What Bridge Engineers Would Like to See in the Geotechnical Report?

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INDOT

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Outline

- Cases where geotechnical issues were encountered.
- Expectations: What the bridge engineer would like to see in the geotechnical report?
- Summary: Expectations.

Expectations – Geotech Report

- IDM 107-3.0 – Chapter 107 Geotechnical Process

Construction

107-3.0 GEOTECHNICAL REPORT

There should be communication between the geotechnical engineer and the designer during the following phases of design to ensure the Geotechnical Report recommendations address all aspects and conditions of the project:

1. preliminary foundation design;
2. structural analyses and modeling;
3. final foundation design;
4. final roadway embankment and retaining wall design;
5. final pavement design; and
6. constructability and construction staging.

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Expectations – Geotech Report

- IDM 107-3.0 – Chapter 107 Geotechnical Process

If the project includes a structure as defined in Section 408-1.06(01), the Geotechnical Report will include a preliminary foundation recommendation. The designer should review the preliminary foundation recommendation in the Geotechnical Report to determine if it provides adequate information. If additional foundation recommendation information is required the designer should provide the geotechnical engineer with the following information:

- Should the designer review **draft** geotechnical report

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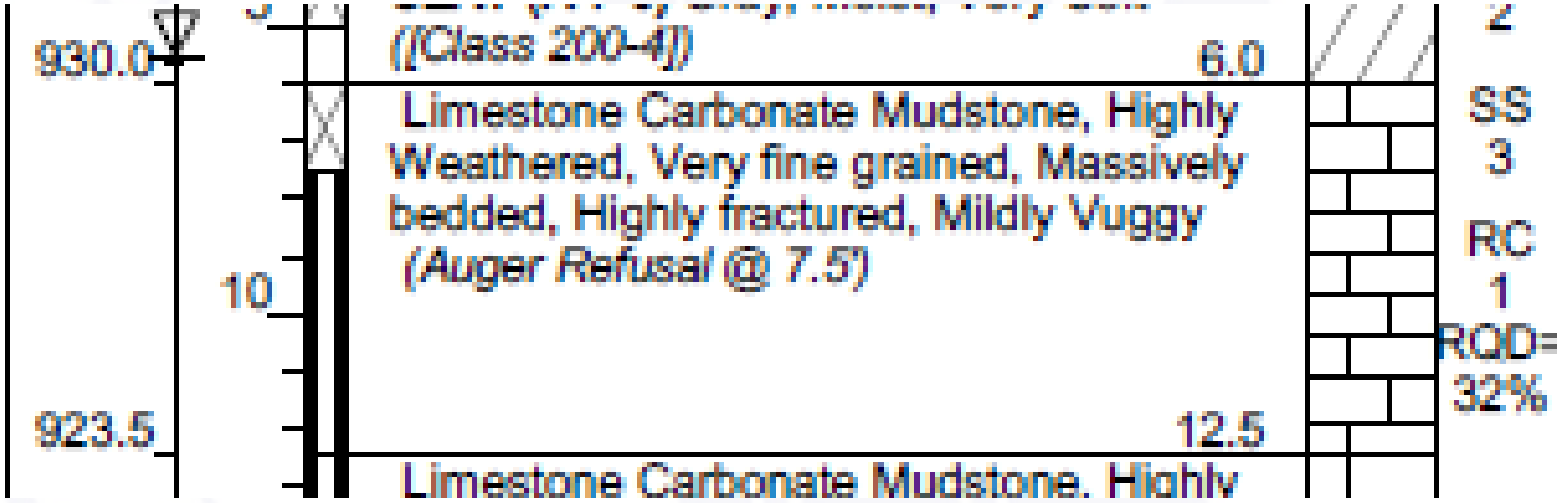
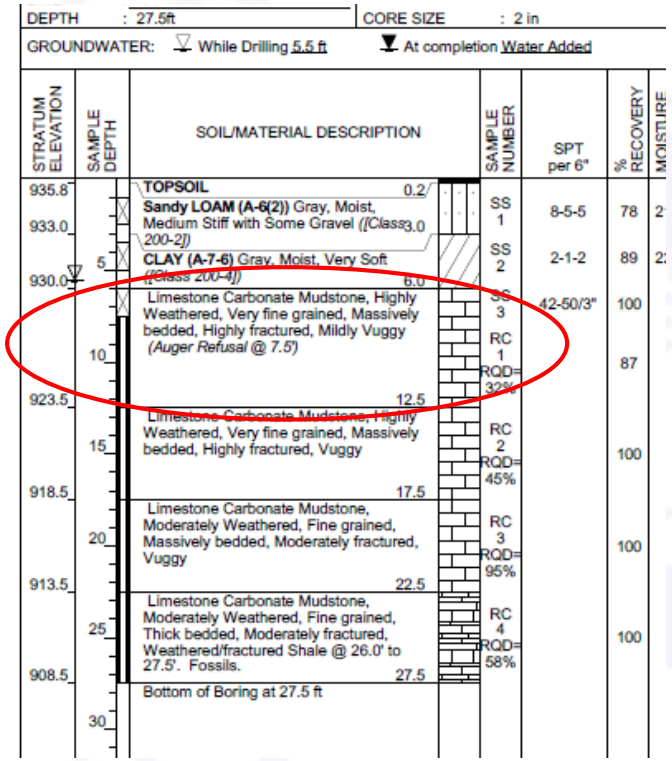
Expectations – Geotech Report

Example: Foundation Type

Expectations – Geotech Report

Example: Foundation Type





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Expectations – Geotech Report

Example: Foundation Type

Table 4: Shallow Foundation Design Parameters

	Bent 1/Pier 2/Pier 3			
Rock Soil Friction Angle, φ_f	37			
Cohesion, c (psf)	1223			
Bearing Resistance Factor, φ_b	0.45			
Estimated Top of Competent Rock Elevation (ft)	923.5/927/927			
Assumed Footing Width (ft)	6	8	10	12
Factored Bearing Resistance q_r (psf)*	45228	49800	52033	58516

* *Using a minimum footing length of 45 ft.*

All foundations shall be founded a minimum of two (2) feet into competent rock.

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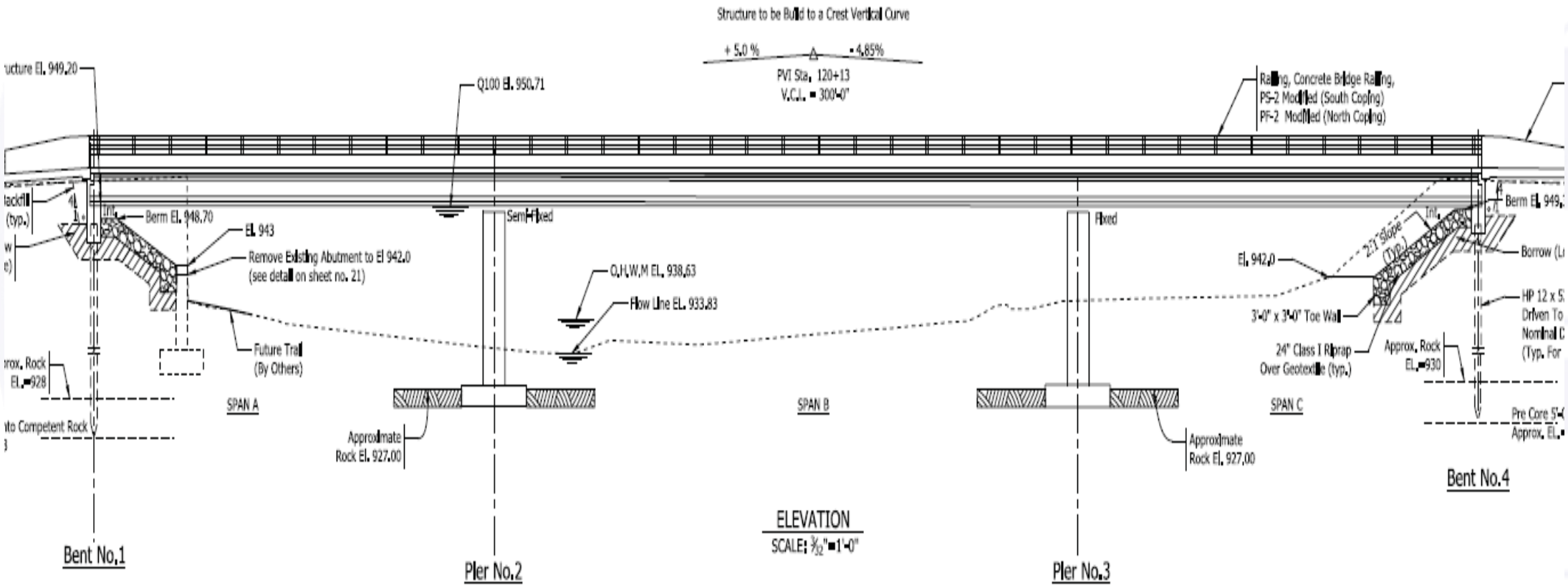
Expectations – Geotech Report

Example: Foundation Type

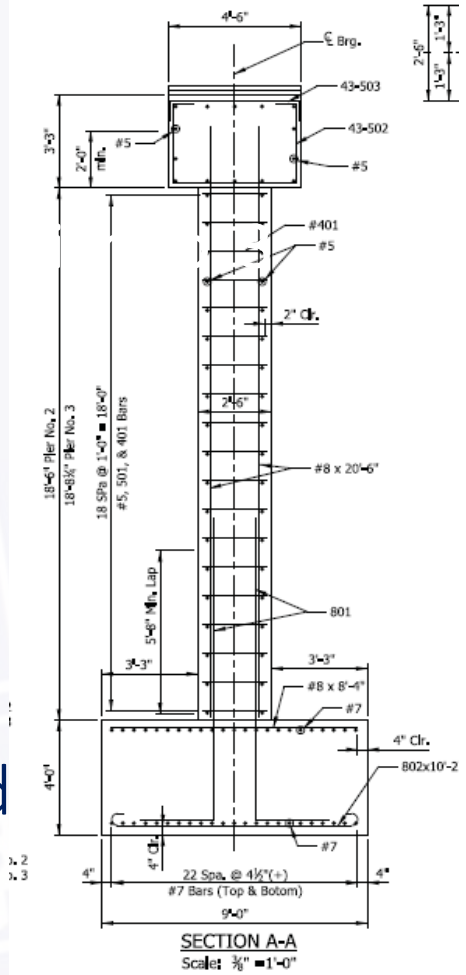


Expectations – Geotech Report

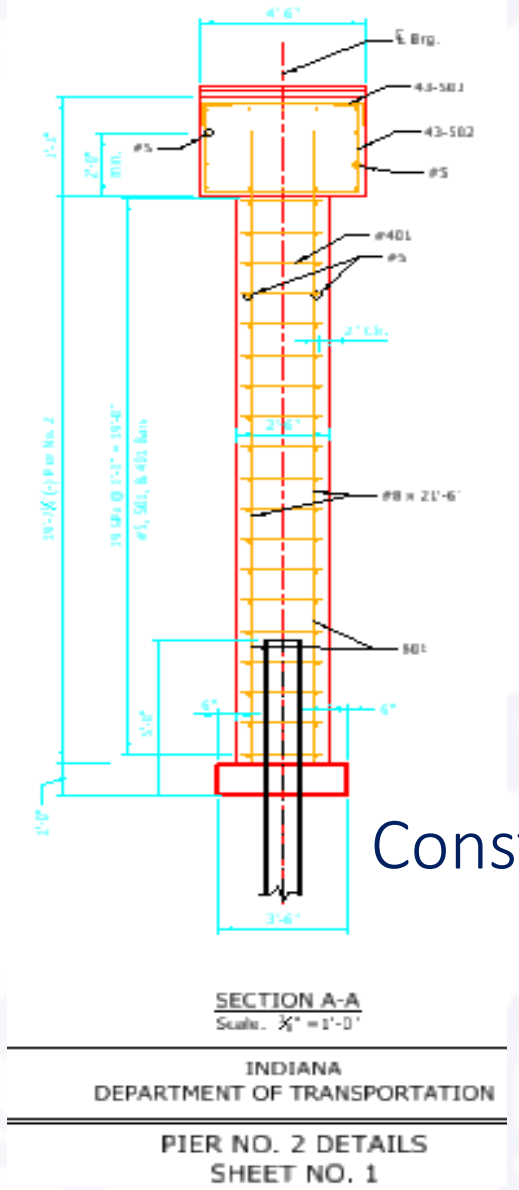
Example: Foundation Type

- Pier 2 on piles
- Pier No. 3 on spread footing

Designed



Constructed



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Expectations – Geotech Report

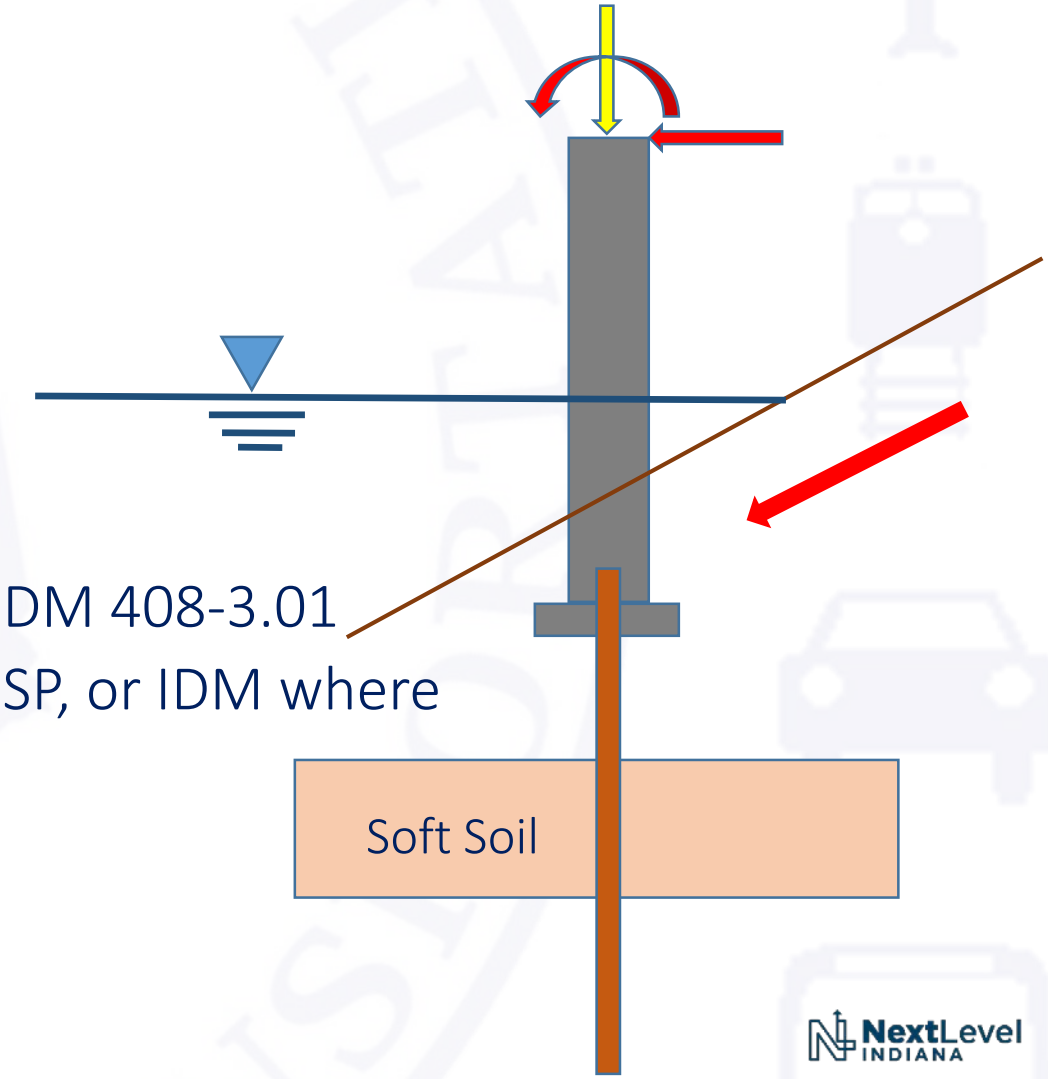
FOUNDATIONS:

- How close soil borings to the bridge supports? To predict abrupt change in the soil Profile.
- More than one Pile size or drilled shaft size to accommodate structural capacity?
- Driven Piles Vs Drilled Shafts:
  - Where both are acceptable
  - Contractor option due to the equipment availability
  - Economy: Contractor may choose cost effective foundation type; CRI
  - To reduce construction time

Expectations – Geotech Report

FOUNDATIONS:

- Wall pier on single row of piles w/ soft soil :
  - Consider lateral stability
  - Battered Piles
  - Multiple row of piles instead
  - Include Narrative in the recommendations section
- Pile Sleeve: downdrag or end bent behind MSE wall
- Pile driving Information – Memo 18-15 (Archived), IDM 408-3.01
- Refer to applicable section(s) Specifications, RSPS, USP, or IDM where possible



Expectations – Geotech Report

FOUNDATIONS:

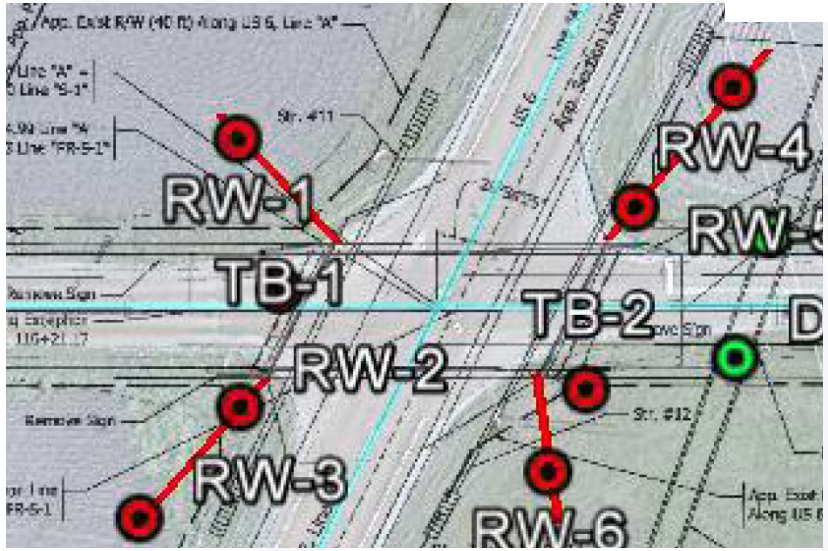
- Pile/ drilled shaft spacing limitations or reference IDM where possible
- Artesian condition
- Foundation Seal / aggressive dewatering
  - When we need it?
  - Should we provide guidance for foundation seal thickness?
  - Do we need to remove cofferdams/ sheet piling adjacent to foundation seal?

Expectations – Geotech Report

Example: MSE Wall

MSE Wall Recommendations

Based upon Preliminary Plan and Profile Sheets provided INDOT, the maximum MSE Wall height is anticipated to be 23 feet with a leveling pad elevation of approximately 880 feet. As a result of our external stability analysis, the retaining wall was found to be stable against overturning, sliding, and bearing capacity failure. A maximum factored bearing resistance of 8,410 psf is recommended for the MSE Wall with length of reinforcement strip at 0.7H.



STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"
883.7		*(Topsoil- Visual)* 0.3		
	2.5	**Sandy LOAM (A-4)** Brown, Moist, Stiff *(Test RB7SS5)*	SS 1	6-5-7
880.0		4.0		
	5.0	**Sandy LOAM (A-4)** Gray, Moist, Loose to Medium Dense *(Test RB5SS2)*	SS 2	3-4-6
	7.5		SS 3	1-5-9
	10.0		SS 4	3-4-9
	12.5			
870.0		14.0		
	15.0	**Sandy LOAM (A-4)** Gray, Moist, Very Stiff *(Test RB7SS5)*	SS 5	9-11-7

GROUNDWATER: While Drilling 10.0 ft At completion 6.0 ft

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"
885.2		*(Topsoil- Visual)* 0.8		
	2.5	**Sandy LOAM (A-4)** Brown, Moist, Very Loose to Loose *(Test RB5SS2)*	SS 1	2-2-3
	5.0		SS 2	4-4-2
879.0		7.0		
	7.5	**Sandy LOAM (A-4)** Brown, Moist, Medium Stiff *(Test RB5SS2)*	SS 3	5-3-5
876.0	10.0	10.0	SS 4	6-6-4
		SAND (A-3) Brown, Wet, Medium Dense with Clay Seams *(Test 0143-01)*		

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Expectations – Geotech Report

Example: MSE wall

Proposed MSE wall

Based upon Preliminary Plan and Profile Sheets provided by INDOT, the maximum MSE Wall height is anticipated to be 23 feet with a base elevation on the order of 880 feet. Soil boring RW-1 was used to provide parameters for the following analysis.

MSE Wall Stability Analysis. The external stability analysis of a proposed MSE Wall is presented in the Appendix of this report. As a result, the retaining wall was found to be stable against overturning, sliding, and bearing capacity failure. A maximum factored bearing resistance of 8,410 psf is recommended for the MSE Wall with length of reinforcement strip at 0.7H. The analysis is presented in the Appendix of this report

It shall be noted the above design values are assuming proper drainage is occurring. Therefore, during construction of the MSE walls, it is recommended that a permanent subsurface drainage system be installed at or near the base of the MSE walls. It is important that the drainage system be protected by some form of filter to prevent fines from clogging the pipe.

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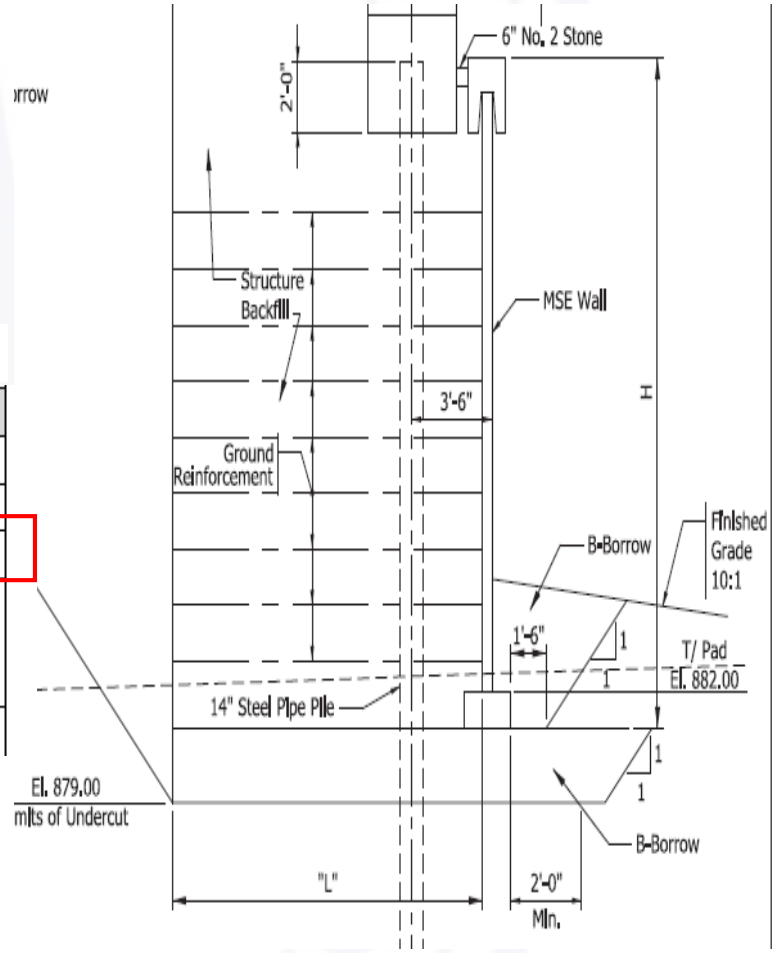
Expectations – Geotech Report

Example: MSE wall

Addendum:

Table 1: MSE Wall Design Parameter and Geotechnical Check Table

Design Recommendations		
Minimum Reinforcement Length/Height Ratio	0.7H	0.7H
Undercut required	**Yes**	Yes
Undercut depth	2 feet	2 feet
Undercut area[(1)]	from Sta. 116+35 to Sta. 116+55 Line "PR-S-1"	From Sta. 117+38 to Sta. 118+25 Line "PR-S-1"
Undercut Backfill Material	B-Borrow	B- Borrow



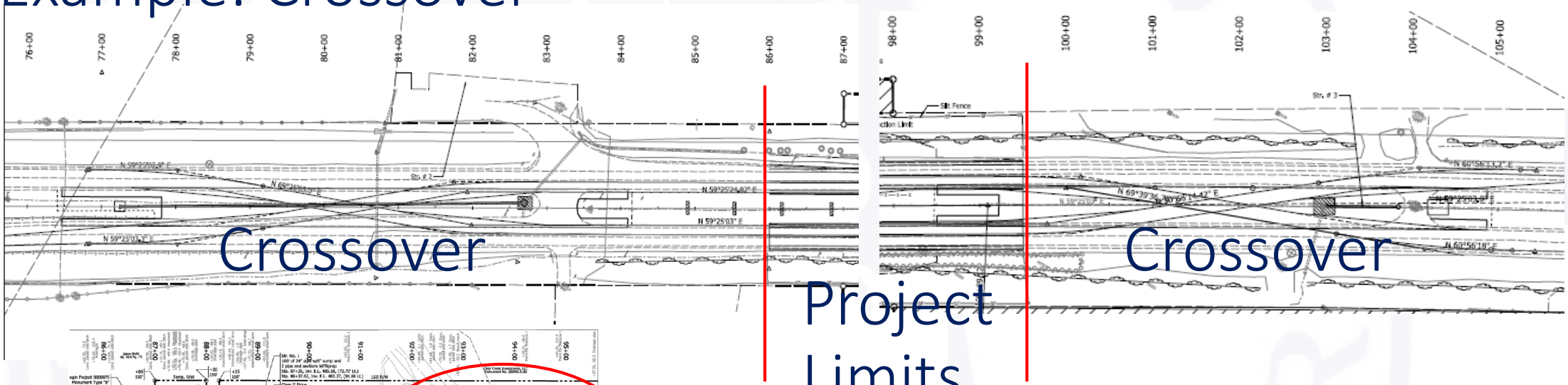
Expectations – Geotech Report

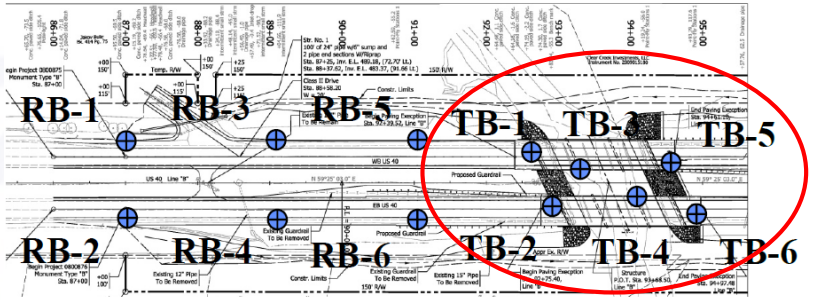
MSE Wall:

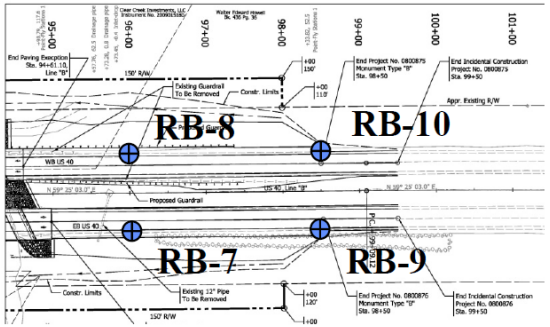
- Undercut limits
- Variation in soil profile: do we need more shallow soil borings
- Backfill Type (for undercut)

Expectations – Geotech Report

Example: Crossover







Expectations – Geotech Report

Example:

Crossovers for maintenance of traffic use HMA for temporary pavement consisting of:

165 lbs/yd^2 HMA Surface, Type B, on
275 lbs/yd^2 HMA Intermediate, Type B, on
6 inches of compacted aggregate, No. 53, base on
Subgrade Treatment Type "IC".

Crossover failed during construction

The crossover temporary pavement and shoulders to maintain the traffic has a design life of ***2 years***. If the temporary pavement or shoulders are intended to be used for longer than ***2 years***, then this design is invalid and the pavement design engineer shall be contacted to resolve the issue.

Expectations – Geotech Report

Crossovers:

- Crossover may fail due to bad soil
- We recommend to Include shallow soil boring
- Include recommendations for soft soil removal

Expectations – Geotech Report

Soft/ Weak Soil

- Highlight in recommendations section
- Stability is critical during construction – pier is still not supported at the top
- More than one pile/ drilled shaft size – Str. Capacity
- Loss of lateral soil resistance → deep foundation should be designed as a column for unsupported length
- Information about estimated location of fixity point & unsupported length
- Consider L-pile analysis
- Settlement: differential settlement & impact to profile grade

Expectations – Geotech Report

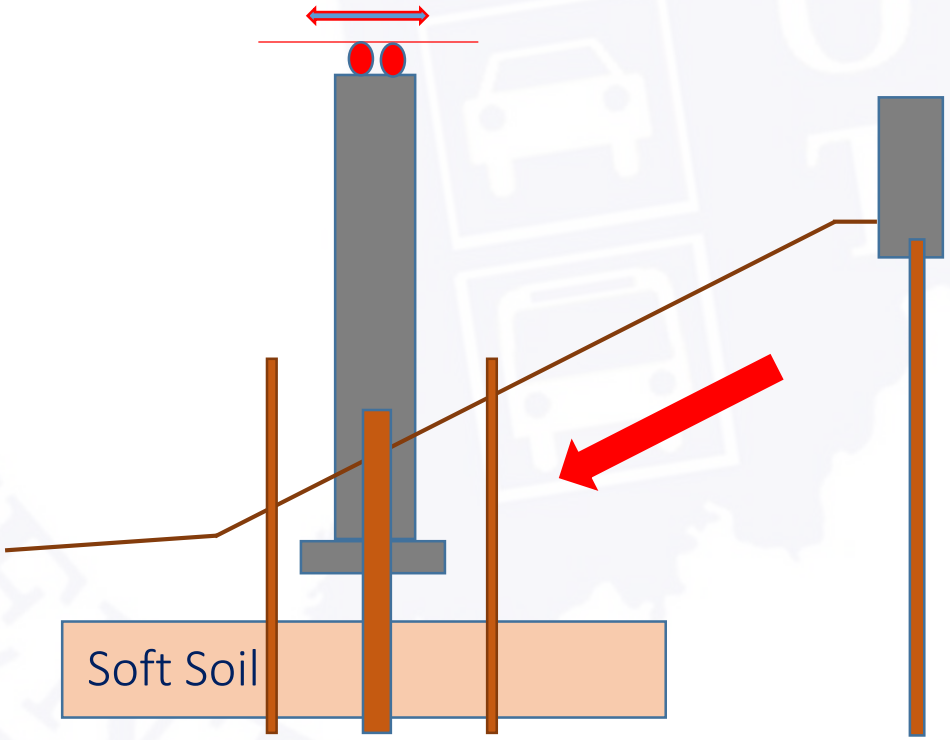
Scour:

- Consider lateral stability
- Recommendations to design pile or drilled shaft as a column
- Consider including recommendations for unbraced length, include approximate location of fixity point
- Consider L-pile analysis?
  - Consider vertical, longitudinal, & lateral forces.
  - Do we need to run L-pile for final design, please indicate in the geotech report.

Expectations – Geotech Report

Cofferdams - Steel Sheet Piling

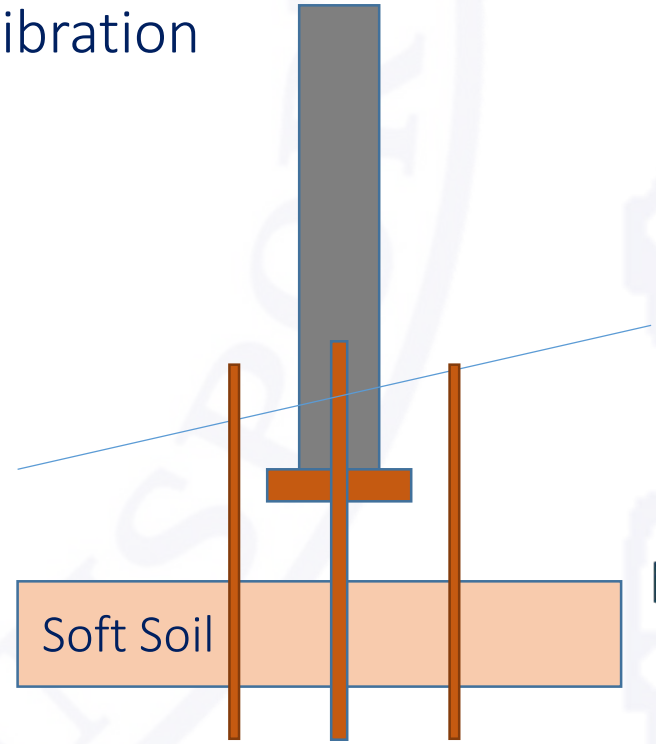
- Stability is critical during construction when driven into soft soil → Include in the recommendations section
- Could Cause soil disturbance when removed due to vibration



Expectations – Geotech Report

Cofferdams - Steel Sheet Piling

- Driven next to Bridge Embankment – Surcharge Load
- Consider L-pile analysis
- When to remove and when to leave-in-place
  - Soft soil – Disturbance to Bridge Foundation due to vibration
  - Phase construction adjacent to bridge supports
  - Adjacent to RR
  - Adjacent to sensitive Utility line
  - Other…..



Expectations – Geotech Report

Implications Due Errors & Omissions

- Designer need to issue a construction change
- Schedule – construction could extend two construction seasons
- Change Order
- Cost/ Budget
- Disruption to everybody: designer, geotech engineer, construction, contractor

Expectations – Geotech Report

Summary:

- Standardize/ consistency in the format
- Give the designer the opportunity to review preliminary geotechnical report
- Recommendations section:
  - Provide more guidance in the recommendations section and less text in other parts of the report
  - bullet point/ list of items to the designer or construction
  - Tables, graphs, numbers, short narrative, specific guidance, etc…
- Reference to applicable sections of standard specifications or RSP where possible

Expectations – Geotech Report

Summary:

- Include a USP where applicable
- Where possible Include material that matches a standard pay item
- Consider recommendations for Undercut (MSE wall, culverts, etc…)
- Consider recommendations for soft soil removal (Crossover, roadway, etc….)
- Consider including information about deep foundation unsupported length
- Approximate location of Fixity point
- L-pile analysis where needed

Expectations – Geotech Report

Summary:

- Recommendations for Runaround
- Recommendations for Temporary Bridge
- Does the designer need to contact geotechnical engineer during design → please indicate in the report.
- Risk Evaluation, specific message to the designer or construction

Expectations – Geotech Report

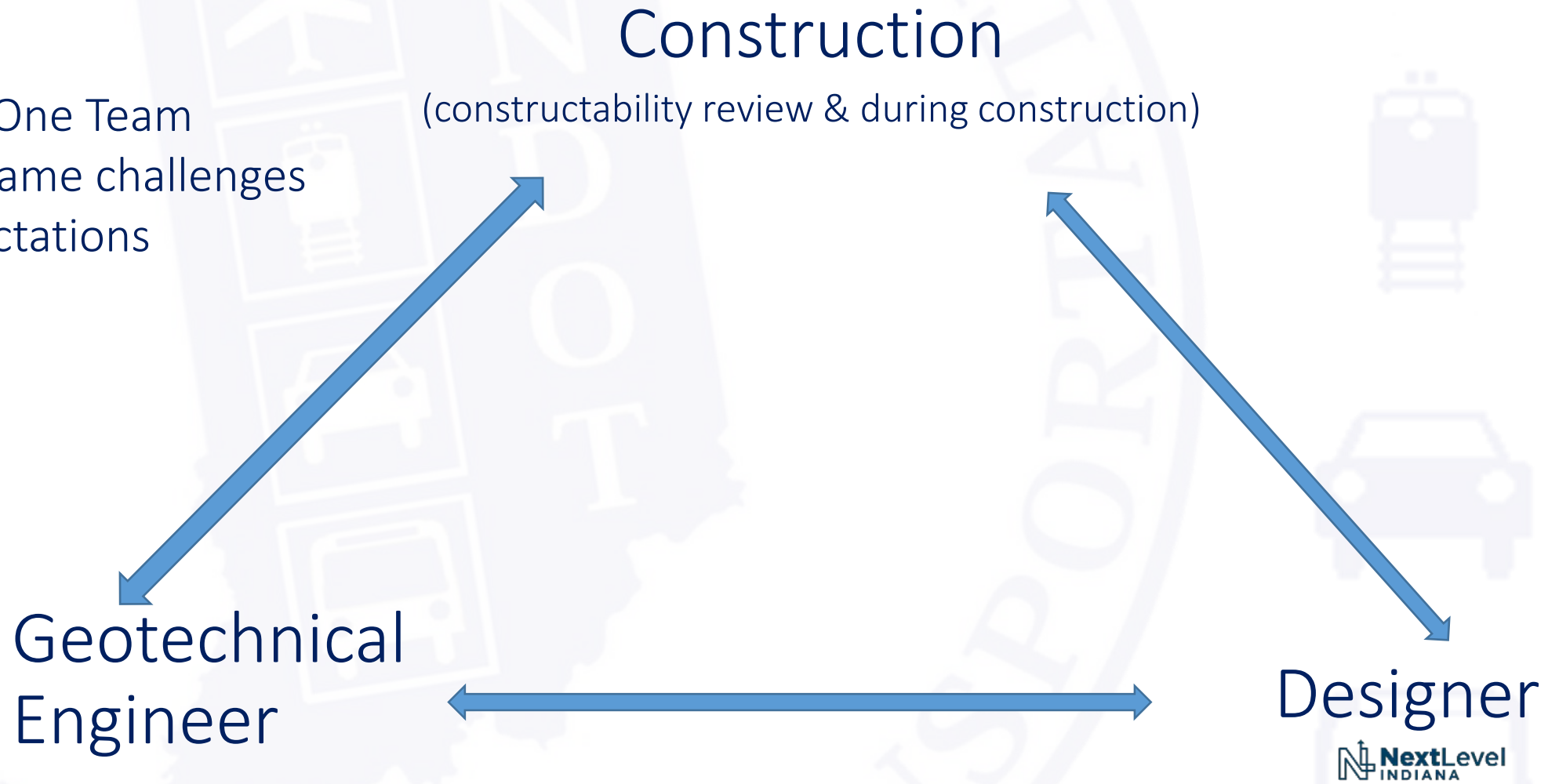
Expectation – the designer

- Did the designer
  - Read the entire geotech report or followed geotechnical recommendation?
  - Review soil profile in the boring logs?
  - Consider lateral soil stiffness?
  - Contact geotechnical engineer where needed?
  - Ask for additional information based

Reading foundation or pile loading table is not enough

Expectations – Geotech Report

- Partners - One Team
- Share the same challenges
- Same Expectations



Thank you!

Questions ?