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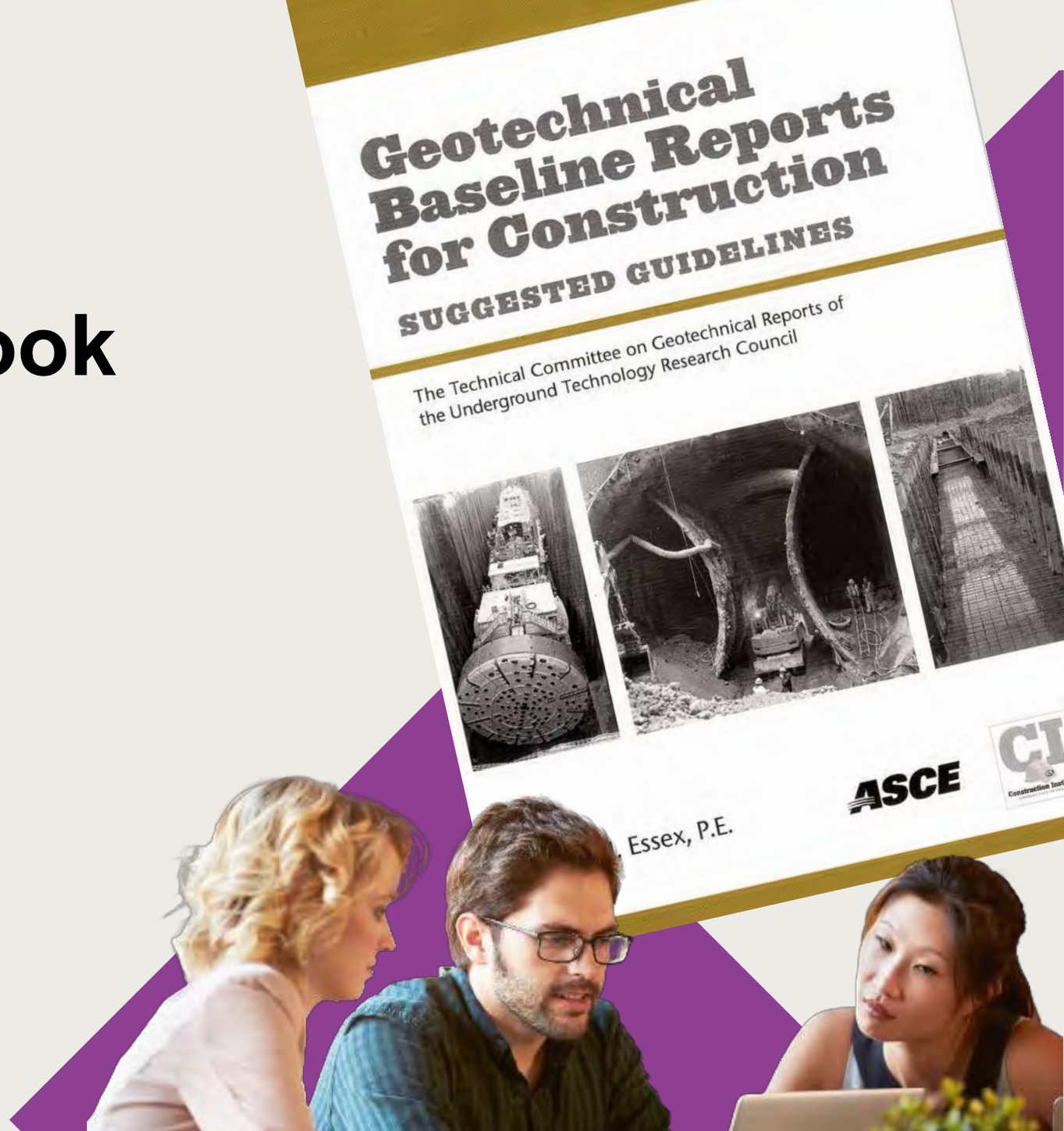
Updating the Gold Book to “Platinum”

Randall Essex, P.E.
Senior Consultant – Tunnels Practice

RISK MANAGEMENT in Underground Construction

Atlanta, Georgia

April 12, 2022



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Topics

Historical Perspective
Task Committee Members
Work to Date
Key 3rd Edition Changes
Completion Schedule

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Historical Perspective

Why/How did GBRs evolve?

Why / How did GBRs evolve?

In the 1970s Owners said “here’s the data, you bid it, you build it.”

Contractors bid optimistically, and filed differing site (unforeseen) condition claims when costs exceeded what they bid

There was an upward spiral of litigation – bad publicity for the owners, poor financials for the contractors

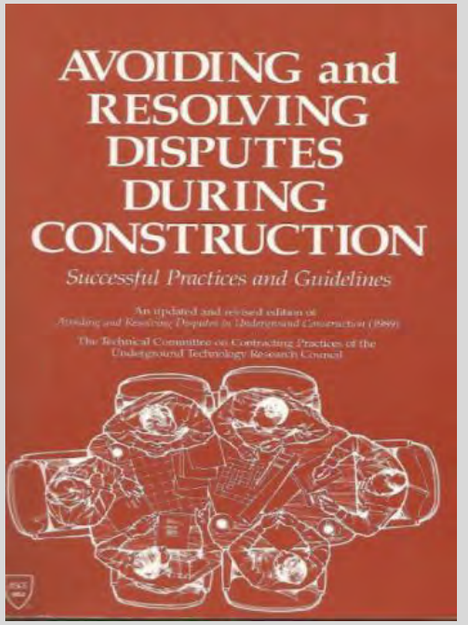
To stop the litigation trend, the U.S. industry produced several research reports

The reports recommended four improved contracting practices:

Differing Site Conditions Clause in the Contract
Geotechnical Baseline Report (GBR) in the Contract
Escrow Bid Documents by the selected bidder
Disputes Review Board to help resolve disputes

1974

1984



1991

Why / How did GBRs evolve?

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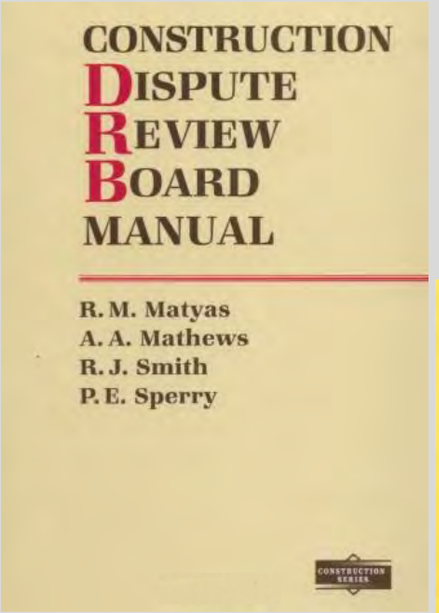
- → Geotechnical Baseline Report (GBR) in the Contract
- Escrow Bid Documents by the selected bidder
- → Disputes Review Board to help resolve disputes

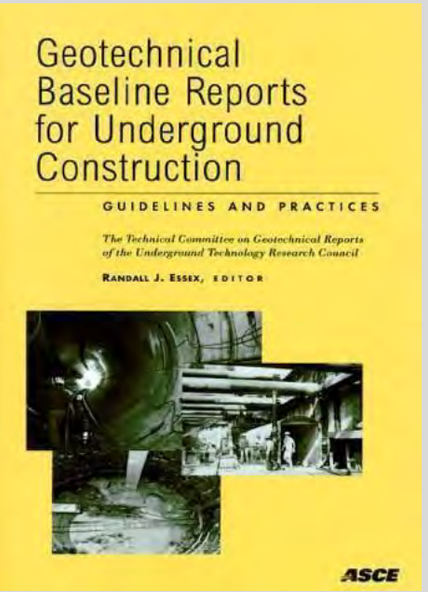
A guideline was published for Dispute Review Boards (1996)

A guideline was published by the American Society of Civil Engineers: 1997 (1st edition); 2007 (“Gold Book”)

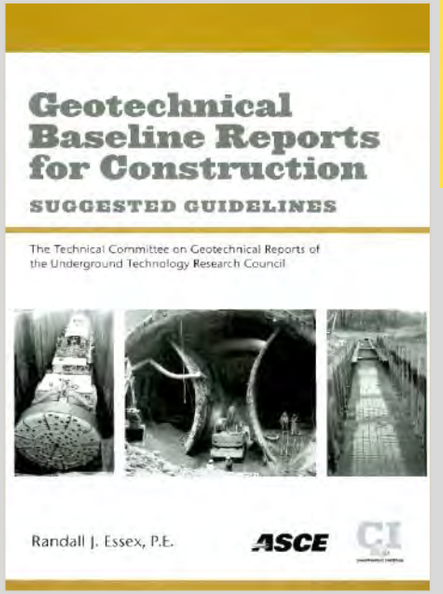
A 3rd edition (fall 2022) is the subject of this presentation



1996



1997



2007

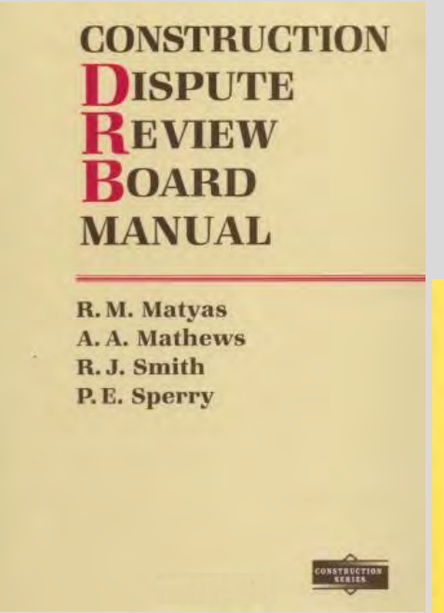
GBR use is growing internationally

GBRs are now used in a growing number of countries:

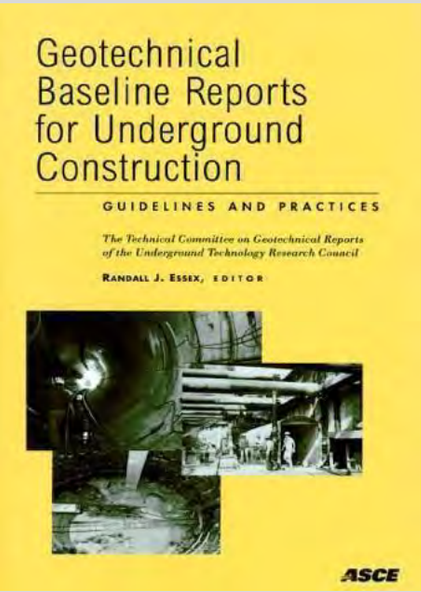
- United States
- Canada
- New Zealand
- Australia
- Singapore
- Hong Kong
- Thailand
- Germany
- France
- Italy
- UK
- Switzerland
- Chile
- Nepal
- Malaysia
- United Arab Emirates
- South Africa

The Emerald Book (2019) by FIDIC/ITA for Design and Construct Delivery: calls for a “collaborative” GBR between Employer and D&C Team

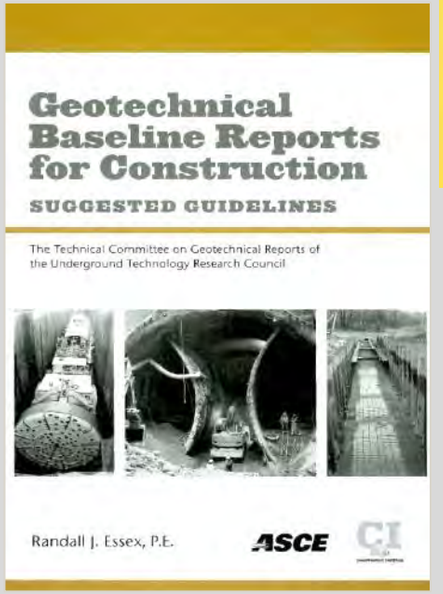
Mott MacDonald has co-written new CIRIA Report 1106 publication (in press) for UK - supplements the Gold Book



1996



1997



2007

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3rd Edition Task Committee

Task Committee on Geotechnical Baseline Reports

Name		Affiliation	Industry Role			
Writing Subcommittee	Review Subcommittee		Owner	Contractor	Engineer	Attorney
Randy Essex (Chair)		Mott MacDonald			X	
Dan Adams		McMillen Jacobs Assoc			X	
Amanda Elioff		WSP USA, Inc	X			
David Hatem		Donovan-Hatem LLP				X
Paul Madsen		Kiewit, Inc		X		
Jim Morrison		STV, Inc			X	
	Randy Anderson	San Franciso Public Utilities Commission	X			
	Sam Baker	Oles Morrison Rinker & Baker				X
	Kathy Murtagh	MWRA	X			
	Mike Roach	Traylor Bros.		X		
	Shane Yanagisawa	Osprey Engineers LLC		X		
	John Yao	LA County MTA	X			
		Totals	4	3	3	2

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Work to Date

Work To Date

"Task Committee on Geotechnical Baseline Reports" exists under the direction of ASCE's Construction Institute

Committee was formed in July 2021

We planned two industry workshops:

- Cutting Edge Conf. in November 2021: Issue identification
- George Fox Conf. in January 2022: Review the draft manuscript
- COVID pushed the George Fox Conf back to May 2022

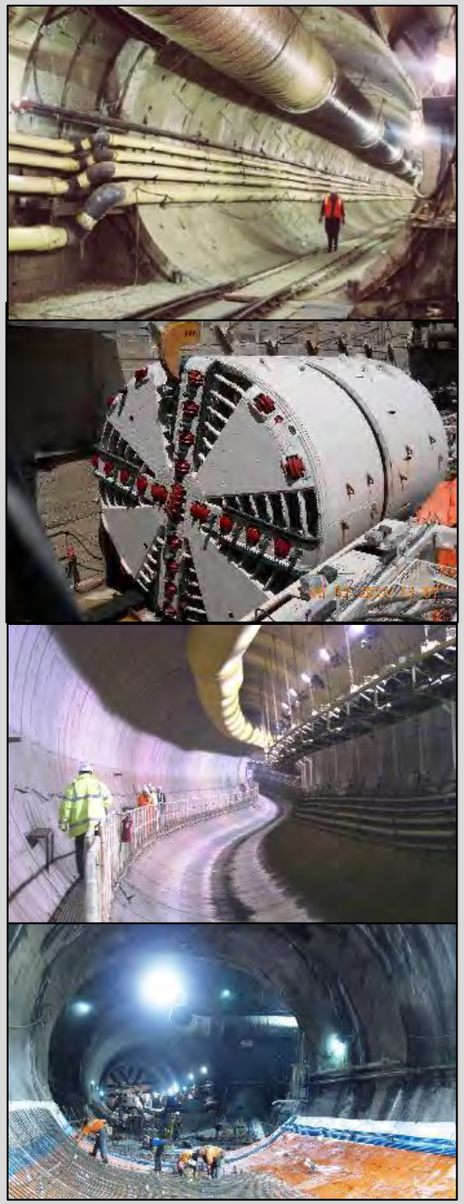
Cutting Edge workshop:

- Sent out a questionnaire in advance
- 2-1/2 hour workshop

We used this input to create a draft manuscript

The Review Subcommittee reviewed it during the month of March

The Writing Subcommittee is currently incorporating their comments

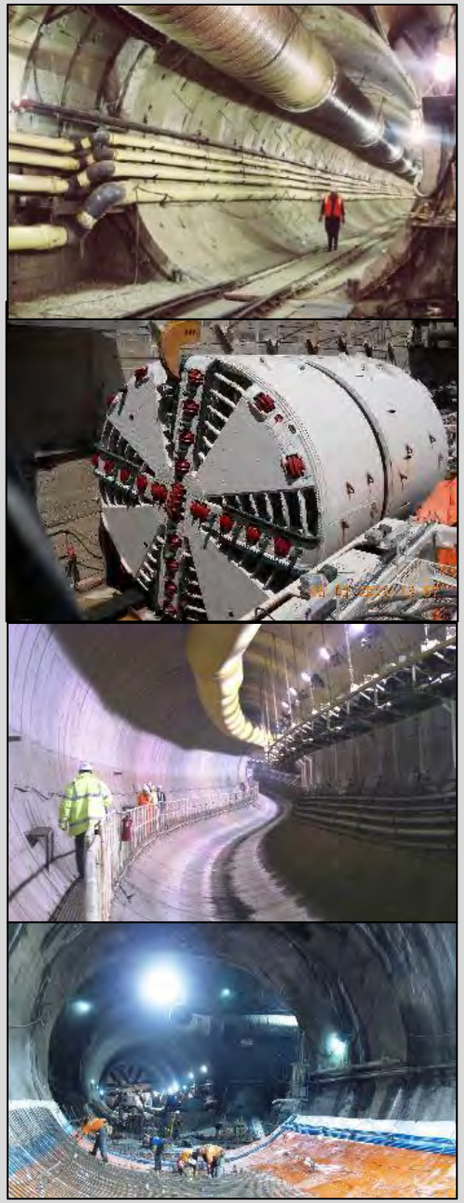


Key Items of 3rd Edition

Draft Table of Contents
New Chapters
New Content

Draft Table of Contents of 3rd Edition

New	Dedication to Al Mathews
Updated	Acknowledgments
Updated	Executive Summary
Updated	1.0 Introduction
Updated	2.0 Geotechnical Reports
Updated	3.0 Differing Site Conditions Clause
	4.0 The Concept of a Baseline
Expanded	5.0 Preparation of a Geotechnical Baseline Report
New	6.0 Delivery Alternatives and GBR Development
Expanded	7.0 Applications for other Excavations and Foundations
New	8.0 Contractual and Legal Considerations
Expanded	9.0 Roles and Responsibilities
Expanded	10.0 Recent Practices and Lessons Learned
	List of Abbreviations
	References
New	Appendix A - Case Histories



Chapter 1 – Introduction

- Concept of “Funding Buckets” to remind Owners that risk assessments are fundamental to setting their budget:

“Budgeting for Uncertainty”

Budgeting for Uncertainty

Some owners believe this is their Budget

Site Investigations, lab testing program, and Reference Design

Quantitative Risk Analysis of likely events

Summarized in GBR

"known knowns" (in the Bid)

(Obstructions, contamination)

Set baseline limits for costly items

Medium probability high cost

"known unknowns"
Pay only if quantities are exceeded

Provisional Sums

Quantitative Risk Analysis of *unlikely* events

Low probability high cost

"unknown unknowns" discovered during construction
Pay only if conditions are encountered

Contingency Fund

Budgeting for Uncertainty

But this should be their Budget

Site Investigations, lab testing program, and Reference Design

Quantitative Risk Analysis of likely events

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Chapter 4 – Concept of a Baseline

- Quantitative vs qualitative baselines
- Provisional baselines – address conditions not evident from the data but likely to be encountered
  - Boulders
  - Faults
  - Vertical shears (Dearborn CSO and Detroit DR02)

Chapter 5 – Preparation of a GBR

Key Points in the Chapter:

- Suggested Outline with page estimates
- Put all you know “on one piece of paper”
- Focus is on construction, not design
- Organize the physical baselines in a logical, efficient manner
- Key to better GBRs = higher competencies; better writing teams; senior-level review of GBR and connection with other Contract Documents

Suggested GBR Outline (with page count)

1. Introduction
2. Project Description
3. Manmade Features
4. Sources of Geologic Information
5. Geologic / Hydrologic Setting

7 pages

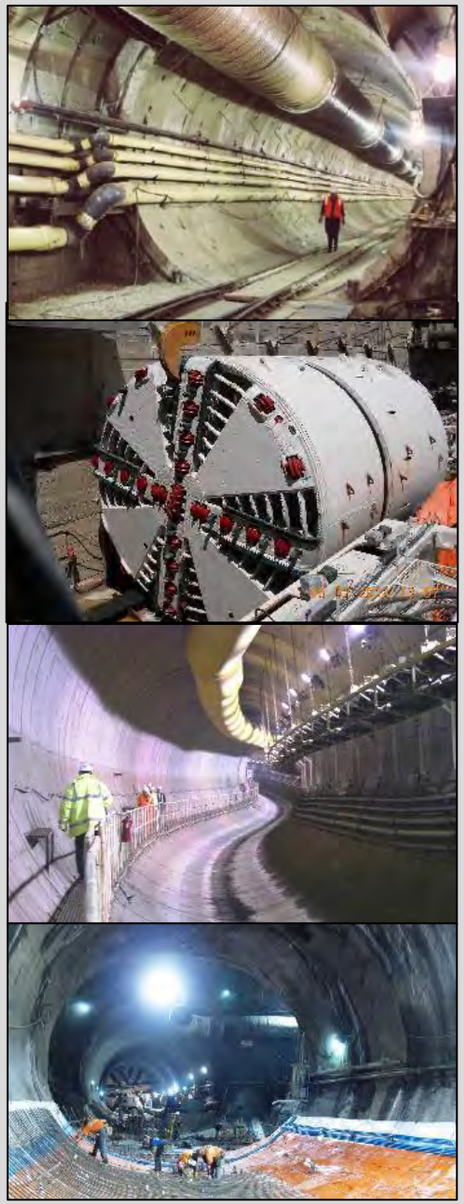
6. Ground Characterization
   - 6.1 Engineering Classification of Soils
   - 6.2 Engineering Classification of Rock
   - 6.3 Groundwater, contamination
   - 6.4 Obstructions

12-17 pages

7. Previous Relevant Construction — 2-4 pages
8. Construction Considerations – Key Project Elements — 10-15 pages
9. Instrumentation and Monitoring — 1 page
10. Spoils, Groundwater, and Gas Management — 2-3 pages

Total 34 - 47 pages

Plus Profiles, Tables and Figures



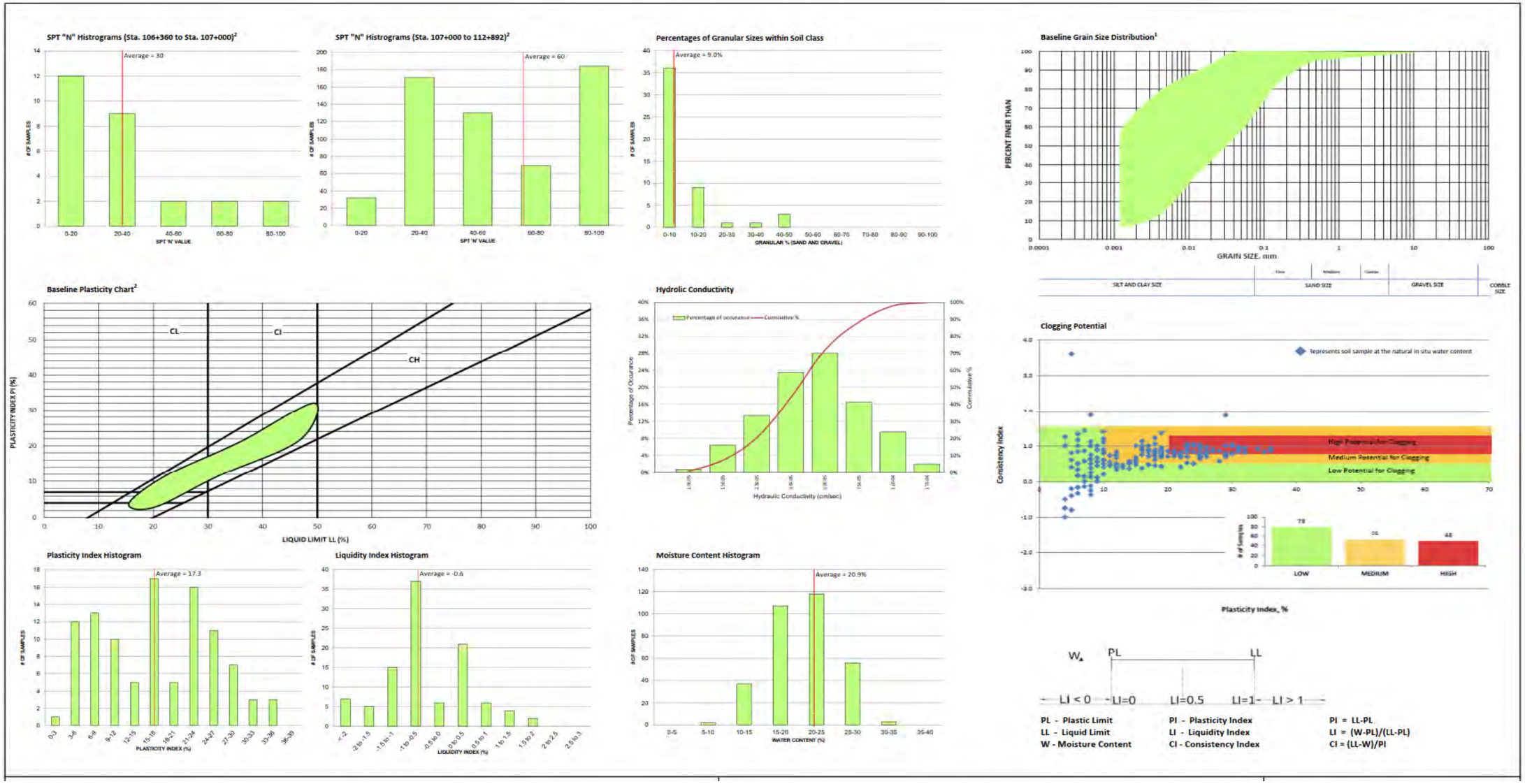
Chapters 5 and 6 ←→ Chapters 6 and 7

Ground Characterization Table with Baselines

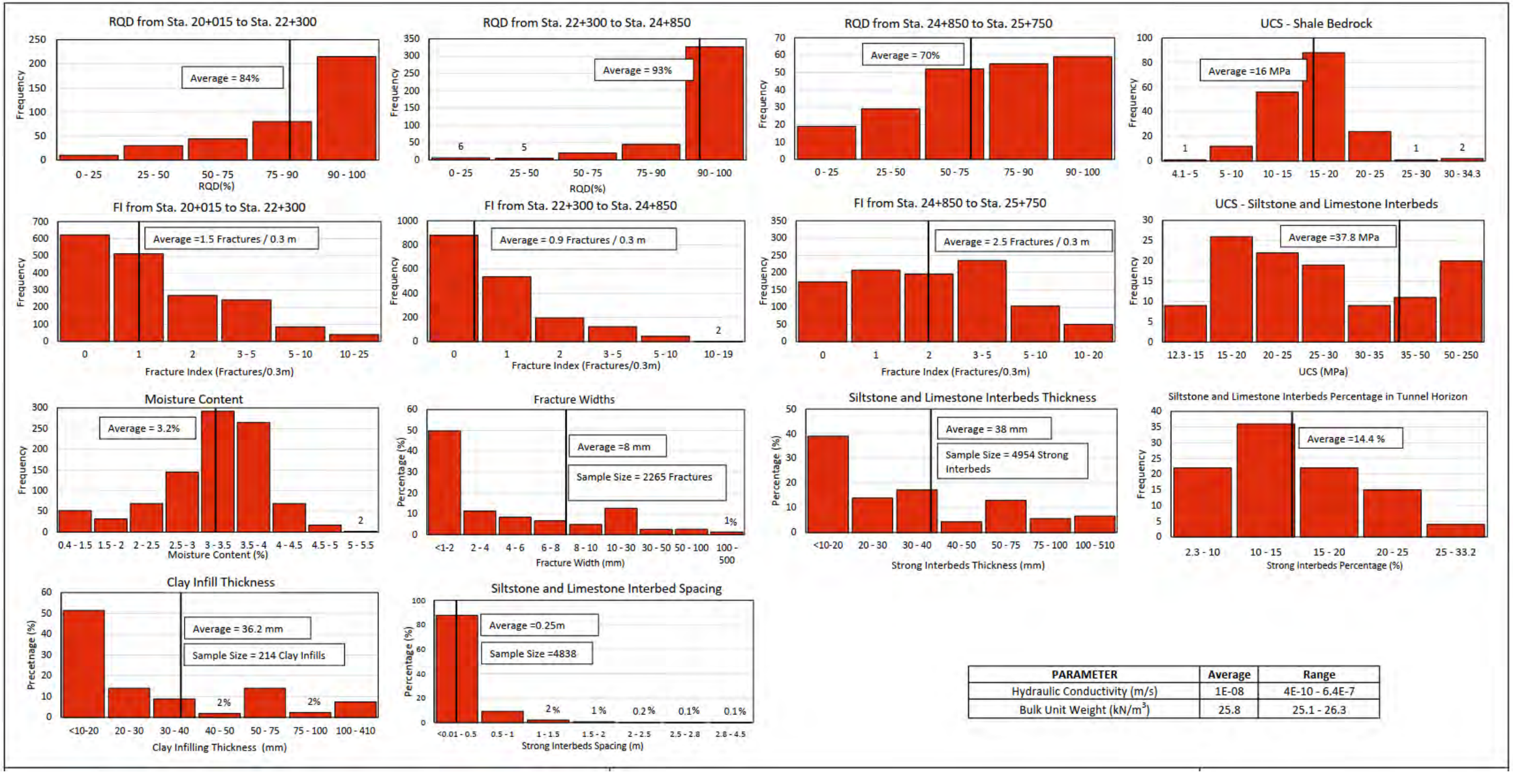
Engineering Class	Colour Code	Material		Description of Engineering Class	Major Soil Deposit	Behaviour of Engineering Class	
		Types	Description			Unpressurized Tunnel; Cross Passages; Manned Interventions	Open Excavation (Unsupported vertical walls, up to 3 m high)
Class A		1	• Fill • Topsoil	• Near surface man-made materials • Includes pavement structure materials (asphalt, sand and gravel) and backfill materials (clayey silt, sandy silt, sand, silty clay, silty sand)	Fill	• Not Applicable	• Behaviour will vary from Slow Ravelling to Running • Not expected to support foundation loads
Class B		2, 3, 4, 5, 6	• Sand • Gravelly Sand • Sandy Gravel • Silty Sand • Sand and Silt	• Brown to grey • Average CU : 12 • Fines content: 5 to 60% • Clay content: < 15% • Cobbles and boulders are expected to be present • Boulder Volume Ratio: 0.098%	Interstadial Sand to Gravel	• Will flow immediately upon exposure below the groundwater table • Higher permeability; groundwater inflows will be high and continuous • Movement of compressed air through Types 2, 3 and 4 soils will dry the soil which will exhibit Running behaviour within 3 hours after exposure. • Dewatering will generally leave residual moisture and capillary tension that will result in Firm to Slow Ravelling behaviour within 6 hours after exposure. Will transition to Slow Ravelling across the face, with Fast Ravelling at the tunnel crown and shoulders after 24 hours	• Will exhibit Fast Ravelling to Running behaviour above groundwater table • Will exhibit Flowing behaviour immediately upon exposure below the groundwater table • Groundwater inflows will be high and continuous • Dewatering will result in Firm behaviour of upon initial excavation; within 6 hours negative pore pressure will dissipate causing a transition to Slow to Fast Ravelling behaviour.
Class C		7, 8	• Silt • Sandy Silt	• Brown to grey • Average CU: 19 • Fines content: 25 to 100% • Clay content: < 20% • Cobbles and boulders are expected to be present • Boulder Volume Ratio: 0.098%	Interstadial Silt to Sand	• Will exhibit Fast Ravelling to Flowing behaviour below the groundwater table • Lower permeability; groundwater inflows will be lower than Class B • With dewatering will exhibit Firm behaviour for up to 12 hours after exposure. Will remain Firm across the face for up to 24 hours, with Slow Ravelling at the crown after 12 hours.	• Will exhibit Slow to Fast Ravelling behaviour above groundwater table • Will exhibit Fast Ravelling to Flowing behaviour below groundwater table • Lower permeability; groundwater inflows into open excavations will be lower than Class B • Dewatering will result in Firm behaviour upon initial excavation; within 12 hours negative pore pressure will dissipate causing a transition to Slow to Fast Ravelling behaviour.
Class D		9, 10, 11	• Silt Till • Sandy Silt Till • Silty Sand Till	• Brown • Average CU : 47 • Fines content: 25 to 90% • Clay content: < 15% • Cobbles and boulders are expected to be present • Boulder Volume Ratio: 0.221%	Non-Plastic Till	• Will exhibit Cohesive Running to Fast Ravelling behaviour below the groundwater table • Lower permeability; groundwater inflows will be lower than Class B • With dewatering will exhibit Firm behaviour for up to 24 to 30 hours after exposure. Will remain Firm across the face for up to 48 hours after exposure with Slow Ravelling at the crown and shoulders after 24 to 30 hours.	• Will exhibit Firm to Slow Ravelling behaviour above groundwater table • Will exhibit Cohesive Running, Fast Ravelling, and Flowing behaviour below groundwater table • Lower permeability; groundwater inflows into open excavation will be lower than Class B • Dewatering will result in Firm behaviour upon initial excavation; within 12 to 24 hours negative pore pressure will dissipate causing a transition to Slow Ravelling behaviour.
Class E		12, 13, 14,	• Clay • Silty Clay • Clayey Silt	• Brown to grey • Locally slickensided • Liquid Limit: 16 to 50%; Plasticity Index: 2 to 36% • Fines content: > 65% • Clay content: 10 to 65% • Cobbles and boulders are expected to be present • Boulder Volume Ratio: 0.052%	Plastic Glacio-lacustrine	• Will exhibit Firm behaviour upon exposure; fissuring and variability in clay content will cause a transition to Slow Ravelling within 24 to 48 hours • Will exhibit low to medium clogging and sticking if not managed with soil conditioning agents • Stability Number, Ns, typically less than 2.5 • Will deteriorate unless supported after exposure • Dewatering is generally not required	• Will exhibit Firm behaviour upon excavation; within 24 to 48 hours fissuring and the variability in clay content will cause a transition to Slow Ravelling behaviour • Wetting and drying cycles and freezing and thawing cycles will reduce the stand-up time • Will deteriorate unless supported shortly after exposure • Dewatering is generally not required
Class F		15, 16, 17	• Clay Till • Silty Clay Till • Clayey Silt Till	• Grey • Material Type 17 is well graded • Liquid Limit: 13 to 35%; Plasticity Index: 2 to 24% • Fines content: > 50% • Clay content: 10 to 40% • Cobbles and boulders are expected to be present • Boulder Volume Ratio: 0.221%	Plastic Till	• Will exhibit Firm behaviour upon exposure; fissuring and variability in clay content will cause a transition to Slow Ravelling within 24 to 48 hours • Stability Number, Ns, typically less than 2.5 • Will deteriorate unless supported after exposure • Water bearing sand pockets and seams will produce water in excavations but general dewatering is not required	• Will exhibit Firm behaviour upon excavation; within 24 to 48 hours fissuring and the variability in clay content will cause a transition to Slow Ravelling behaviour • Wetting and drying cycles and freezing and thawing cycles will reduce the stand-up time • Will deteriorate unless supported shortly after exposure • Water bearing sand pockets and seams will produce water in excavations but general dewatering is not required
Class G		18	• Bedrock	• Grey • Underlies glacial till in western section of alignment • Soft clayshale, interbedded layers of strong limestone and siltstone • 10 mm to 300 mm clay and silt seams in top 3 m • 1 m to 3 m below top of bedrock: Highly weathered; RQD <30% • > 3 m below top of bedrock: Moderately weathered to fresh; RQD > 60%	Sedimentary Bedrock	• Fractured zones close to the bedrock surface may produce water in excavations but general dewatering is not required • Limestone and siltstone interbeds in this material are abrasive	• In the top 3 m will exhibit Firm behaviour upon excavation; within 2 to 3 days weathered and highly fractured zones will cause the ground to transition to Slow Ravelling behaviour • Below 3 m will be moderately weathered and will exhibit Firm behaviour • Wetting and drying cycles and freezing and thawing cycles will reduce the stand-up time • Will deteriorate to Slow Ravelling behaviour unless supported shortly after excavation • Fractured zones will produce water in excavations but general dewatering is not required

Notes: (1) CU = Coefficient of Uniformity (D60/D10) (2) Clays are particles <0.002 mm (3) Fines are particles < 0.075 mm (4) Boulder Volume Ratio = Cumulative Volume of Boulders/Volume of Excavated Material (5) RQD = Rock Quality Designation

Baseline Parameters for Engineering Class (Soil)



Baseline Parameters for Engineering Class (Rock)



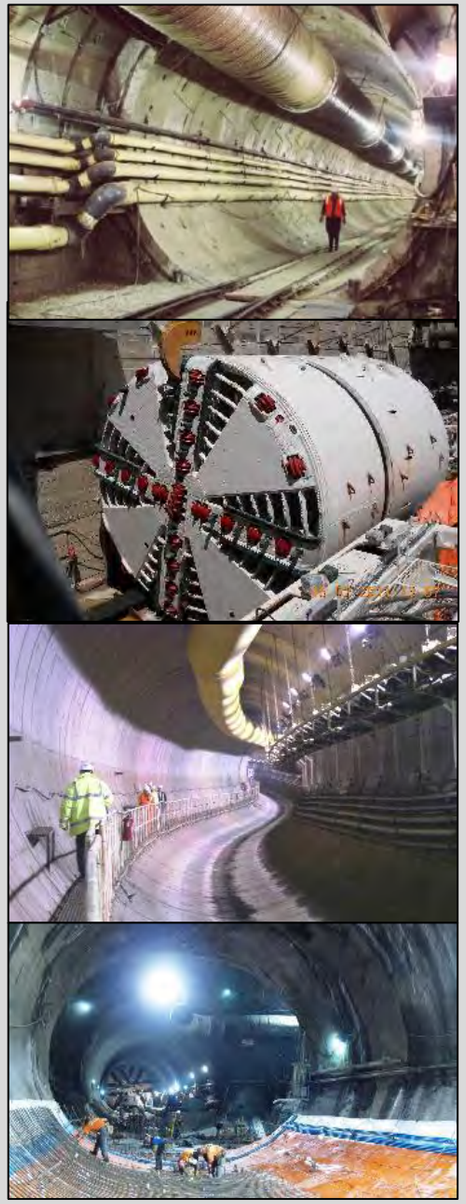
PARAMETER	Average	Range
Hydraulic Conductivity (m/s)	1E-08	4E-10 - 6.4E-7
Bulk Unit Weight (kN/m^3)	25.8	25.1 - 26.3

Who should author a GBR

Geologist:	Regional geology and hydrology
Geotechnical Engineer:	Ground characterization from exploration and lab programs
Construction Specialist:	Construction considerations: understanding of equipment, means and methods, diverse ground behavior, groundwater, gas, obstructions, contamination, sensitive facilities, etc
Designer:	Project overview, references to contract drawings, specs, third-party constraints, payment provisions, *Contract compatibility*

Key concerns:

1. While “Geotechnical” is in the title, GBRs should *not* be written solely by geotechs
2. GBRs must be prepared and reviewed by professionals with the right competencies and experience



Chapter 6– Delivery Alternatives/GBR Development

Two fundamental delivery approaches: DBB and DB

Goals and objectives applicable to both:

- Should not start GBR preparation until >50% of site and lab data is in hand
- Should not go to Contract with a GBR until the site exploration is substantially completed.
- GBR must reflect the actual equipment, means, and methods that will be used in construction. Having an Owner guess does not work. Minimal input from the bidders and Contractor does not work

Key differences between DBB and DB delivery:

With DBB – designer works for Owner

- Strong connection between designer and Owner
- GBR needs to reflect bidder input during procurement

With DB – designer does NOT work for the Owner

- No link between designer and Owner; Owner seeks full design risk transfer
- Poor link between Owner and Contractor
- GBR requires collaboration between Owner and the DB team

How a collaborative GBR is developed is described for each delivery method.

Variations on the theme are briefly addressed (ECI, CMAR, GCCM, Progressive DB, etc.).

Chapter 8 – Contractual and Legal Considerations

GBR Standing within the Contract

Entitlement Standard

- US Federal DSC clause – “Indications in the Contract” vs
- “Foreseeability” clause in FIDIC, NEC 3, NEC 4, ICE, etc
- Should the GBR be the only basis for evaluating a DSC? No.
- Example – hard rock TBM with anticipated groundwater inflows

What to do if the GBR is silent on a particular condition

Baselines in the GBR are not a Warranty

Reliance and Causation

- How to demonstrate/clarify in the EBDs or Contract how the Contractor relied on the GBR (or other indications) in developing its bid

What establishes a “Material” difference

Chapter 10 – Recent Practices / Lessons Learned

The quality of GBRs is decreasing in the industry

- Why?
- What needs to be done to reverse the trend?

Owners, particularly in DB delivery, are seeking full or substantial risk transfer to the Contractor or DB team

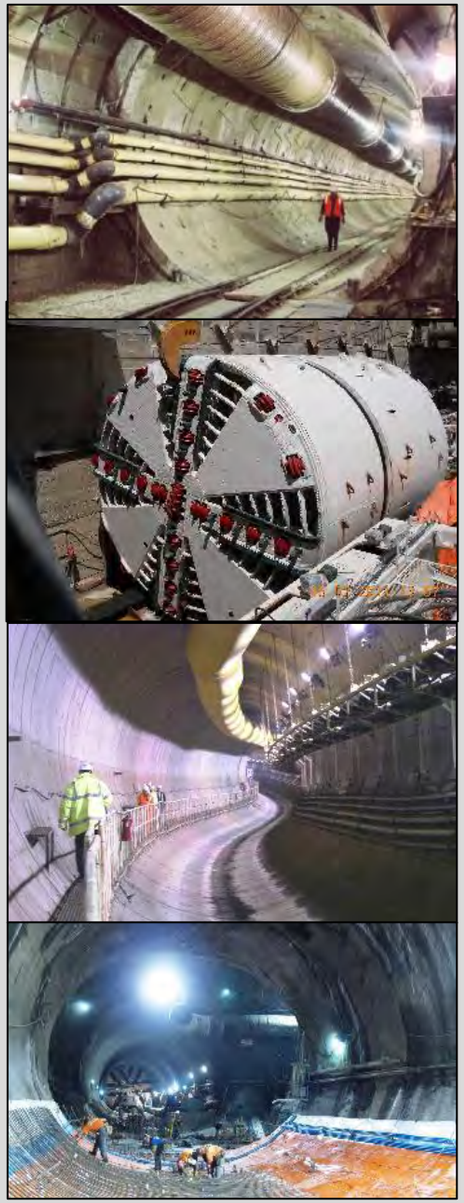
- What needs to be done to reverse the trend?

Undesirable practices

- Setting the “baselines” apart from the rest of the GBR
- Bolding certain statements that are contractually binding vs non-bolded statements
- Clauses that penalize bidders if they elect to utilize a GBR and DSC
- Skimping on site exploration data during project development, particularly in DB delivery; how to ensure that data for construction, not just for design, is a priority

Appendix – Case Histories

- 10-15 case histories that illustrate how baselines were used in the resolution of disputes



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Completion Schedule

Completion Schedule

Now until April 22
- Incorporate Subcommittee review comments

April 22
- Send draft manuscript to George Fox workshop attendees

May 11
- George Fox GBR Workshop

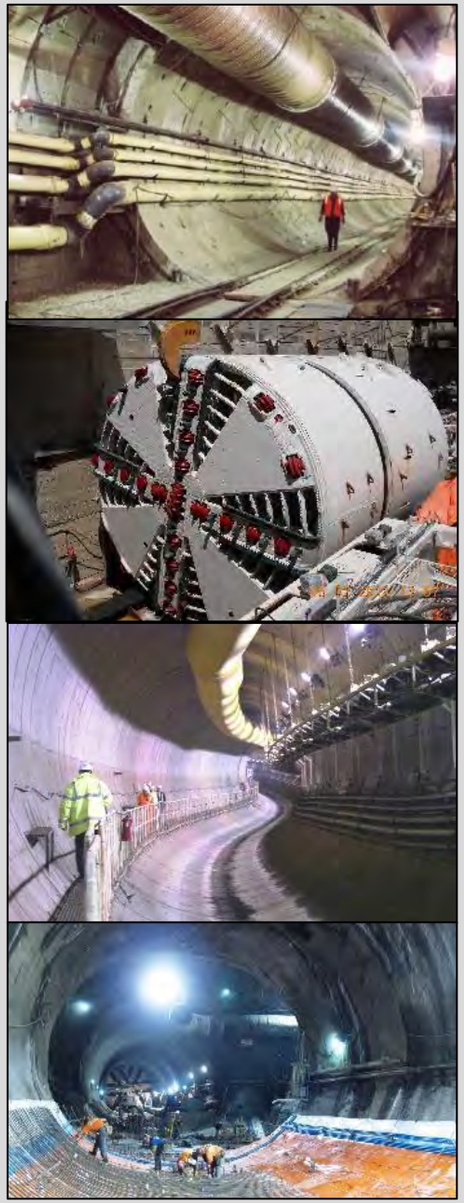
May 11 – June 3
- Incorporate G Fox Workshop comments

Month of June
- Second round by Review Subcommittee

Month of July
- Incorporate Review Subcommittee comments

End of July
- Submit final manuscript to ASCE Book Department

Early November
- ***Platinum Book*** published (hopefully)



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Thank you

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