Engineering geological models, projects and geotechnical risk

Presenter: Chih-Ching Tseng
Advisor: Prof. Jia-Jyun Dong
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Abstract

- Engineering geological models (EGMs) comprise both conceptual ideas and observational data.
- The observational data are associated with aleatory uncertainty.
- The conceptual ideas are the core of any EGM.
- The most powerful capability of an EGM is the ability to anticipate what might be present at a project site and evaluate how the ground could adversely affect the project.
- EGMs are much more than visualizations, they should represent an understanding of the geological conditions that are of engineering significance to the project.

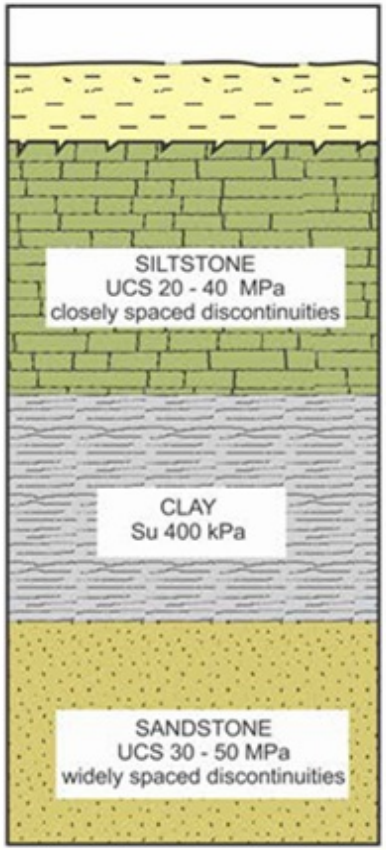
Introduction

Defined By IAEG Commission 25

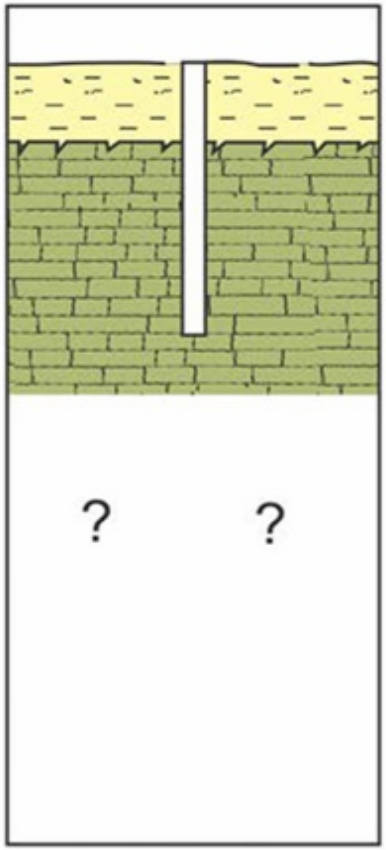
1. Any approximation of the geological conditions, at varying scales, created for the purpose of solving an engineering problem.
2. Noted that the development of EGMs provides a knowledge framework that can contribute to the solution of geotechnical engineering problems and the management of geotechnical risks.

THE CONCEQENCES OF AN INADEQUATE MODEL

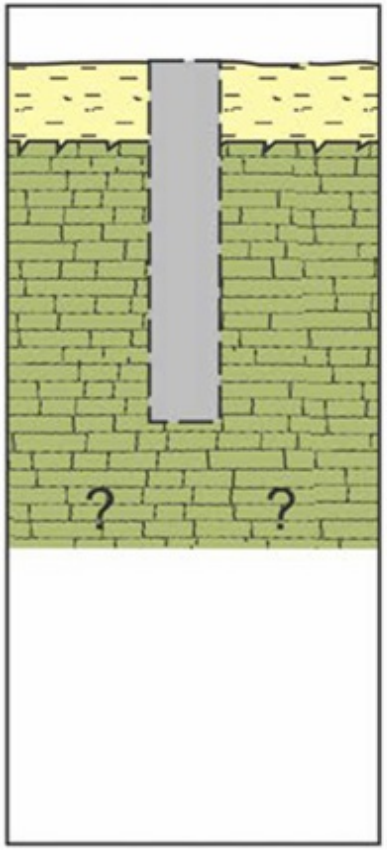
THE MODEL



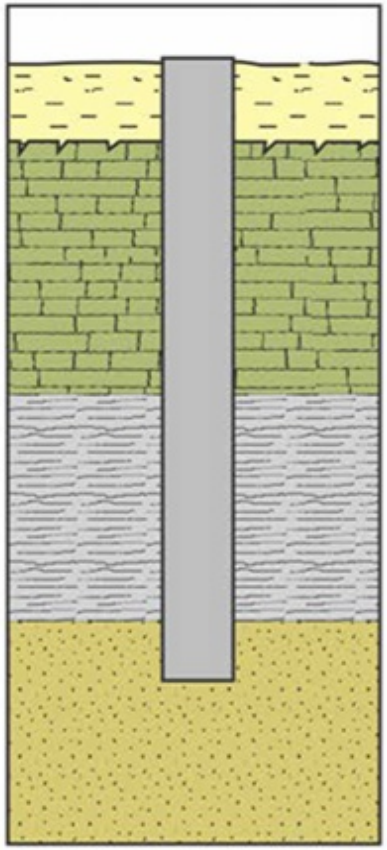
1.IVESTIGATION



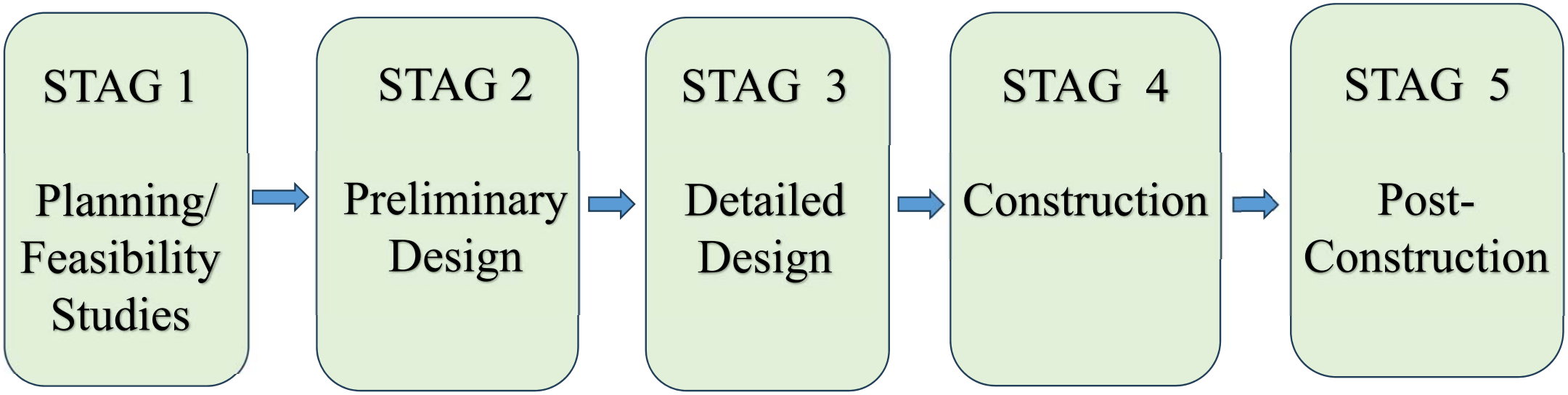
2.DESIGN



3.CONSTRUCTION



Anticipation – the power of engineering geological models



Approaches to the generation of EGM

1.Conceptual approach

Models potentially involve a relatively high degree of uncertainty.

2.Observational approach

These models are therefore based on data that relate to actual 3D space.

They are so profoundly interlinked

Methodology

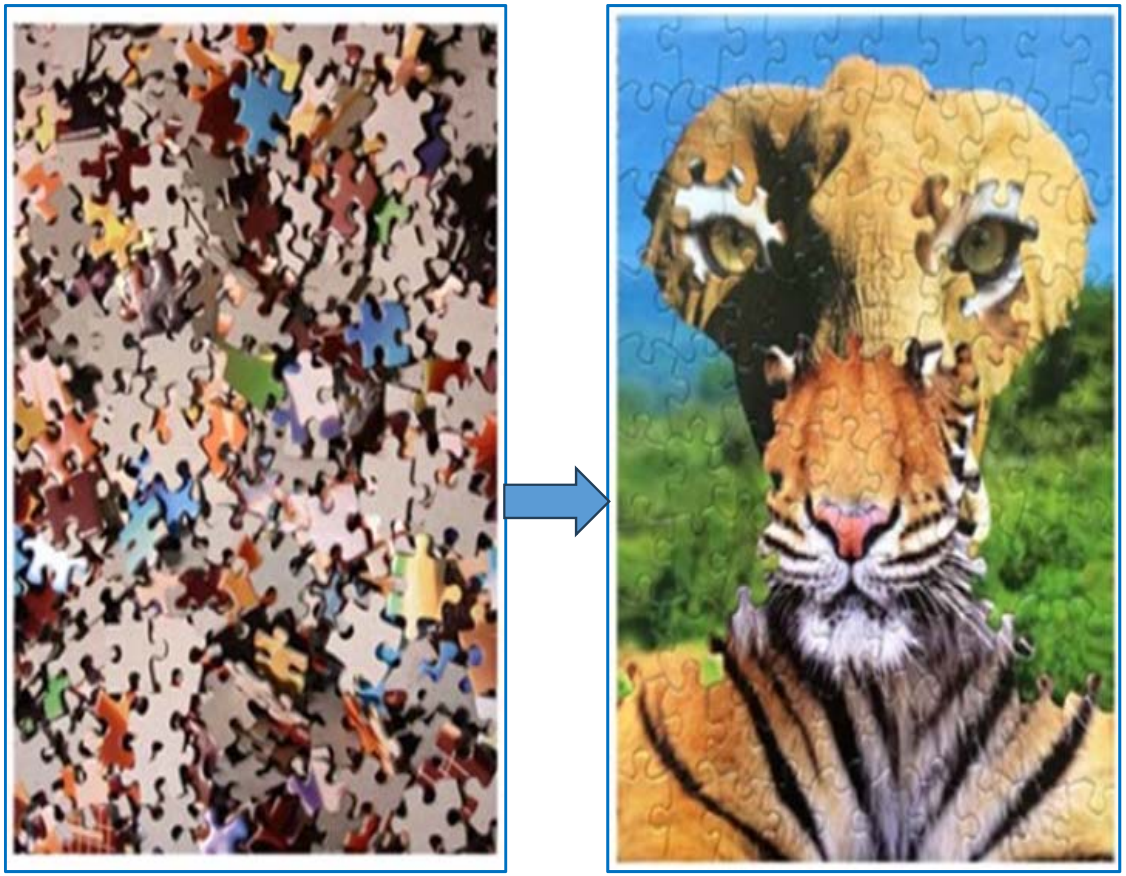
Engineering Geological Models

uncertainty

1. Aleatory uncertainty which is due to variability and randomness of the intrinsic properties of the system.

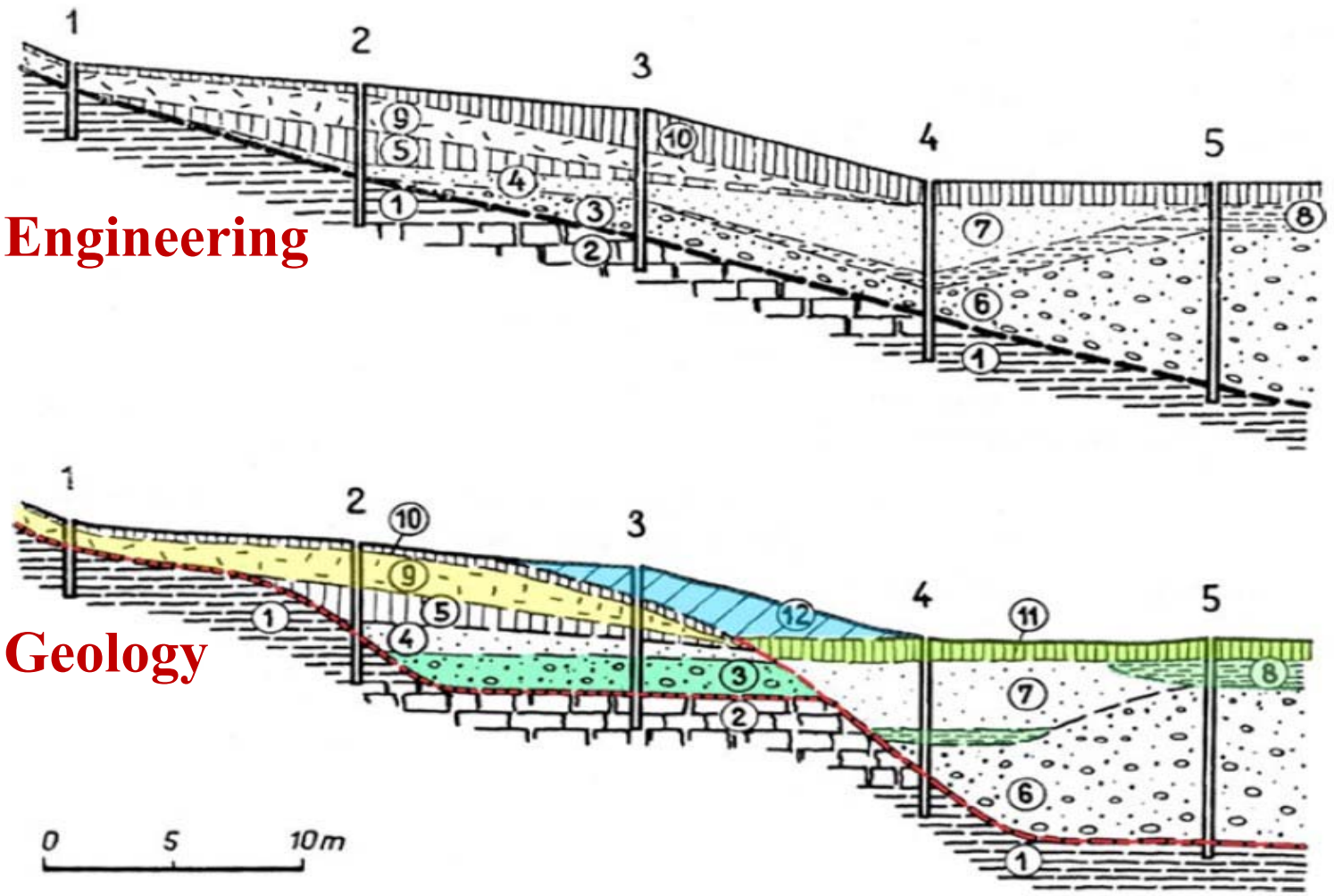
2. Epistemic uncertainty which is due to ignorance, a lack of knowledge or an incomplete understanding of the system on the part of the observer.

Conceptualization as the first step



If isolated observational data are fitted together without a holistic understanding of what they might represent, a model can be generated but it could potentially be nonsense and, probably worse.

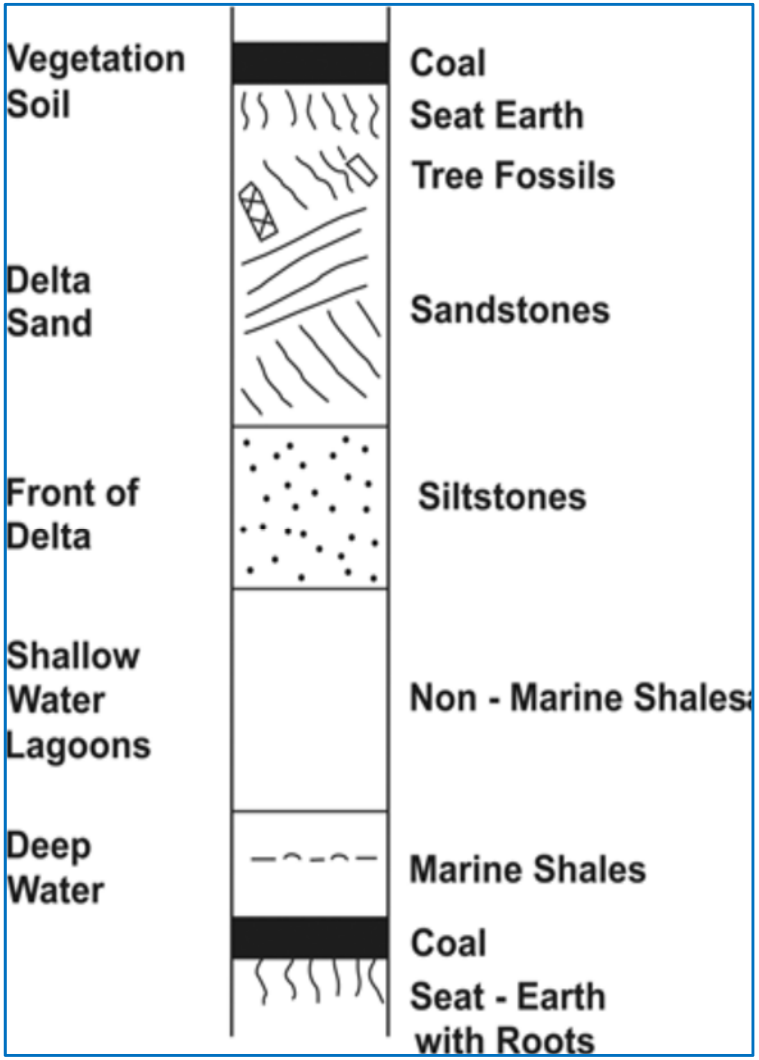
Methodology

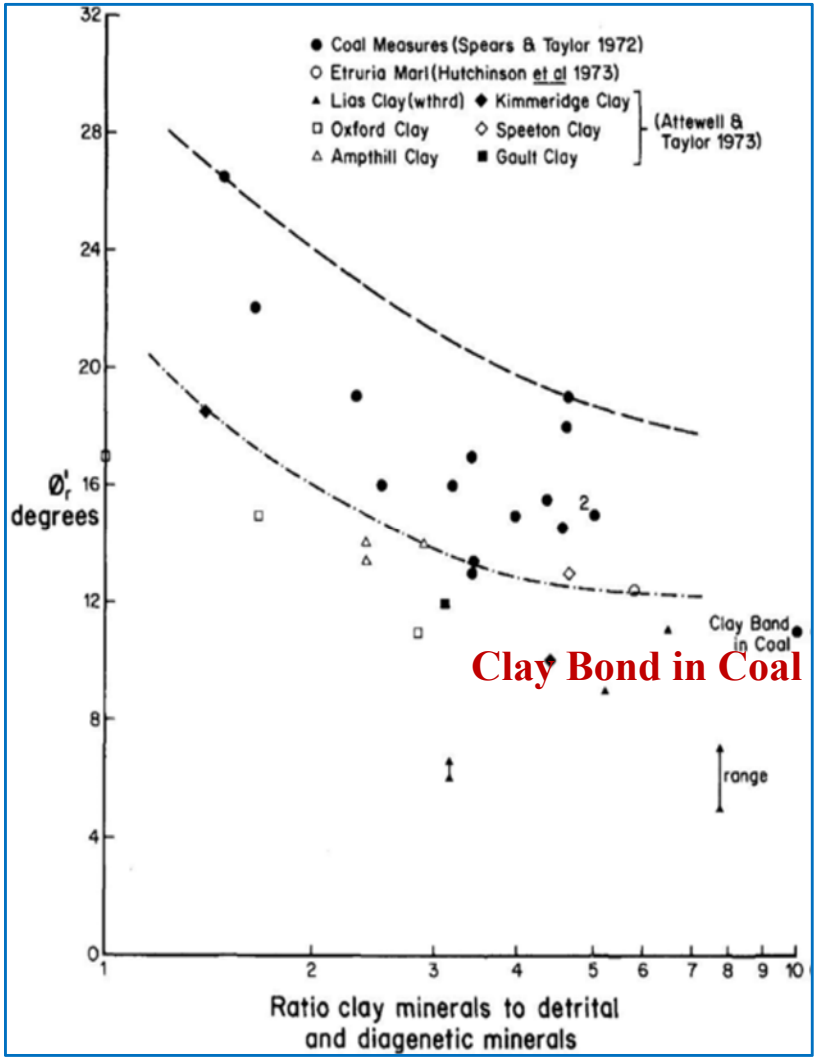


Pattern

1.Cretaceous marls;
2.Cretaceous sandstones
3.4. Sand and gravel of lower terrace
5.Loess loam
6.Sand and gravel of the valley terrace
7.Sand;
8.Holocene clayey alluvium;
9.Slope detritus;
10. Recent soil profile;
11. Floodloam;
12. Fillin

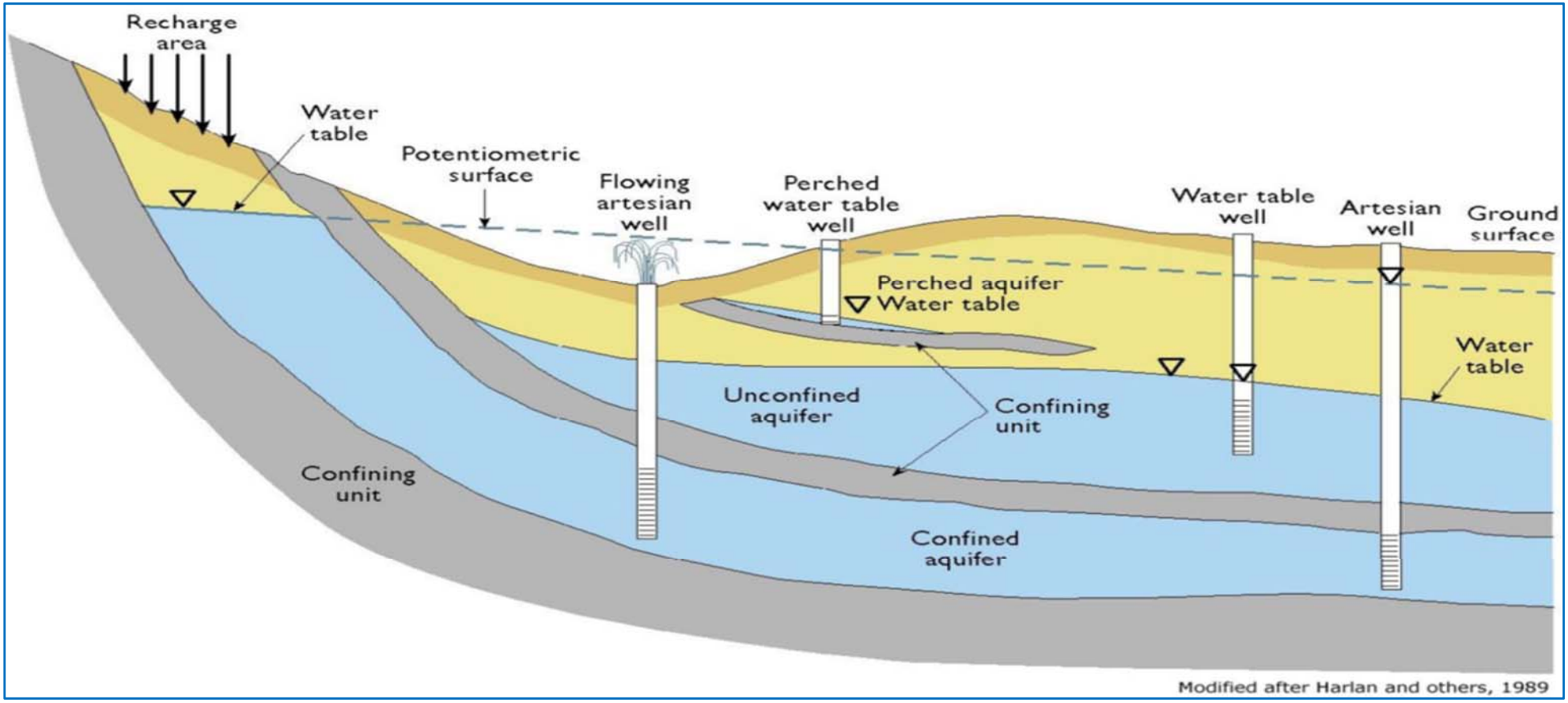
Methodology





Clay Bond in Coal

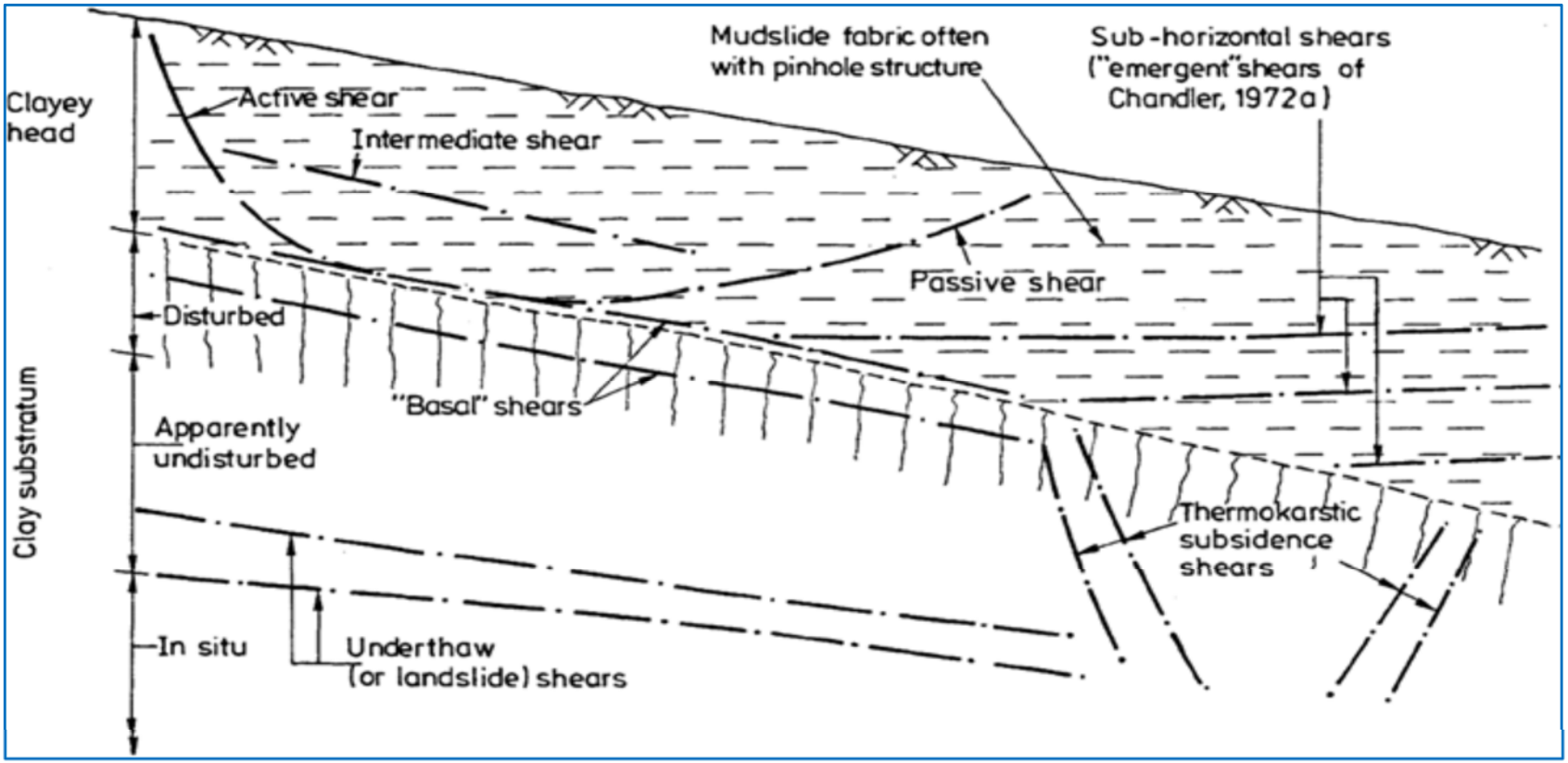
Methodology



The seat earths also often form an aquiclude above the thick sandstone units.

Methodology

uncertainty



The model will vary laterally and vertically

Results

EGM that connects the project to the site can be developed, initially by identifying the geological factors associated with the site that could have implications for the project engineering

Results

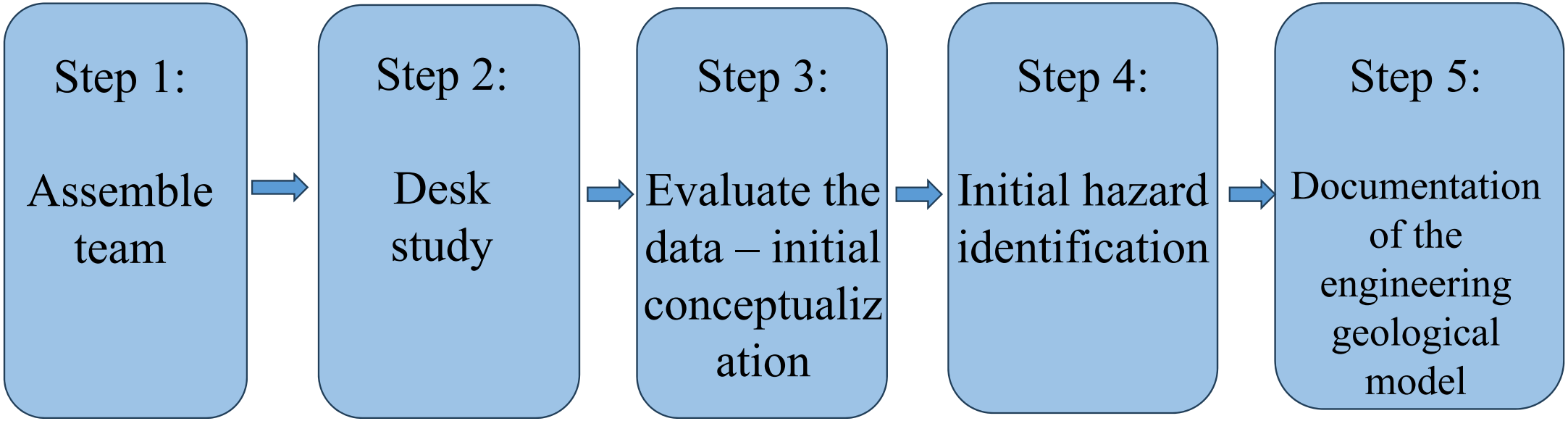
Baildon – developing a risk register from the EGM

- geological factors with possible engineering implications (primarily conceptual)

Geological factors	Possible engineering geological implications for project
Sloping ground	Slope instability and landslides
Quarry	Sub-vertical quarry rock faces, rockfall
Coal seams	Low strength backfill, cavities, subsidence
Seat earth	Clay-rich, high plasticity, interbed shear, residual strengths
Mudstone	Low strength, extensive weathering, low permeability
Sandstone	Wide joint spacing, high permeability,difficult to excavate
Sedimentary depositional environments	Spatially variable lithology
Landslides	Affecting excavations and operations
Groundwater	Highly variable permeability,Confined aquifers, high porewater pressures

Introduction

Ageneric site investigation methodology driven by conceptualization



Results

Baildon – developing a risk register from the EGM

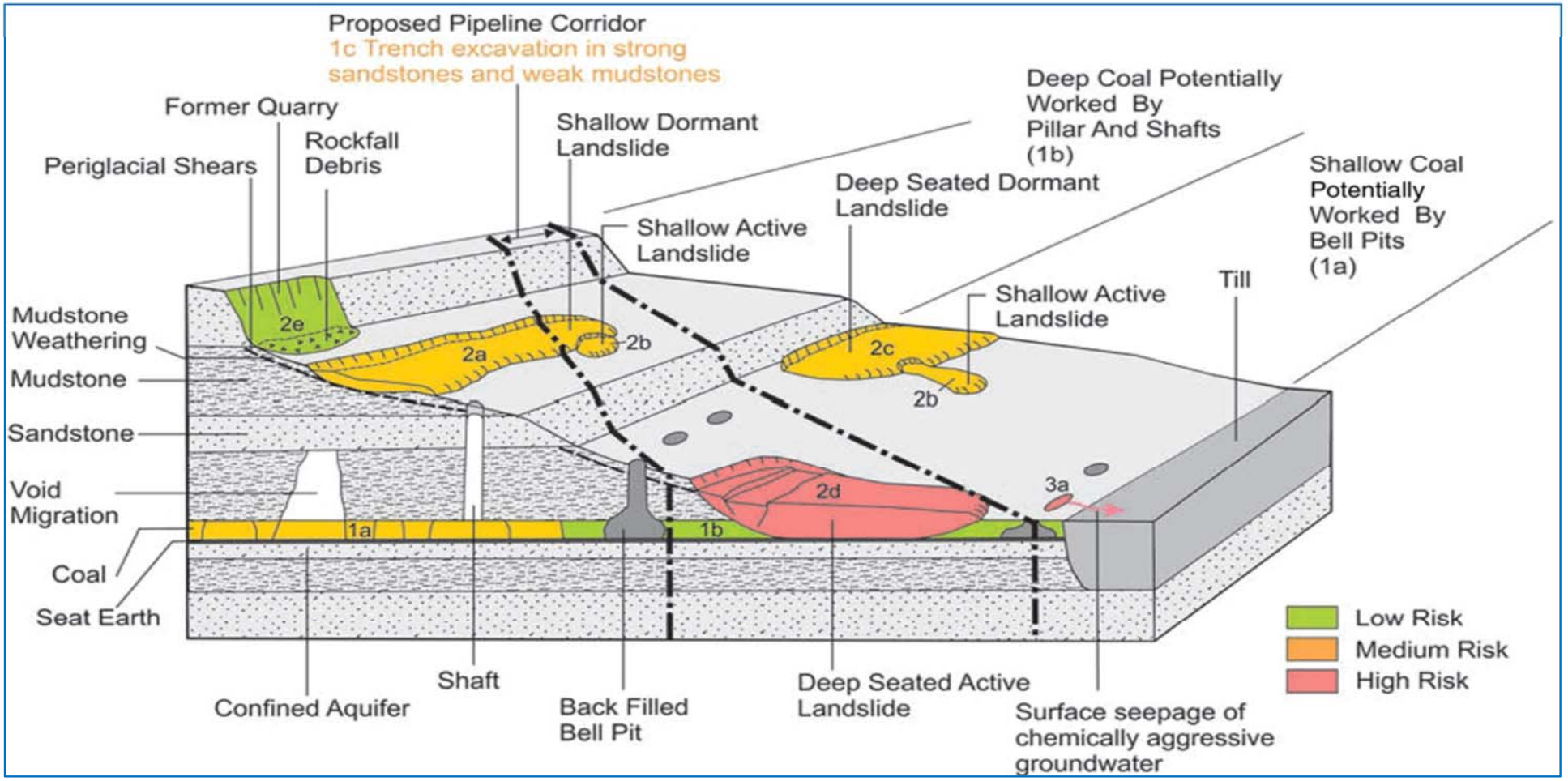
Hazard ID	Hazard Description	Justification of significance	Likelihood of impacting project	Consequence if impacts project	RISK
Stratigraphy - Coal Seams - Coal seams shown on BGS map beneath site. (Soft Bed, Middle Band, Hard Bed)					
1a	If seams are present, have they been worked by pillar and stall?	Potential subsidence associated with collapse of working. Unrecorded shafts	Possible	Major. Large scale subsidence could affect integrity of pipeline	Medium
1b	If seams are present, have they been worked by bell pits?	Unrecorded shafts/variable ground conditions/poor quality backfill	Unlikely	Minor, localized subsidence unlikely to affect pipeline integrity	Low
1c	Thick strong Sandstones and weak interbedded mudstones	Variable trench excavatability, possible refusal	Likely	Minor, may cause delays and changes to machinery	Medium
Landslides - BGS map shows "landslip deposits"					
2a	Shallow inactive landslide	Could be reactivated by construction if pipeline crosses the landslide However, it is likely that the pipeline will be lower than the shear surface and trench backfill should stabilize in the short term. Acceptable during operation.	Likely	Minor	Medium
2b	Shallow active landslide	Could move during construction if pipeline crosses the landslide However, it is likely that the pipeline will be lower than the shear surface and trench backfill should stabilize in the short term. Acceptable during operation.	Almost certain	Minor	Medium
2c	Deep seated inactive landslide	Could be reactivated by construction but trench backfill should stabilize so probably OK during operation.	Unlikely	Medium	Medium
2d	Deep seated active landslide	Could move during construction but could rupture pipeline during operation.	Possible	Catastrophic	High
2e	Rockfall	Restricted to former quarries so unlikely to impact pipeline and pipeline also protected by backfill	Unlikely	Insignificant	Low
Groundwater Chemistry – coal workings often have aggressive groundwater seepages					
3a	Acidic groundwater	Corrosion of pipeline	Likely	Major	High

Likelihood	Consequence				
	Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain				2b	
Likely		3a		1c, 2a	
Possible	2d	1a			
Unlikely			2c	1b	2e
Rare					

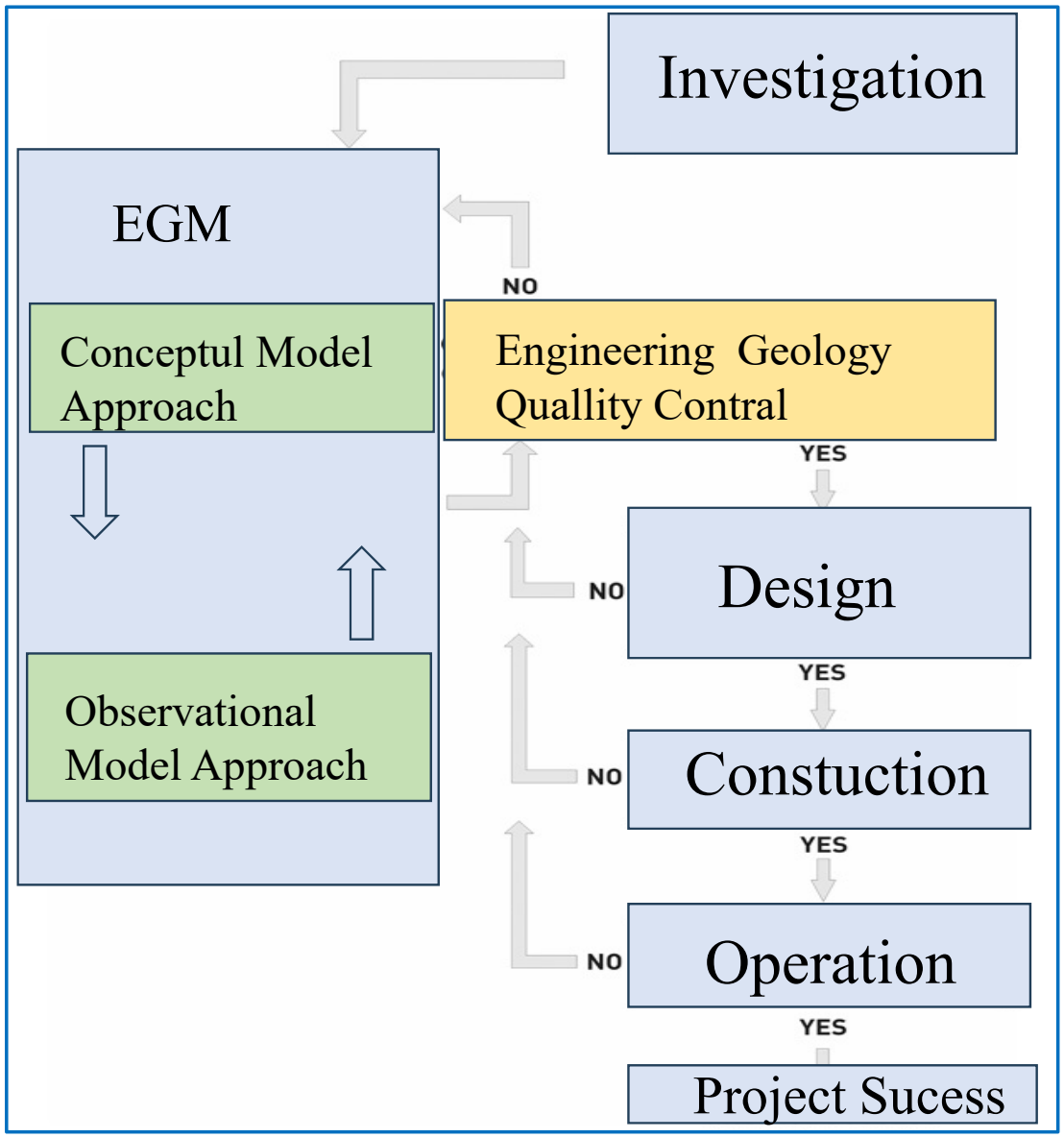
High Risk | Medium Risk | Low Risk

Results

The EGM assists in the identification of potential hazards and used to prioritize targets and define the scope for the site investigation



Results



The central role of the engineering geological model in ensuring project success

conclusion

1. An engineering geological model is an approximation of the engineering geological conditions created to help solve geotechnical engineering problems and manage geotechnical risks
2. The EGM should be generated at the start of the project, be reviewed and updated as additional data become available
3. The success of the conceptualization will be dependent on the engineering geological knowledge and experience of the individuals involved in the project

Thanks for your attention