

National Exams May 2009

04-Geol-B3, Site Investigation

3 hours duration

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.  
Candidates may use one of two calculators, the Casio or Sharp approved models.
3. Questions do not have equal value. The grade for each question is given.  
It is suggested that the candidate proportion time based on the allocated value.
4. All questions require an answer in essay format. Clarity and organization of the written answer and any figures or sketches are important.

**Question 1. (20%)**

For both the Standard Penetration Test (SPT) and the Cone Penetration Test (CPT) in medium dense sand below the water table:

- a) Describe the surface and down-hole equipment required to conduct each test.
- b) Detail the procedures of how to conduct each test.
- c) Illustrate the quantities measured in each test. Provide typical values.
- d) List and discuss the advantages and disadvantages of each test.
- e) Comment on the reliability and repeatability of each test.

**Question 2. (60%)**

A study of surface geological maps and air photos suggests that at a proposed site, ground conditions involving 15-25 m ( $\pm 5$  m) of glacial till with sand lenses overlying fractured limestone (5  $\pm 2$  m thick) and unfractured limestone could reasonably be encountered. The ground water table is expected to be within 10 m ( $\pm 5$  m) of the ground surface. Prepare detailed and specific site investigation and construction monitoring programs for three (3) of the following four (4) projects:

- a) A three story medium-duty industrial building built on shallow foundations and slabs-on-grade. The plan area of the building is 50 m by 80 m.
- b) A 20-m-deep vertical excavation with shoring support to permit construction of the basement of a 40-storey condominium building. The building foundations are to be end-bearing rock sockets. The plan area of the building is 20 m by 30 m.
- c) A 5-m-diameter sewer tunnel with a precast concrete segmental liner constructed with a tunnel boring machine at a minimum cover of 7 m.
- d) A municipal solid waste landfill. The total thickness of the waste will average 20 m and the base of the landfill is 10 m below the ground surface. The plan area of the landfill is 200 m by 300 m.

Include consideration of: what are the important engineering issues that need to be assessed in the investigation and monitoring (if any), how deep the investigation should extend, what type of tests/measurements should be conducted, and how many locations should be tested/monitored. The practical issues of cost and the risk involved in each project must also be considered.

**Question 3. (20%)**

The results of field and laboratory tests from a site investigation are summarized in Figure Q3 on page 3.

- a) Describe how to obtain the liquid ( $w_L$ ) and plastic limits ( $w_P$ ).
- b) Explain the engineering significance of sensitivity.
- c) What inference (if any) can be made with regard to the geological history of the deposit(s)?
- d) Explain the discrepancy in undrained shear strength results between the field vane and laboratory unconfined compression for depths larger than 12 m. Which values provide a better estimate of the true strength of the soil?
- e) Is the low undrained shear strength measured at a depth of approximately 16 m due to experimental error or is this real? Provide reasons.

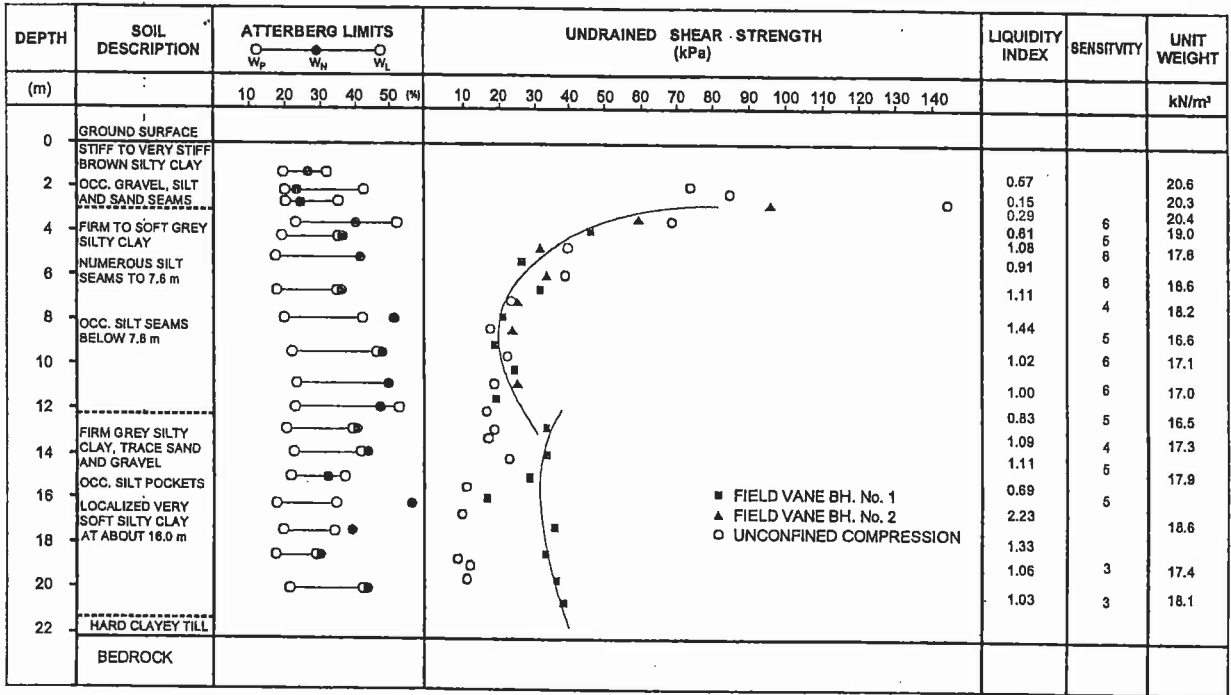


Figure Q3. Summary of results from a site investigation for Question 3.

$W_L$  = liquid limit

$W_P$  = plastic limit

$W_N$  = natural (*in situ*) gravimetric water content

END OF EXAMINATION