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Earth Retention and Slope Stabilization
Retaining Wall RW-20
I-95 Section 100

Presented by
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Objectives

- Project Background
- Slope History
- Design Methodology
- Construction
- Conclusions

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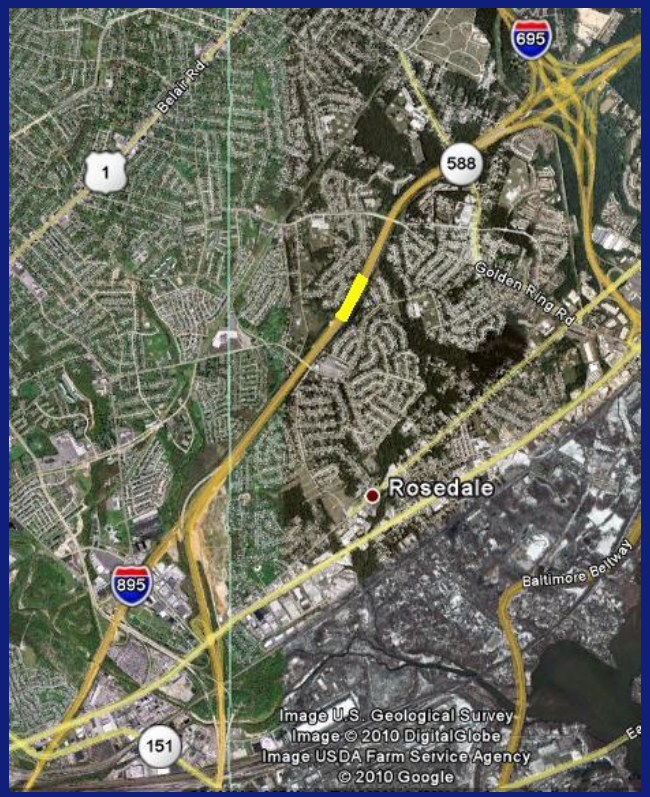
Project Background

- I-95 Section 100 ETL
- Contract KH-1503
- Owner:
  - Maryland Transportation Authority (MDTA)
- Client:
  - Greenhorne & O'Mara, Inc./ Century Engineering Inc., JV
- Wall Designer:
  - Schnabel Engineering
  - Sabra-Wang and Associates



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- Site Geology:
  - Potomac Group
    - Coastal Plain Deposits
  - Arundel Formation
    - Lower Cretaceous age
    - Highly over consolidated clays, fractured and fissured, perched water in sand lenses
    - Low residual strengths

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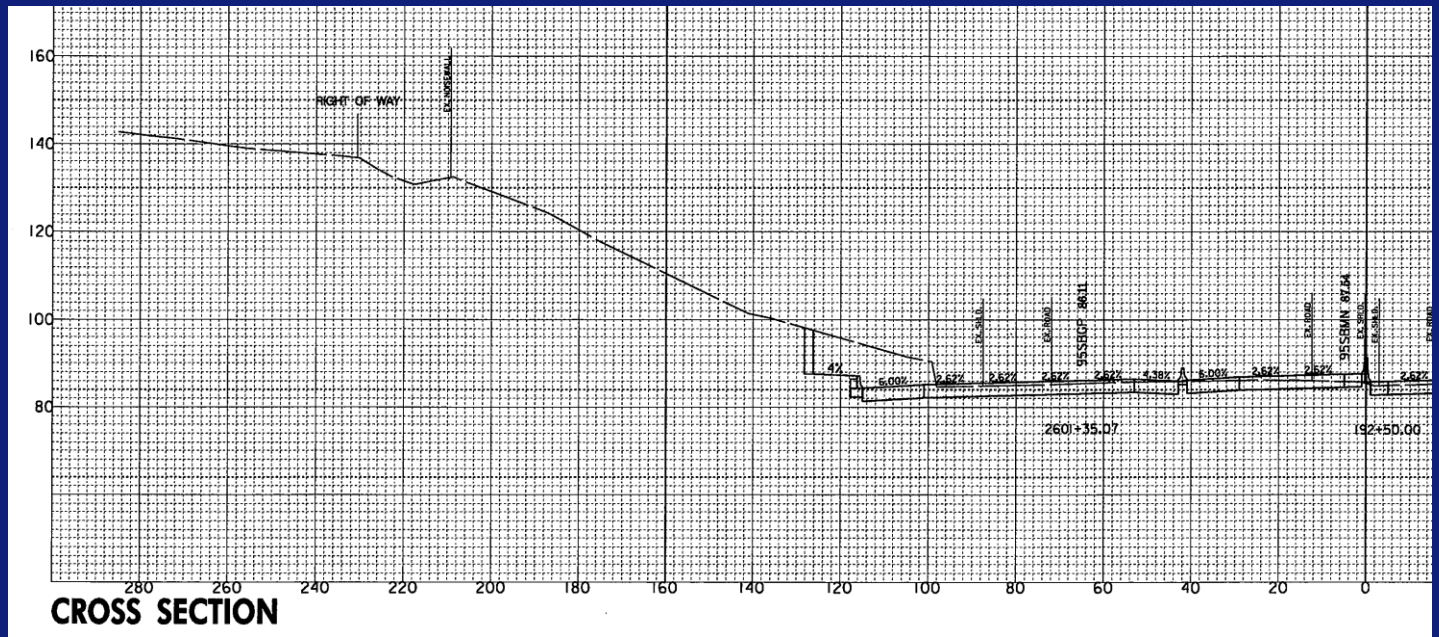
Project Background

- Widen the roadway into the existing slope for two new managed lanes.
- About 950 feet of slope affected.
- The slope has a long history of failures and instability



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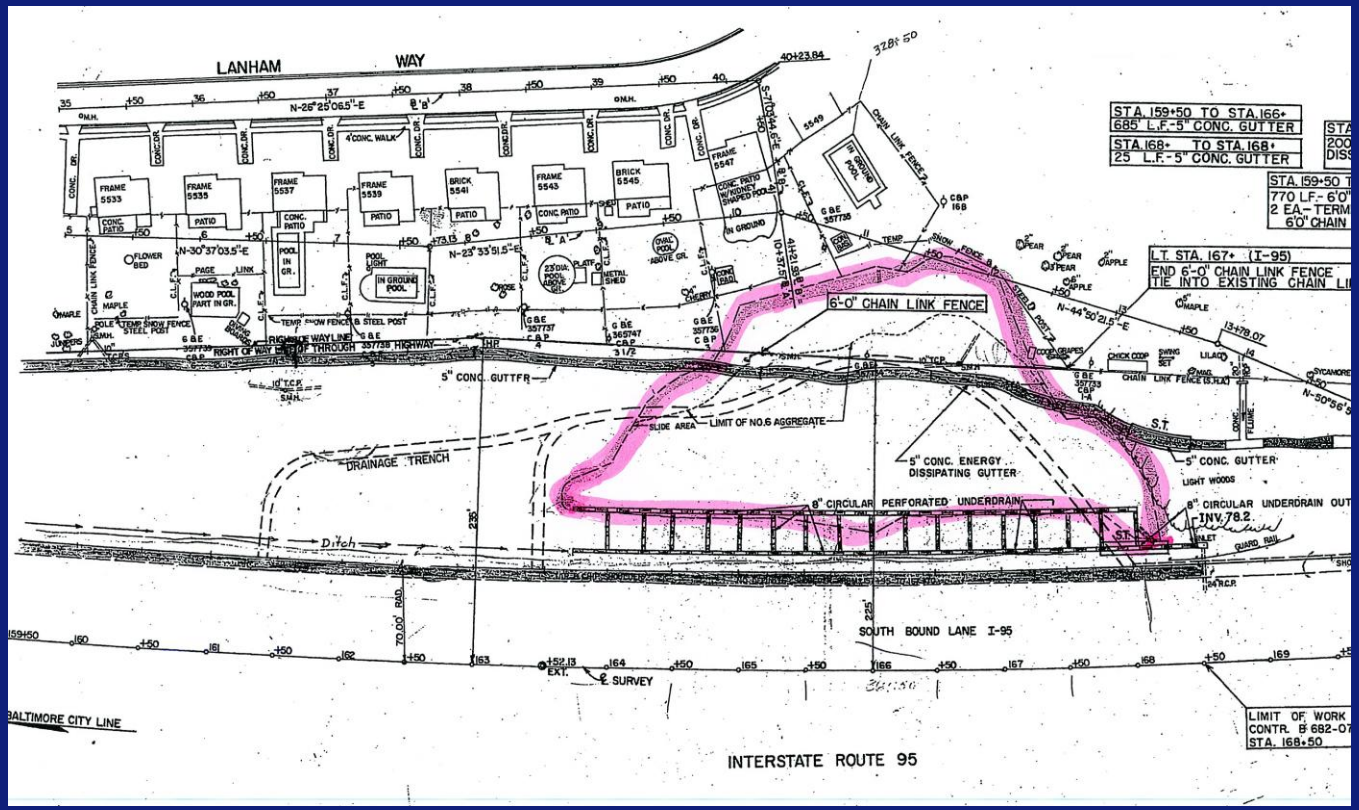
Slope History

- Slope constructed around 1963.
- Constructed at 2.5H:1V
- Slope Failure in 1976



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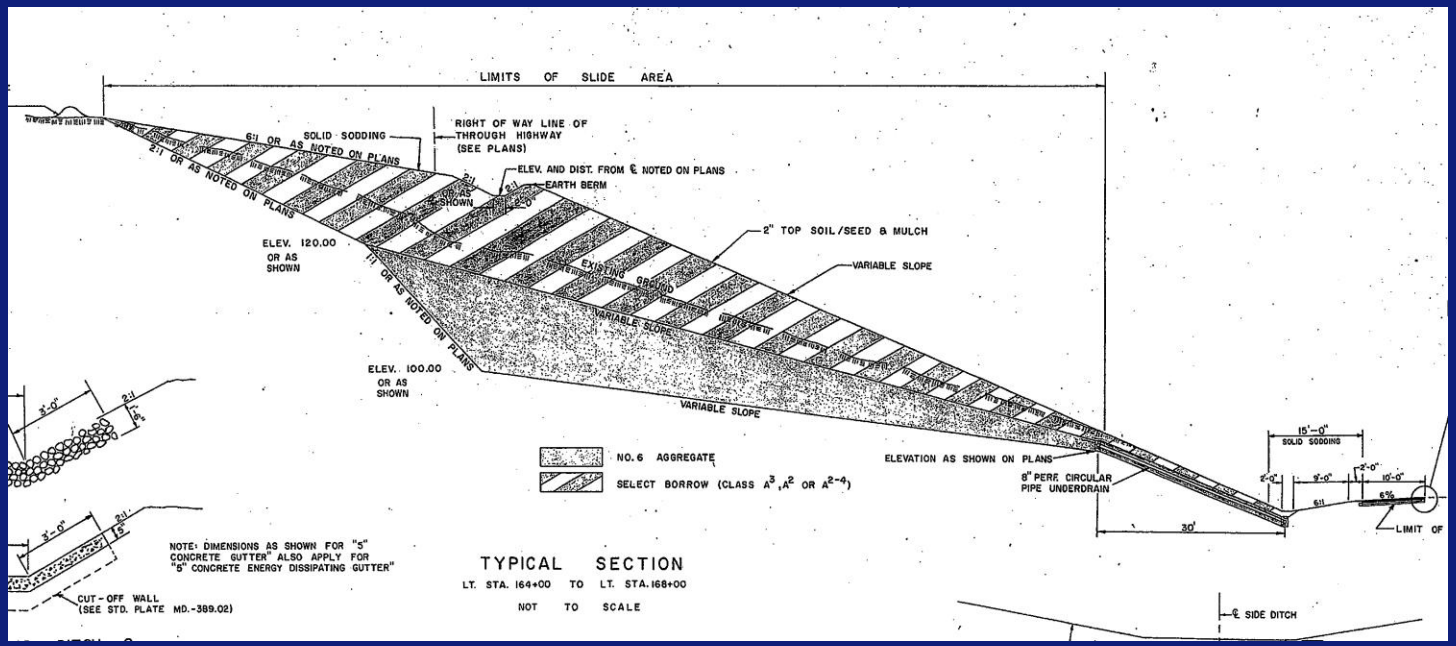
Slope History

- Slope repair in 1976 included:
  - Remove the failed section and replace with aggregate and Select Borrow
  - Install toe drainage



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Slope History

- Slope instability reported in 1998
  - No known repairs were performed
- Roadway widened in 2002
  - A short retaining wall was placed 12-ft into the slope
  - The slope angle remained the same

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Site Reconnaissance

- Water flowing over top of wall - Spring 2006

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Site Reconnaissance

- Evidence of slope instability - 2006

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Site Reconnaissance

- Cracks in slope - 2006

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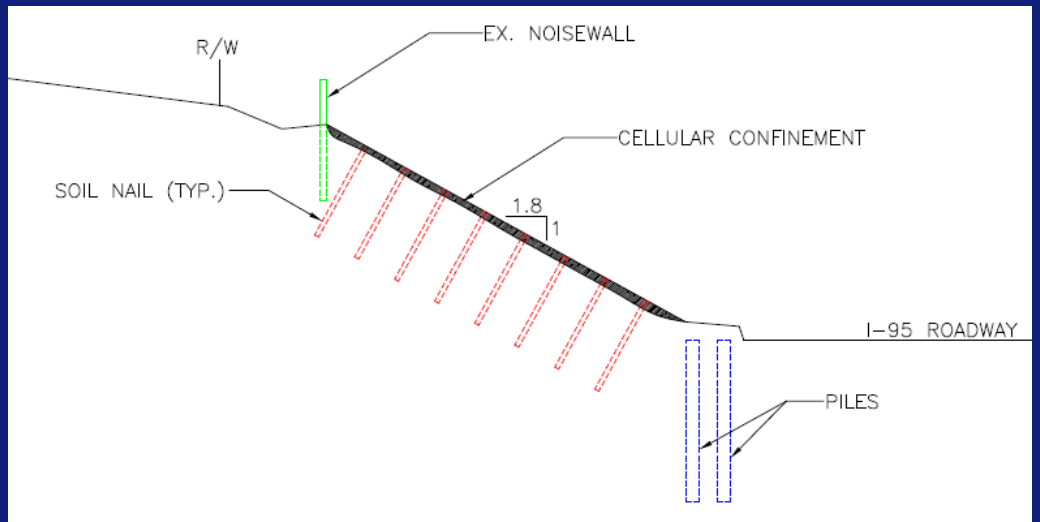
Design Options Considered

- Steepened Slope
  - Advantage:
    - Aesthetics – no visible structures
  - Disadvantage:
    - Soil nails, piles, cellular confinement needed to provide stability
    - Costly



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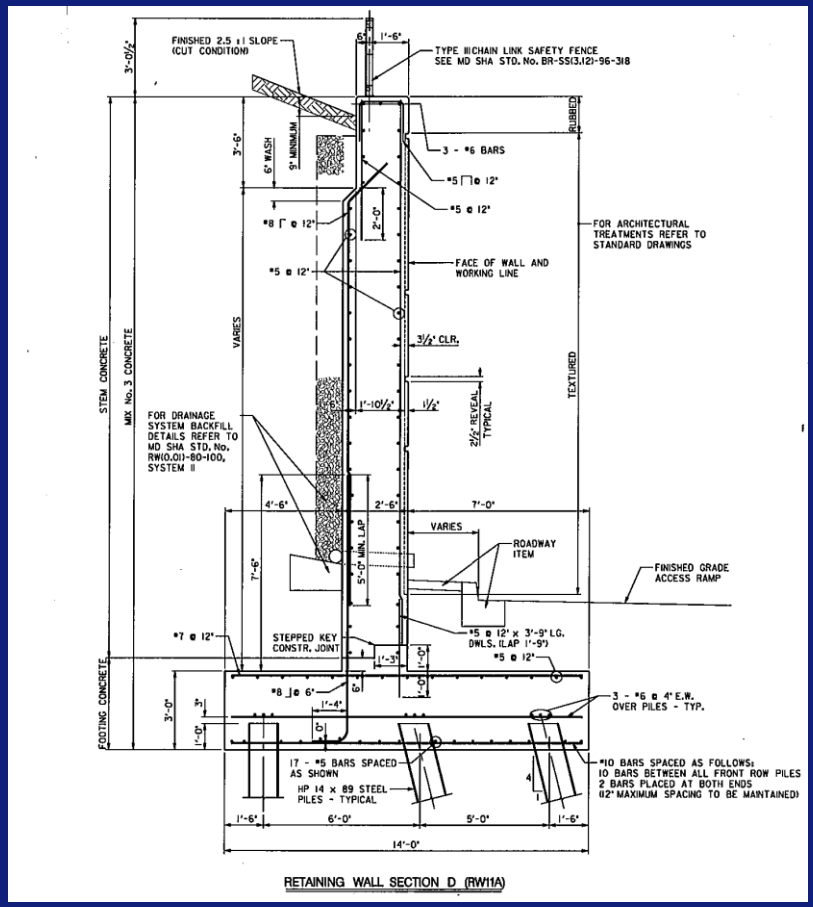
Design Options Considered

- Conventional CIP wall: 950 feet long, maximum height = 27 feet
  - Advantage:
    - Specialized contractor not required
    - Slope can be flattened for stability
  - Disadvantage:
    - Bottom-up construction
    - Temporary soldier beam wall is needed
    - Relatively costly



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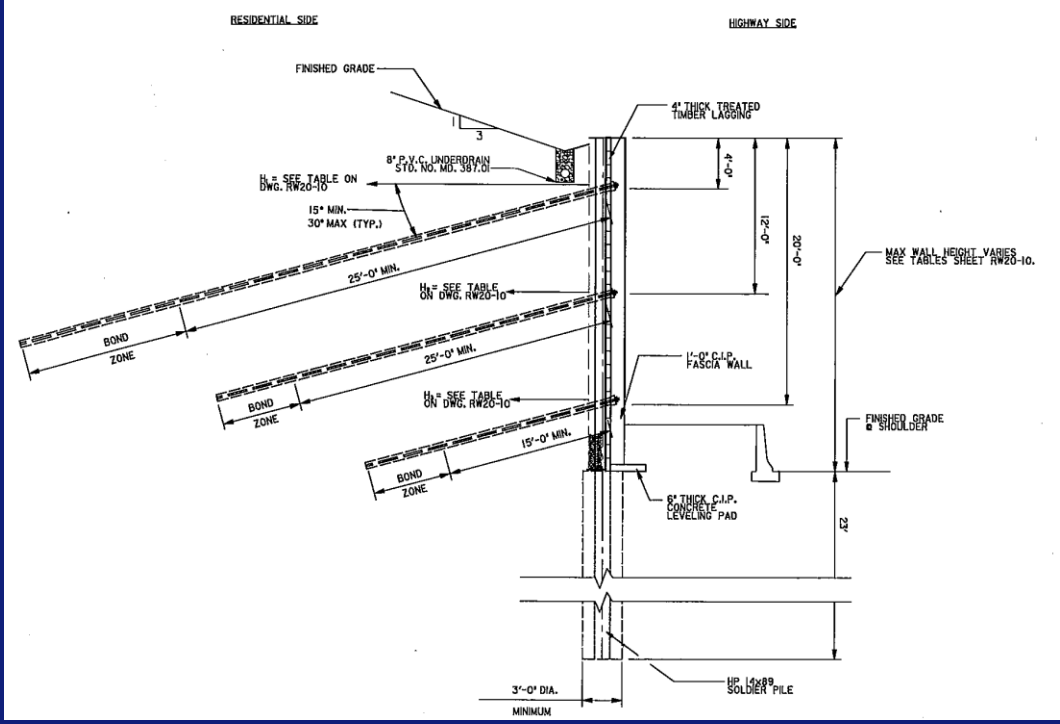
Design Options Considered

- Soldier Beam wall with CIP facing: 950 feet long, maximum height = 27 feet
  - Advantage:
    - Most cost effective
    - Slope can be flattened for stability
  - Disadvantage:
    - Specialized contractor
    - Designed by Specialty Contractor



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Design Methodology

- Determine required slope angle to provide project specified Factor of Safety
- Design soldier beam size and spacing
- Analyze global stability of wall and slope
- Design soldier beam embedment lengths based on global stability requirements
- Preliminary tieback design
- Sabra-Wang designed the CIP facing
- Contractor to design tieback & connection detail

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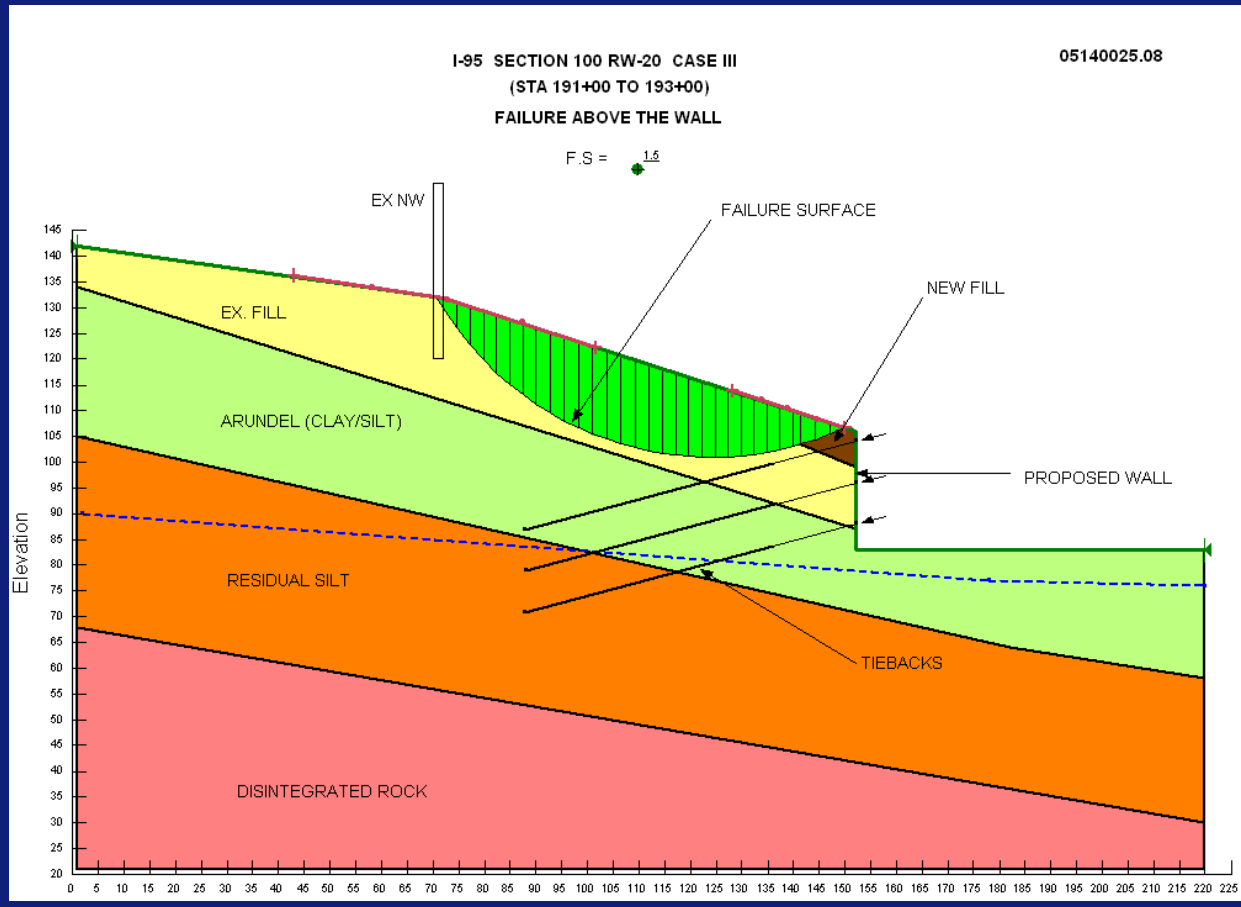
Design Methodology

- Project Required

  FS = 1.3
- Determine slope angle
  - 3H:1V



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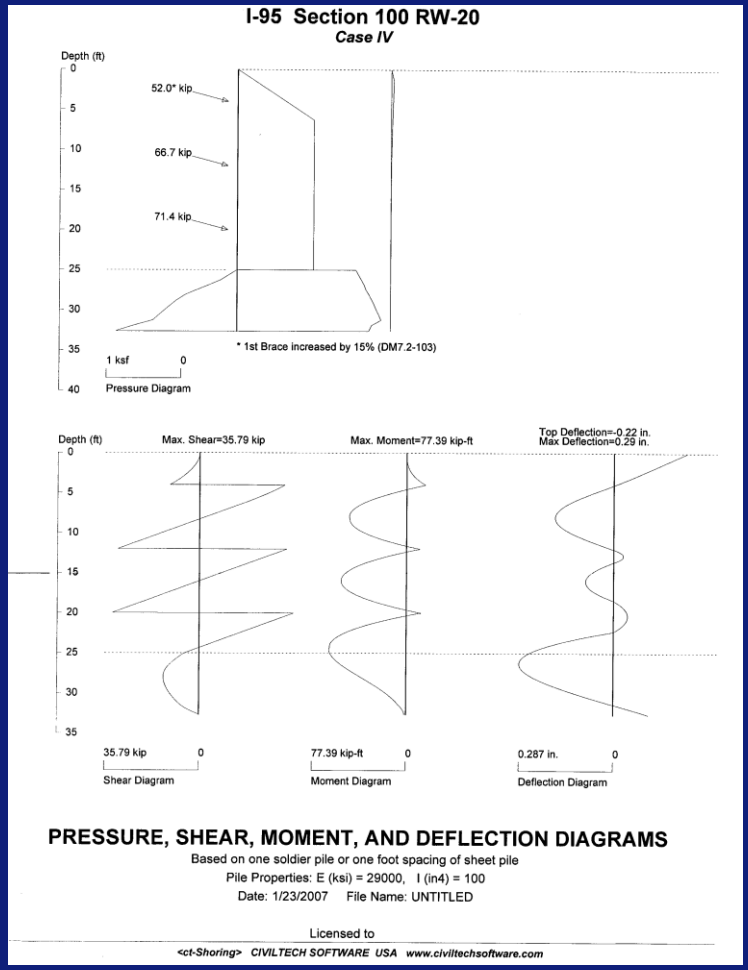
Design Methodology

- Design soldier beam size and spacing
  - HP14x89 Beams
  - 8 feet o.c.



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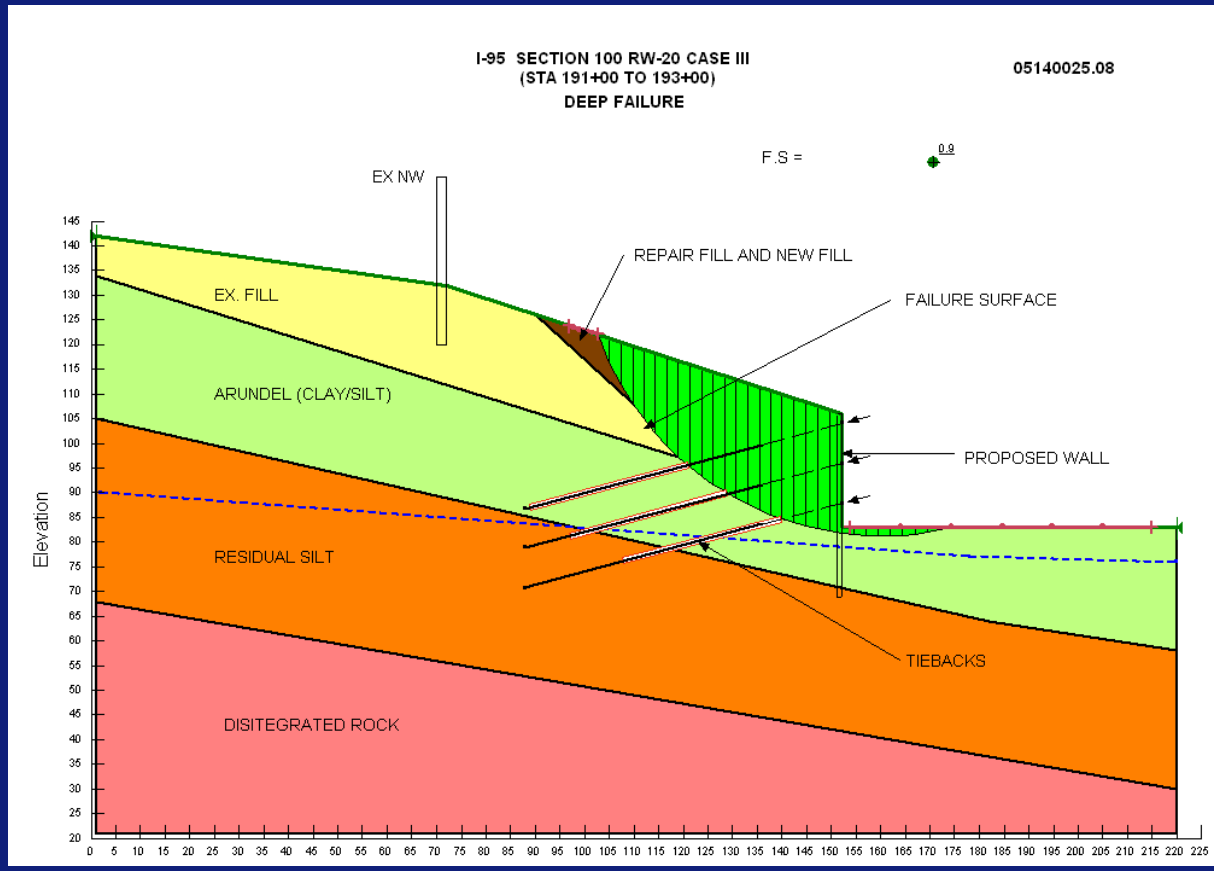
Design Methodology

- Beam embedment
- Consider Global Stability
- Tieback un-bonded lengths



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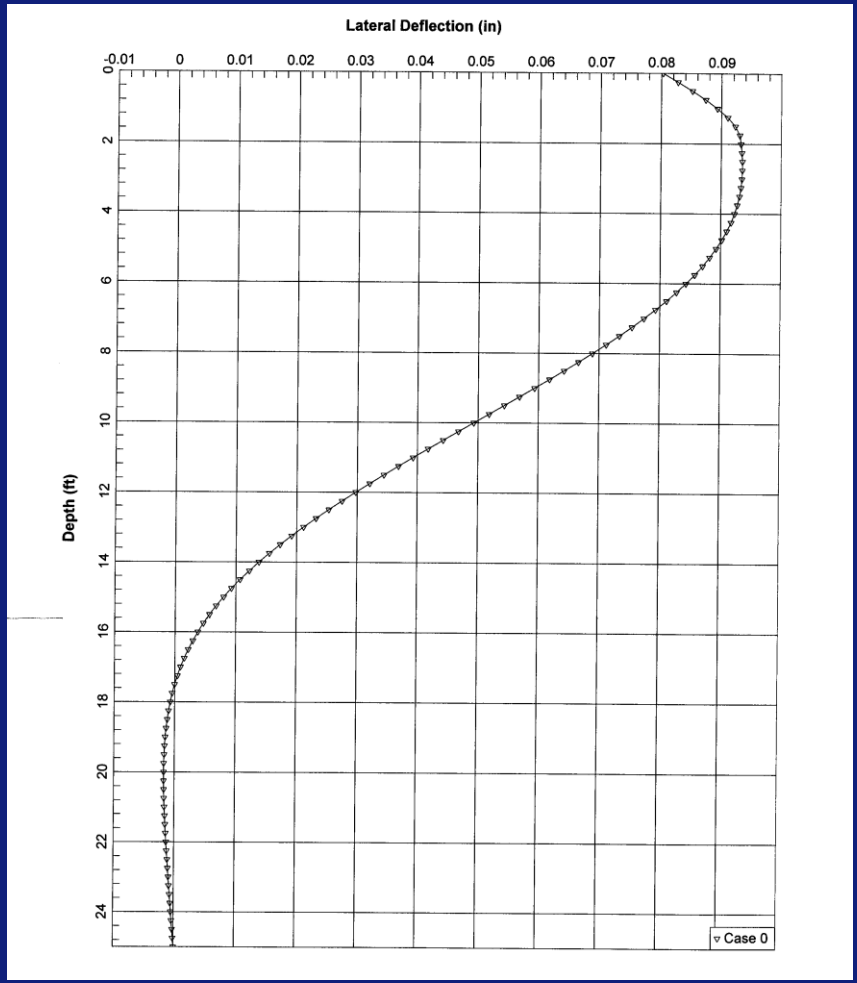
Design Methodology

- Design soldier beam embedment using LPILE
  - 15 to 23 feet embedment depths



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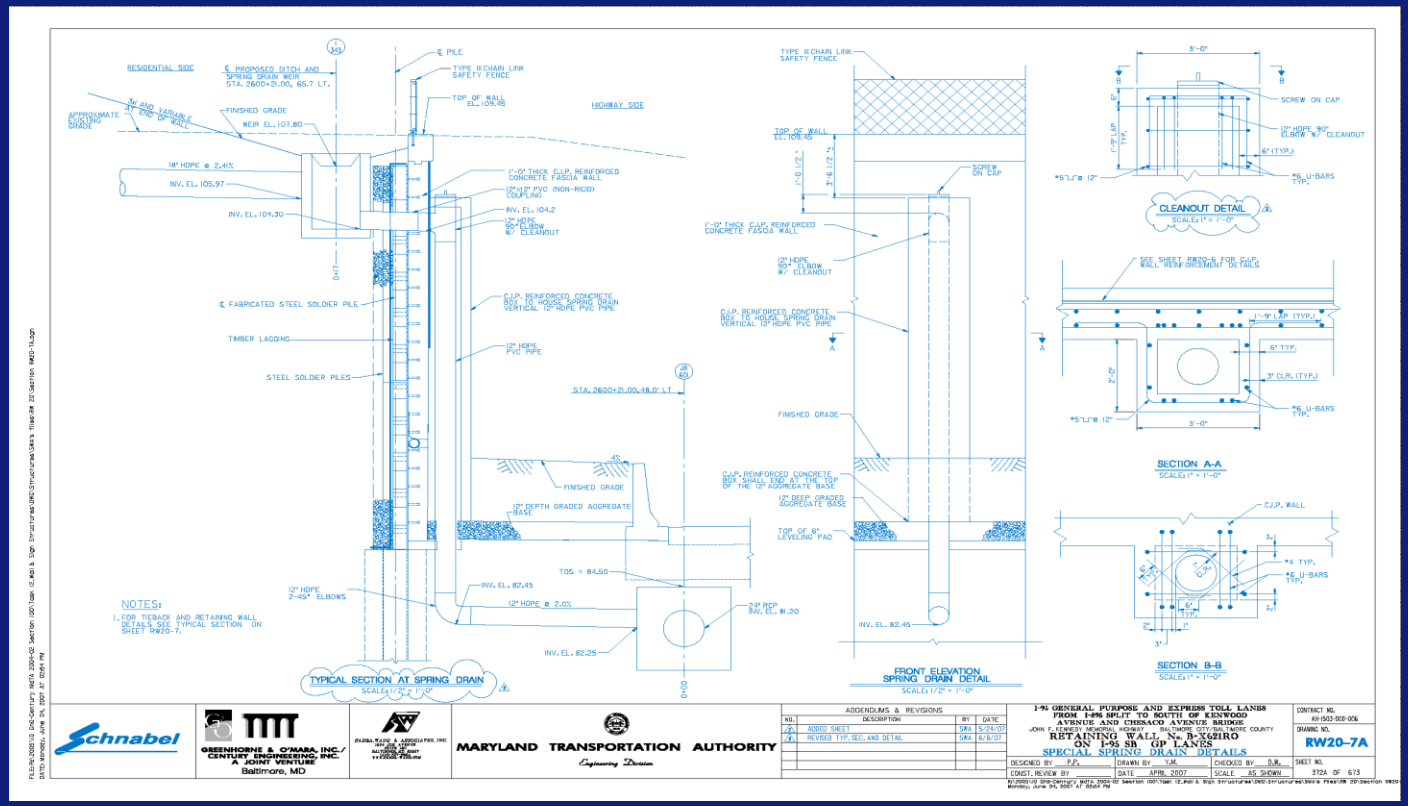
Design Methodology

- Spring Drainage
  - Spring Box and perforated underdrain



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Wall Construction

- Project was awarded in 2007
  - Cherry Hill Construction, Inc
  - $86.8M
- RW-20
  - The Engineer's Estimate was $1.8M.
  - Schnabel Foundation installed the wall

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Wall Construction

- Construction started in February 2009
  - Install temporary bench
  - Install soldier beams in pre-augured holes

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Wall Construction

- Timber lagging installed and Select Borrow placed to flatten slope – June 2009

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Wall Construction

- Excavate and install timber lagging

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Wall Construction

- Install earth anchors
- Testing per Post Tensioning Institute (PTI)

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Wall Construction

- Install drainage boards, reinforcement, and CIP wall facing – August 2009

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Wall Construction

- Wall completed – April 2010

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Wall Construction

- Finished Wall

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Conclusions

- Due to slope, critical soldier beam wall designed by Design Engineer
- Wall design and construction considered slope history, stabilization, and spring water control
- No evidence of slope instability since wall was constructed

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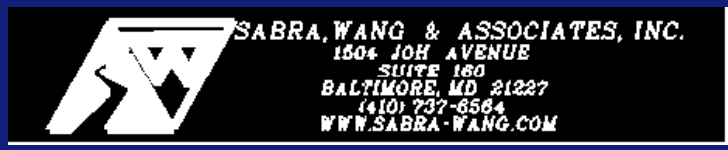
Special Thanks to:

- Greenhorne & O'Mara, Inc. /Century Engineering, Inc., JV,
- Sabra-Wang and Associates
- Maryland Transportation Authority



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