive is positioned on the right side of the frame, and the track extends into the distance. The background shows some greenery and a clear sky.

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## Fast Lagrangian Analysis of Continua (FLAC)

FLAC Analysis – Settlement w/o Piles

FLAC Analysis – Settlement with Piles

- Design included 560 piles over 215 m of track
- Piles installed in rows of 5
  - 3 near vertical
  - 2 battered at 15° towards existing track

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## Reinforced Soil Beam

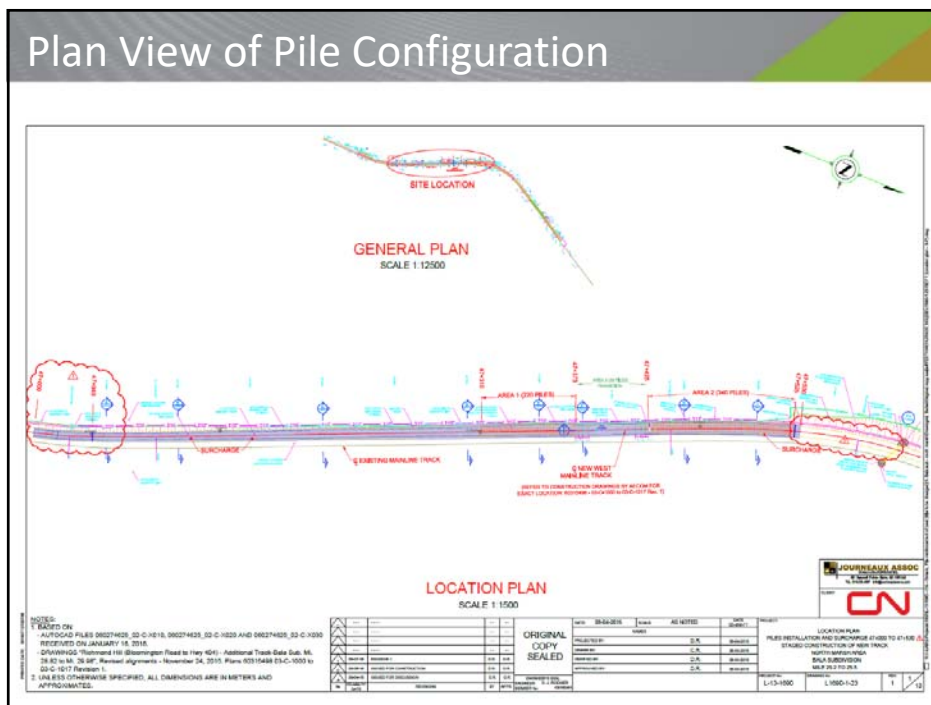
- Similar principle to embankment supported by piles & geosynthetics
- Two mechanisms govern behavior:
  - Arching effect into soil embankment
  - Tension membrane effect of the geosynthetic
- Vertical load can be transferred onto piles
- Adapted from British Standard (BS) 8006 **Code of practice for strengthened/reinforced soils and other fills**

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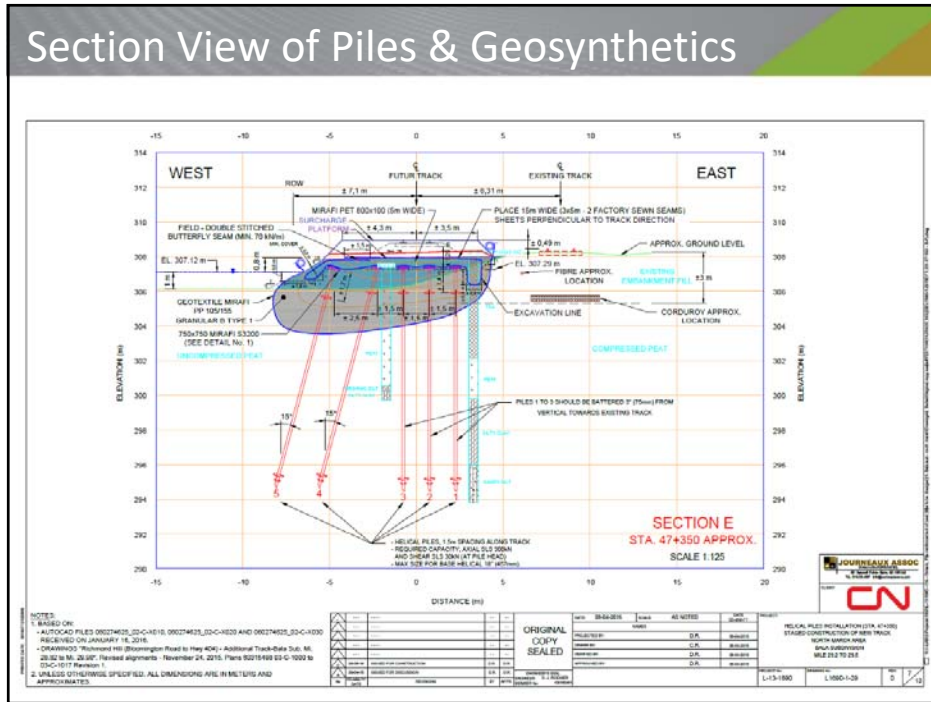
## Geosynthetics Used for Reinforced Beam

	High Strength PET Geotextile 3 (Reinforced Soil Beam)		Nonwoven Geotextile (Pile Cap Cover)	
	MD	XD	MD	CD
Tensile Strength @ Ultimate (kN/m)	800.0	100.0	N/A	N/A
Tensile Strength @ 5% Strain (kN/m)	280	N/A	N/A	N/A
Seam Strength (kN/m)	> 70	N/A	N/A	
Weight (g/m <sup>2</sup> )	N/A		1084.8	
Thickness (mm)	N/A		8.1	

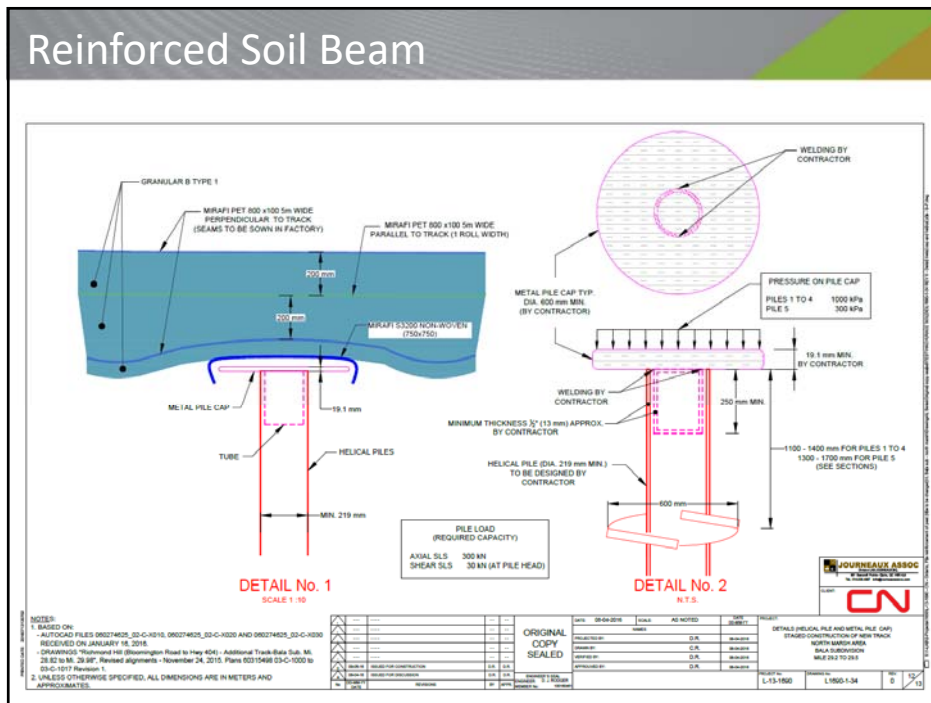
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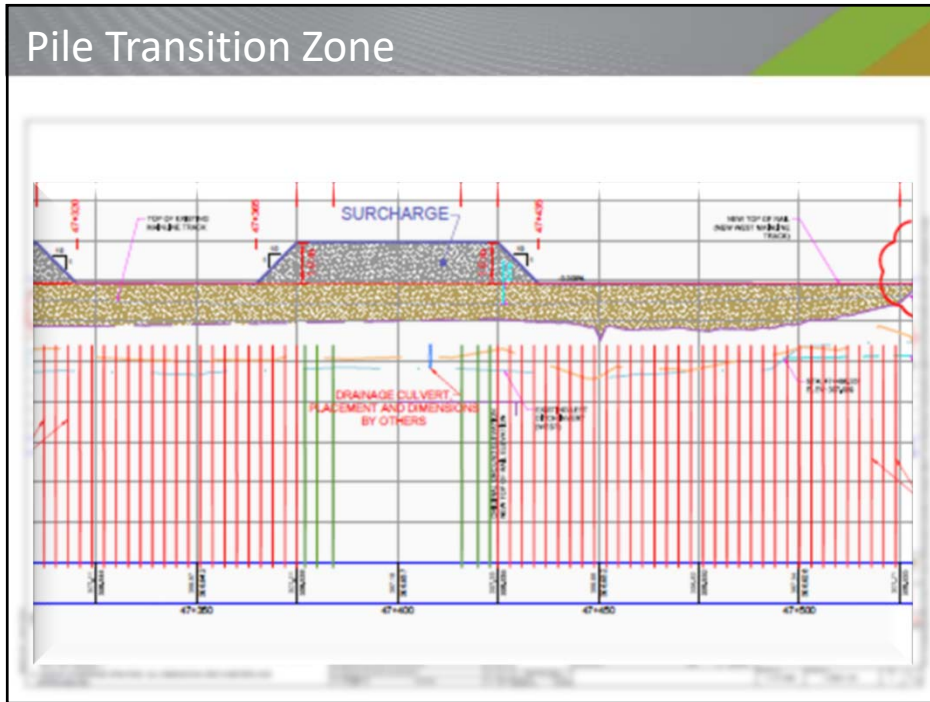
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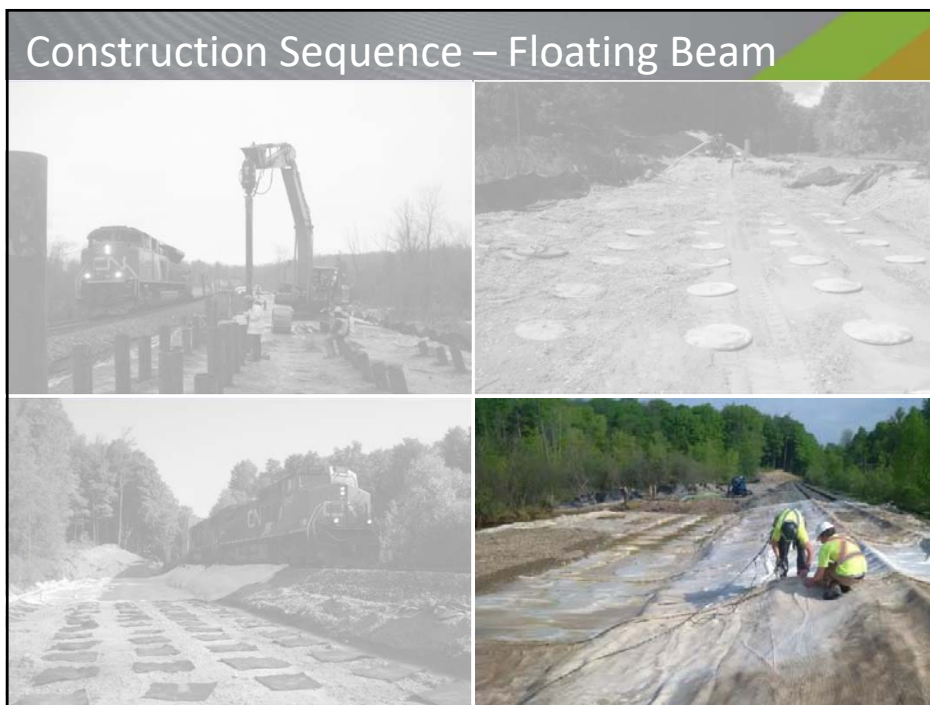
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## The Completed 2<sup>nd</sup> Line




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## Successes & Lessons Learned

- Floating soil beam design is suitable for building adjacent to existing tracks through deep peat deposit
- Maintained operations on 1<sup>st</sup> mainline without interruption
- 2<sup>nd</sup> mainline in service since Fall 2017
  - Minimum to no settlement on track supported by floating soil beam
- Very beneficial if contractor is experienced in installing geosynthetics
- Tight coordination between manufacturer, distributor, sewing contractor and general contractor
- Care with geosynthetics
  - Cleanliness
  - Damage prevention

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