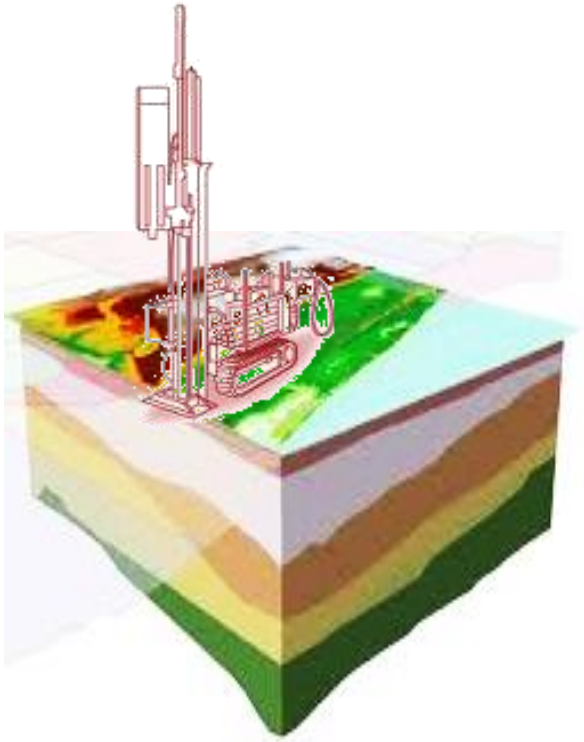


Foundation Engineering

CE 483

2. Site Investigations

Contents

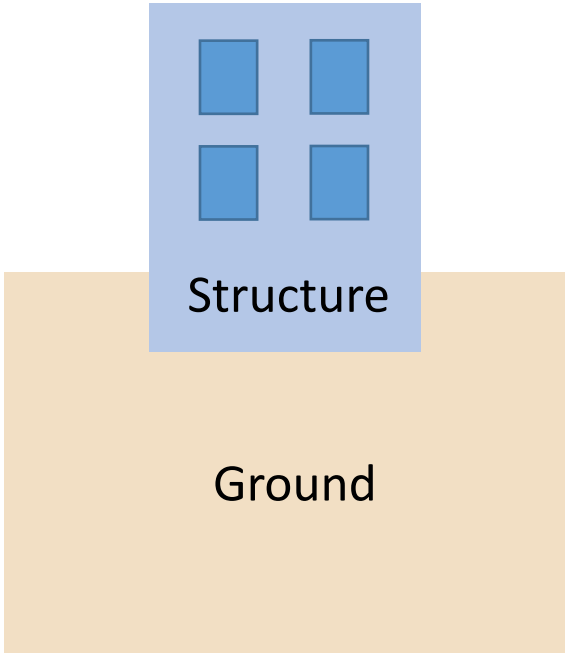
Introduction

- What is Site Investigation (SI)?
- Why Site Investigation?
- What are the Objectives of Site Investigation?

What is site investigation (SI)?

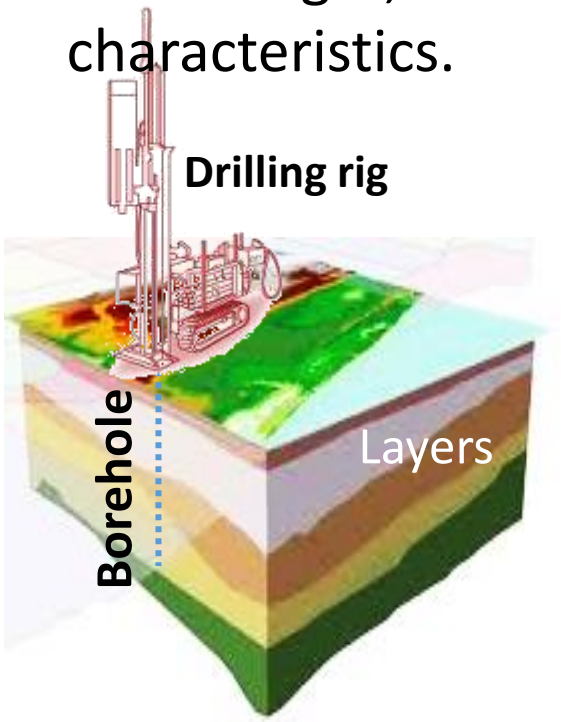
The design of foundations of structures (such as buildings, bridges, and dams) generally requires **information** about:

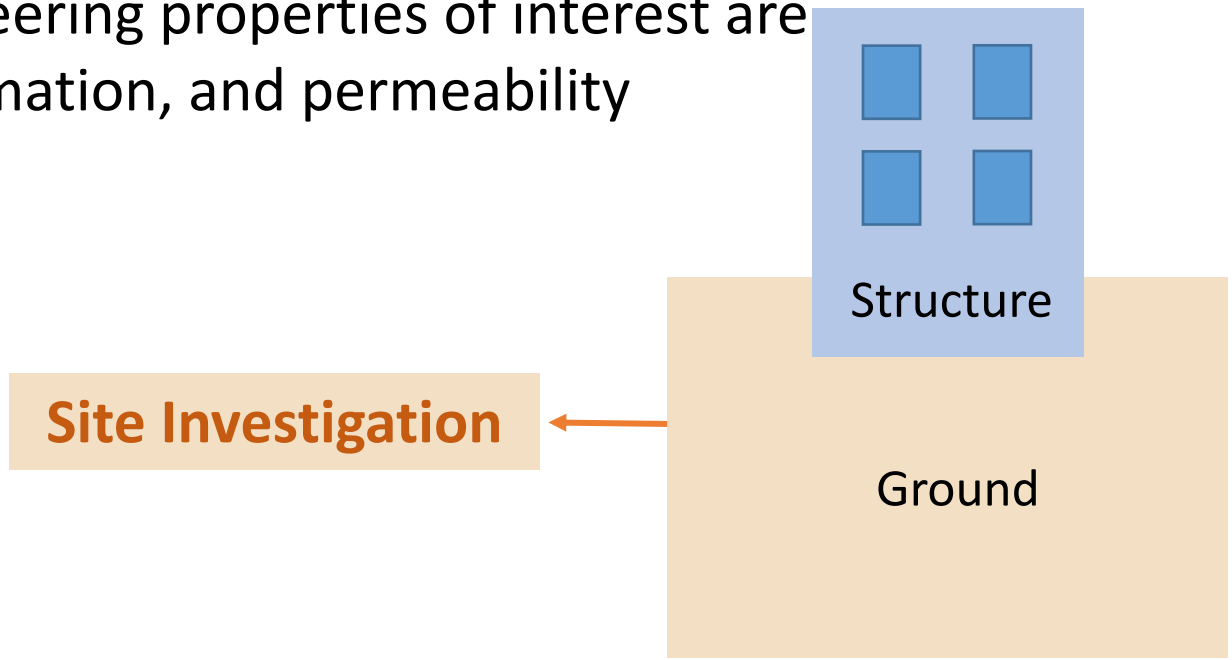
- Structure
- Ground



What is site investigation (SI)?

- Site investigation (SI) or soil exploration is the process of gathering **information**, within practical limits, about the stratification (layers) and engineering properties of the soils/rocks underlying the proposed construction site.
- The principal engineering properties of interest are the strength, deformation, and permeability characteristics.





Why site investigation (SI)?

Many engineering problems (failures) could have been avoided if a proper site investigation had been carried out.

The site has a **sinkhole risk** which might have been discovered in a proper site investigation

Why site investigation (SI)?

- The **success** or **failure** of a foundation depends essentially on the reliability of the knowledge obtained from the site investigation.
  Sophisticated theories alone will not give a safe and sound design.

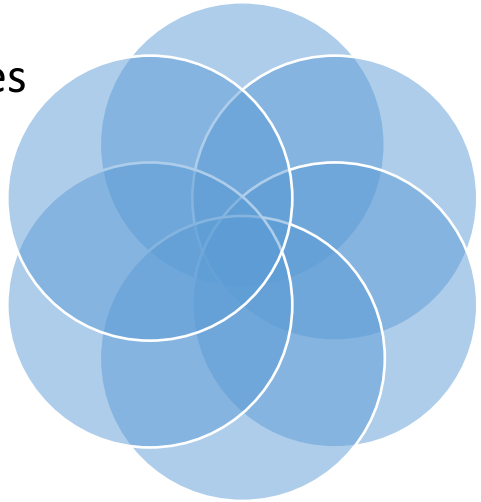
Objectives of site investigation

The knowledge about the ground of the proposed construction site is obtained by Site Investigation, and used **to determine**:

Suitability: of site for the proposed construction?

Effect of changes: How will the design affect adjacent properties and the ground water?

Type of design solution: e.g. type of foundation: shallow or deep.



Design parameters: such as strength, compressibility, permeability & other parameters used for geotechnical design

Geo-materials: available on site which can be re-used?

Site Investigation

Ground or Ground-water conditions: that would affect the design and construction? e.g. expansive soil, collapsible soil, high ground water…

Objectives of site investigation

Site Investigation

Program of site investigation

- Before Site Investigation
- The sequence of Site Investigation

Before Site Investigation

- Site Investigation is usually carried out as part of **Subsurface Exploratory** program.
- Before conducting the Site Investigation, the program usually include: Desk Study and Site Reconnaissance.

Desk Study [Stage 1]

Collect and review preliminary information about the site, and the structure to be built.

Site Reconnaissance[Stage 2]

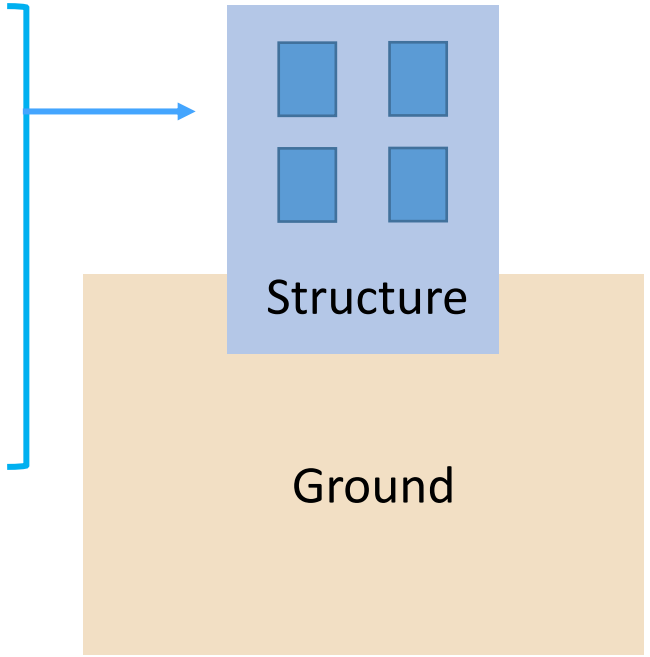
Visual inspection of the site.

Desk Study [Stage 1]

Collecting general information about the **structure**, **from** the architectural and structural design:

Information about the Structure

- **Type, dimensions,** and **use** of the structure, and any special architectural considerations.
- the **load** that will be transmitted by the superstructure to the foundation system
- the **requirements** of the local building **code** (e.g. allowable settlement)

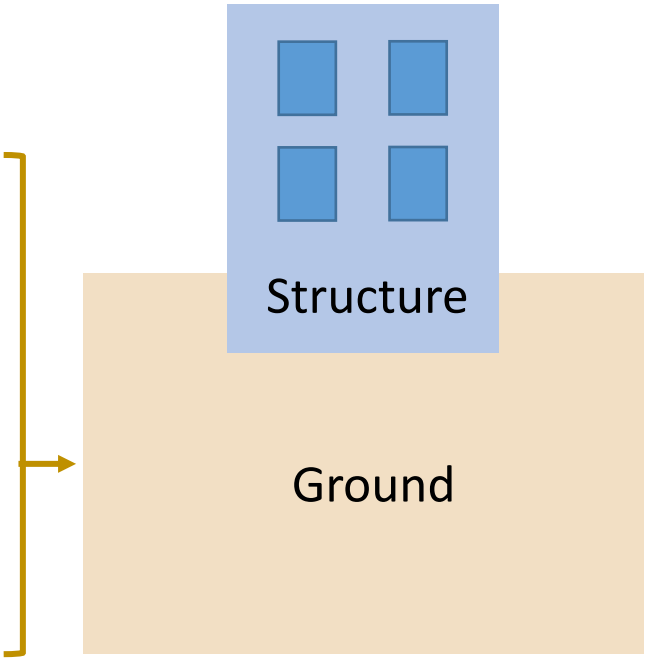


Desk Study [Stage 1]

Collecting general information about the **ground**, **from** already existing data such as: geological maps, seismic maps, OS maps, Ariel Photography, Services records (Gas, Water, Electricity), Previous geo-environmental or geotechnical reports, … etc. at or near site.

Information about the ground:

- the **geological** conditions of the ground (e.g. layers, Geological features, Ground water, Flood & Earthquake risk in the area, ..).
- the **historical use** of the site – if previously used as quarry, agricultural land, industrial unit with contamination issue, man-made fill/slope, etc.



Ariel Photograph taken for a site – shows a possible sinkhole

Site Reconnaissance [Stage 2]

The Site Reconnaissance is normally in the form of a **walk-over survey** of the site.

What things do I need to look for?

Engineer during Site Visit

Site Reconnaissance [Stage 2]

Important evidence to look for is:

1. **Stratification of soil:** from deep cut, such as those made for the construction of nearby highway or other projects – if any.
2. **Slope**: signs of slope instability include bent trees, shrinkage cracks on the ground and displaced fences or drains.

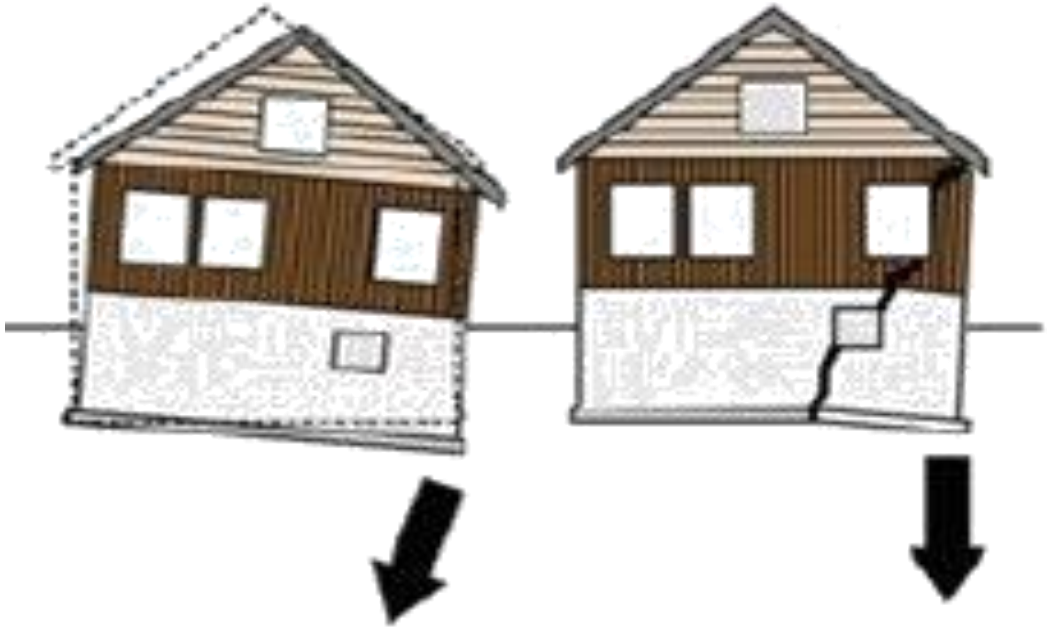
Stratification of soil

Signs of slope instability

Site Reconnaissance [Stage 2]

Important evidence to look for is:

3. **Structures:** type of buildings in the area and the existence of any cracks in walls or other problems. You may need to ask local people.



Tipping settlement (often without cracks)

Differential settlement (with cracks)

Indication of possible ground-related problem

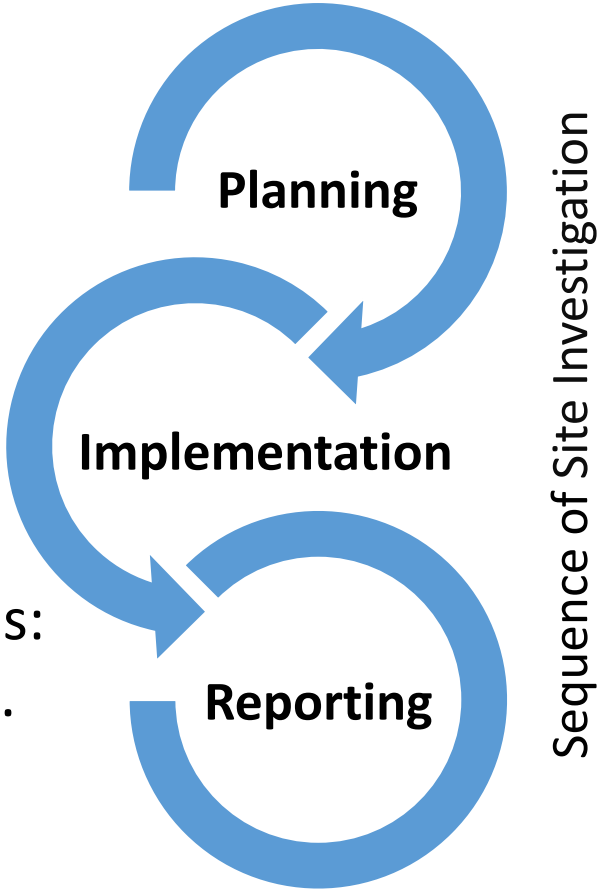
Site Reconnaissance [Stage 2]

Other important evidence to look for is:

4. **Mining:** The presence of previous mining is often signs of subsidence and possibly disused mine shafts. Open cast mining is indicated by diverted streams replaced or removed fence/hedge lines.
5. **Hydrogeology**: Wet marshy ground, springs or seepage, ponds or streams and Wells.
6. **Topography:** possible existence of drainage ditches or abandoned debris or other man-made features.
7. **Vegetation:** may indicate the type of soil.
8. **Access**: It is essential that access to the site can be easily obtained. Possible problems include low overhead cables and watercourses.

The sequence of Site Investigation

- Soil exploration is a requirement for the design of foundations of any project.
- In large construction projects, 2 site investigations (SI) are carried out:
  - Preliminary SI, followed by
  - Detailed SI.
- Whether investigation is preliminary or detailed, there are three important phases: **planning**, **implementation** and **reporting**.



Planning (A preliminary site investigation) [Stage 3]

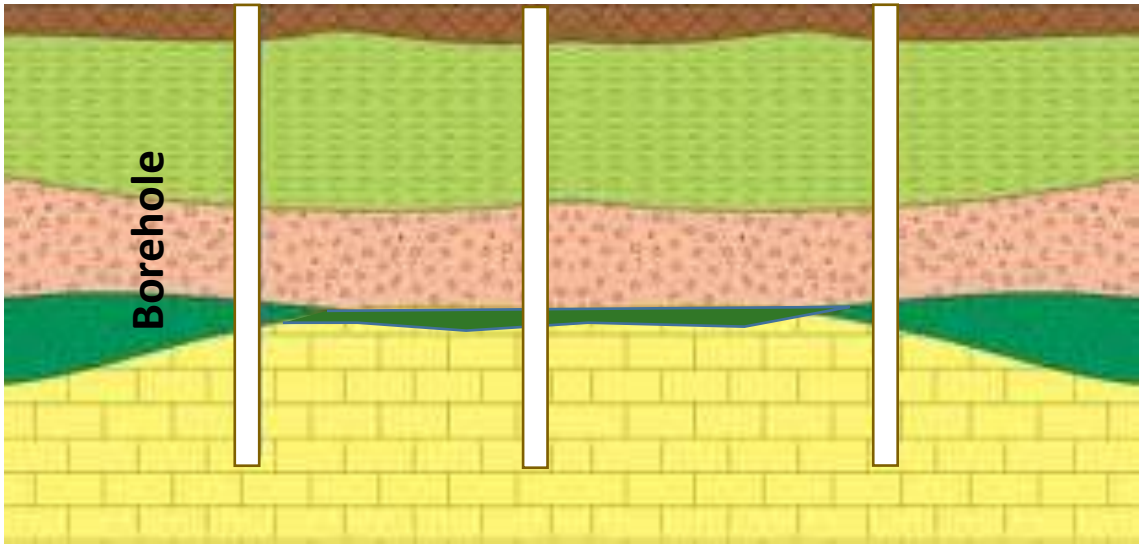
Why planning

- Depth of investigation
- Spacing of boreholes

Why planning?

- How many borings do we need?
- How deep the borings should be?

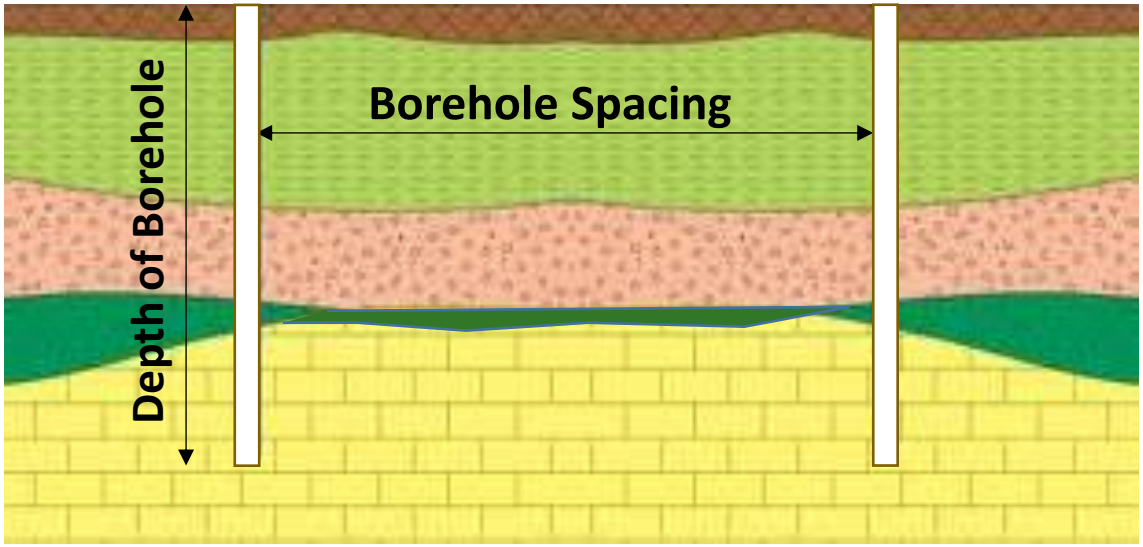
The more the better, but what about the cost?



Why planning?

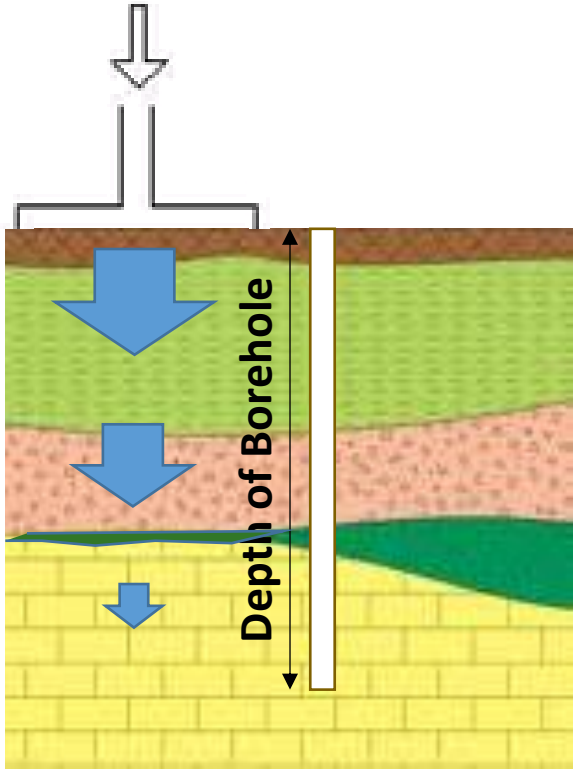
Planning for site investigation is required to:

- Minimize cost of explorations and yet give reliable data.
- Decide on quantity and quality depending on type, size and importance of project and whether investigation is preliminary or detailed.
- Decide on minimum **depth** and **spacing** of exploration.



Depth of investigation

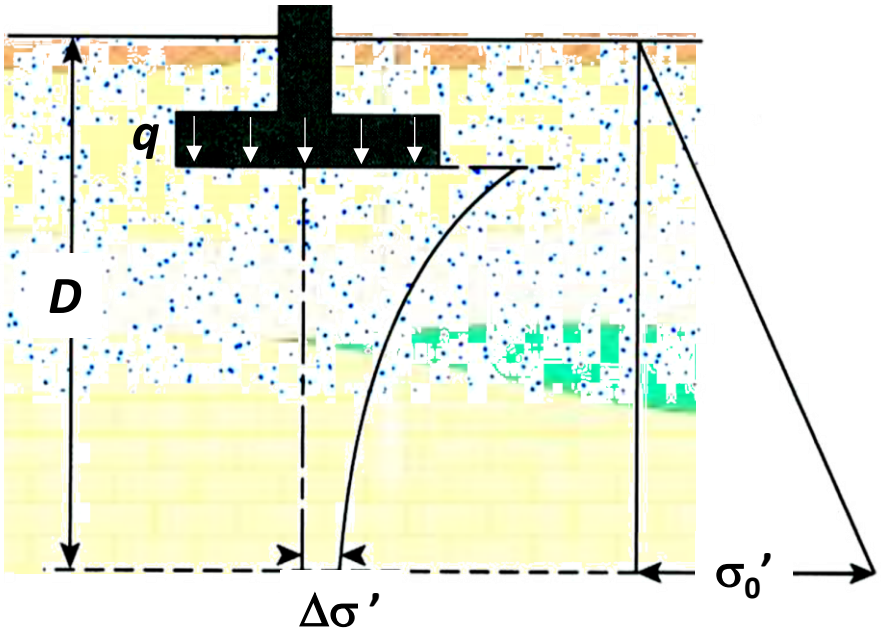
- In general, depth of investigation should be such that any/all strata that are likely to experience **settlement** or **failure** due to **loading**.
- The estimated depths can be changed during the drilling operation, depending on the subsoil encountered.
- To determine the approximate minimum depth of boring, engineers may use the following rules:



Depth of investigation

Determination of the minimum depth of boring

1. Determine the net increase of stress, $\Delta\sigma'$ under a foundation with depth as shown in the Figure.
2. Estimate the variation of the vertical effective stress, σ'_0, with depth.
3. Determine the depth, D = D1, at which the stress increase $\Delta\sigma'$ is equal to (**1/10**) q (q = estimated net stress on the foundation).
4. Determine the depth, D = D2, at which $\Delta\sigma'/\sigma'_0$ = **0.05**.
5. Unless bedrock is encountered, the smaller of the two depths, D1 and D2, is the approximate minimum depth of boring required.



Depth of investigation

Table shows the minimum depths of borings for buildings based on the preceding rule.

Building width (m)	Number of Stories				
	1	2	4	8	16
	Depth of Boring				
30.5	3.4	6.1	10.1	16.2	24.1
61.0	3.7	6.7	12.5	20.7	32.9
122.0	3.7	7.0	13.7	24.7	41.5

What do you notice about this table?

Spacing of boreholes

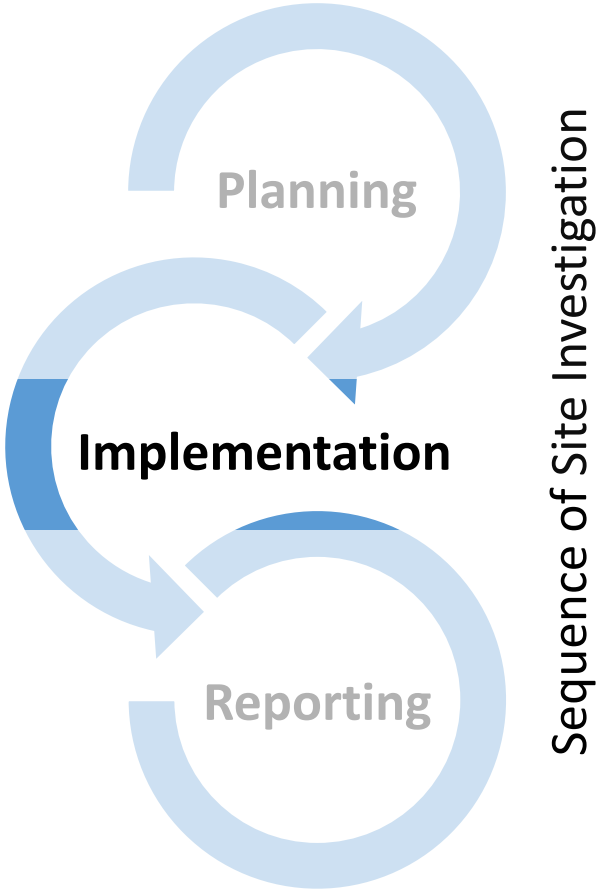
- There are no strict rules for the spacing of the boreholes.
- The following table gives some general guidelines for borehole spacing.
- These spacing can be increased or decreased, depending on the subsoil condition.
- If various soil strata are more or less uniform and predictable, the number of boreholes can be reduced.

What do you notice about this table?

Type of project	Spacing (m)
Multistory building	10-30
One story industrial plants	20-60
Highways	250-500
Residential subdivision	250-500
Dams and dikes	40-80

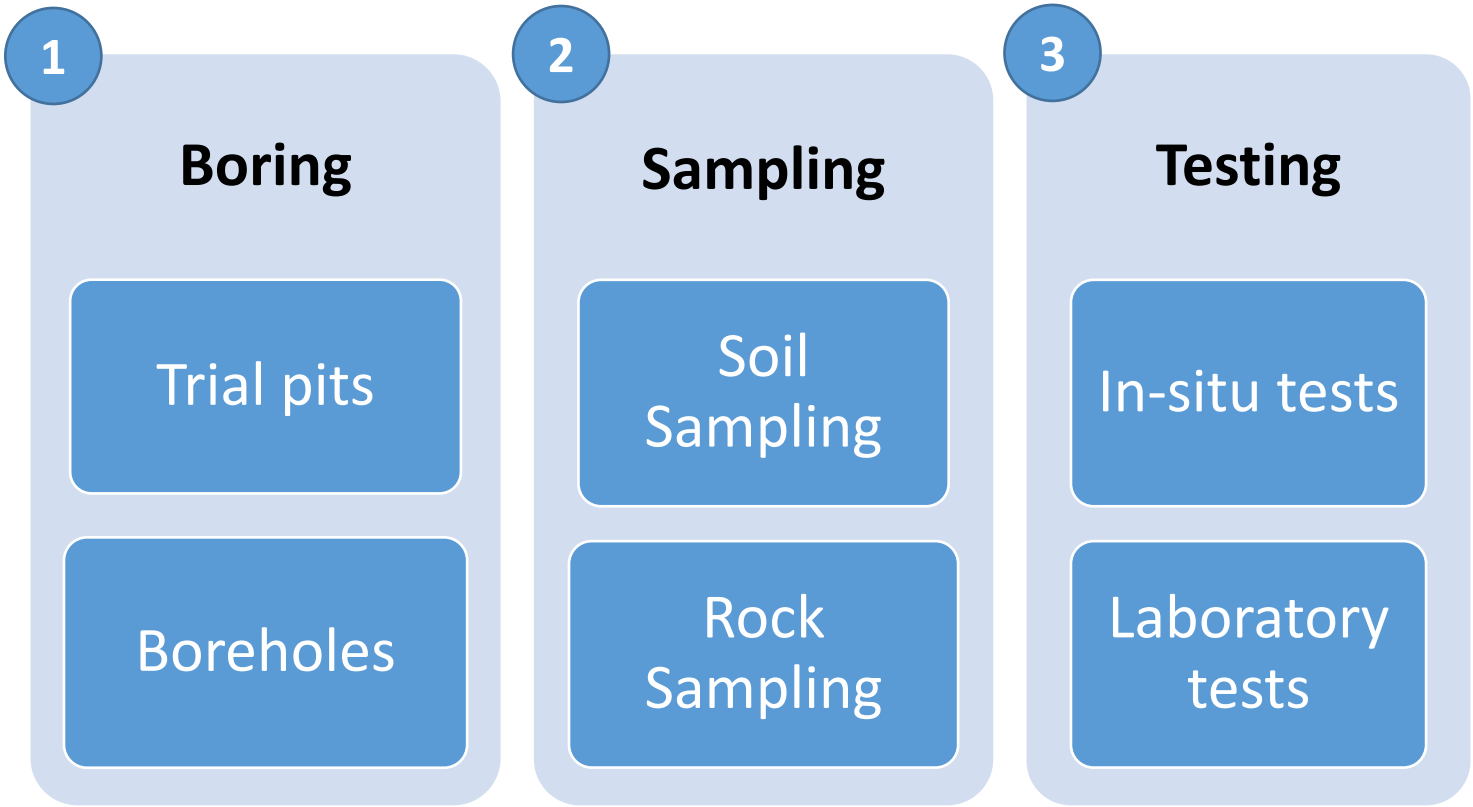
Implementation (A detailed site investigation) [Stage 4]

- Overview
- Boring
- Sampling
- Testing

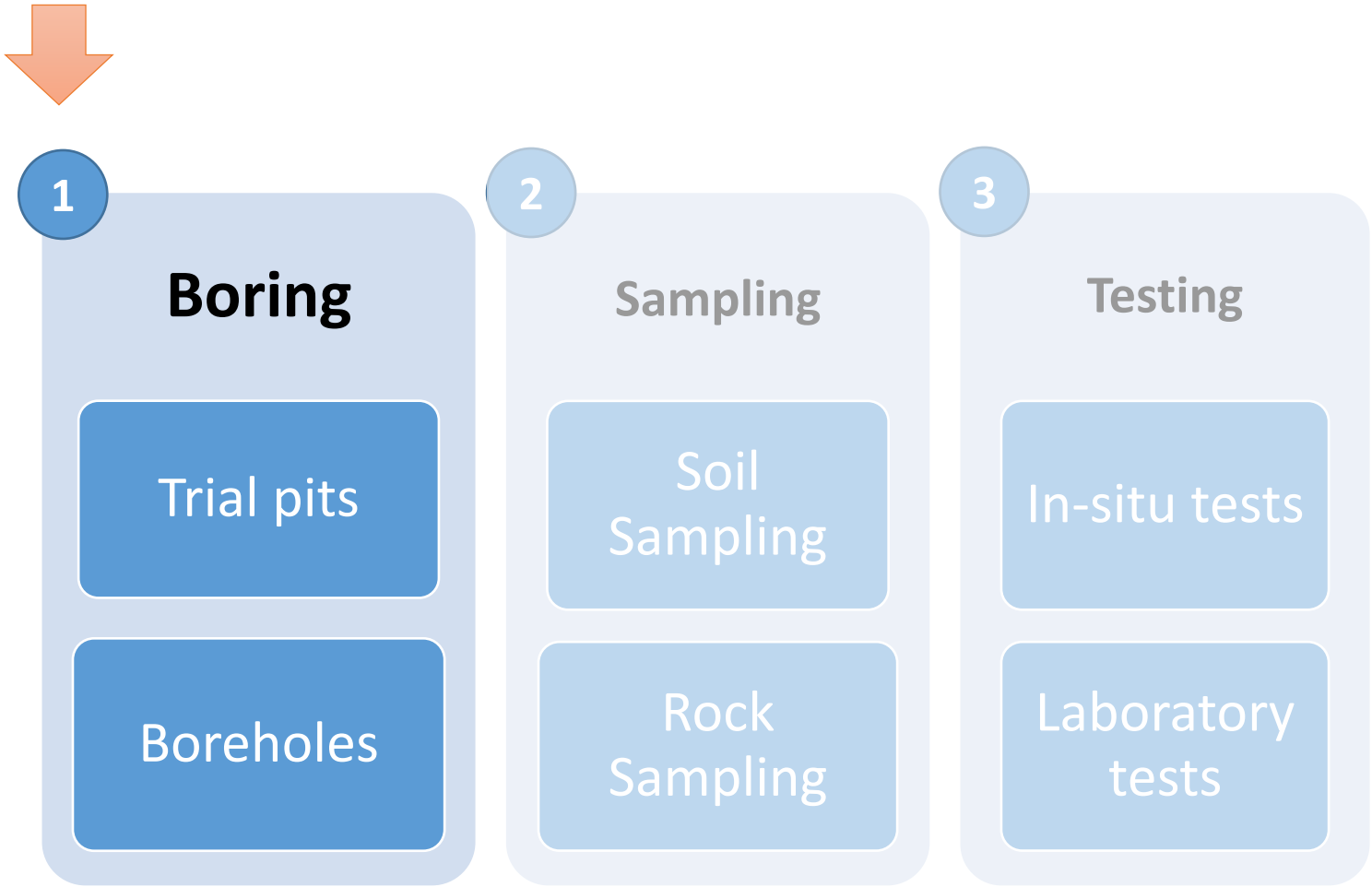


Overview

The implementation phase of site investigation usually includes **three** important aspects:



Boring


1
Boring
Trial pits
Boreholes
2
Sampling
Soil Sampling
Rock Sampling
3
Testing
In-situ tests
Laboratory tests

Trial pits

- Trial pits are shallow excavations - less than 6m deep.
- The trial pit is used extensively at the surface for block sampling and detection of services prior to borehole excavation.
- For safety *ALL pits below a depth of 1.2m must be* ***supported***.

Depth	Excavation Method
0-2m	By Hand
2-4m	Wheeled Back Hoe
4-6m	Hydraulic Excavator