National Exams December 2019

18-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 an OPEN BOOK EXAM.

3. Candidates may use any non-communicating calculator.

4. Questions have equal value. The grade for each question is given. It is suggested that the candidate proportion time based on the allocated value.

5. All questions require an answer in essay format. Clarity and organization of the written answer and any figures or sketches are important.

6. The examination has an overall value of 100 Marks: 4 questions consisting of 25 Marks each.

7. **NOTE: CHOOSE ONLY 4 OF THE QUESTIONS** TO ANSWER OUT OF THE FIVE (5). IF MORE THAN 4 ARE ANSWERED, ONLY THE FIRST 4 THAT APPEAR IN THE ANSWER BOOK WILL BE MARKED.

Value

25 Marks **Question #1**

A group of geotechnical subject matter experts have gathered in order to discuss the proposed construction of a high-rise building within the limits of a Canadian city. As an Engineer that is sitting in at the meeting, your employer asks you what you believe the site investigation should entail. Describe in detail your response in terms of how you would go about planning and designing a comprehensive site investigation for this project.

10 Marks a. What would be the major topics that you would cover? i.e. What would be the major headings that would be summarized in the final geotechnical/site investigation report?

10 Marks b. Propose what resources you would require to conduct the site investigation.

5 Marks c. What would the costs associated with such an investigation be? i.e. What percentage of the overall budget should the site investigation be?

25 Marks **Question #2**

Answer the following questions as thoroughly as possible:

10 Marks a. What is the purpose of instrumentation for a site investigation?

5 Marks b. Cite and comment on 5 common instruments (or techniques) that are used for site investigations. What are they used for, specifically, and what are they trying to obtain? What geotechnical questions the instrumentation plan is trying to answer?

5 Marks c. What are the common geotechnical mechanisms that one is interested in determining as part of a site investigation?

5 Marks d. What are the primary considerations of a monitoring or instrumentation plan as they apply to site investigations?

25 Marks **Question #3**

The rock and groundwater are critical factors in foundation design and construction. Many infrastructure-related problems stem from poorly characterizing the rock formations as well as not sufficiently taking into consideration the groundwater conditions and influences.

5 Marks a. How are rock types and rock formations (rock masses) determined in the field? What are the multiple techniques available to an Engineer?

5 Marks b. How can one determine the orientation of stress in rocks? Explain why this is improtant from a site investigation persepective.

5 Marks c. What are the main factors of importance when conducting a groundwater investigation?

10 Marks d. How would one go about organizing a physical investigation of groundwater? What type of equipment would be required? What factors must be considered in the set-up of one's borehole spacing and distribution? What type of wells are required? and why?

25 Marks **Question #4**

Describe the significance of the following laboratory or in-situ tests as part of the site investigation. Describe the test/process/instrument/equipment, why/when it is applicable and the knowledge/data obtained from such an item.

All parts of this question are worth 2 Marks unless otherwise noted.

a. Cone penetrometer test;

b. Oedometer test;

c. Usage of Shelby tube;

d. Vane Test;

e. Constant Head Test;

f. Flight Augering;

g. California Bearing Ratio Test (CBR);

h. Triaxial testing;

i. Resistivity (laboratory and in field);

j. Modified Proctor Test;

k. Dilatometer test;

l. Piezometer analysis; and,

m. Sand cone and rubber-baloon tests/methods (1 Mark).

25 Marks **Question #5**

It has been determined that a 10 km subway system extension will be constructed in an urban center (large city) and will be passing under civil infrastructure, populated areas as well as environmentally sensitive regions. As such, make recommendations in terms of how to proceed with a site investigation for the following components:

5 Marks a. How many boreholes will be required? Justify your answer or cite relevant factors in this determination.

10 Marks b. How can one determine the zone of influence of the subway tunnels' excavation activities? What factors will influence this zone of influence? How can one determine the extent of this zone of influence using activities associated with the site investigation plan?

5 Marks c. Are there any differences in the site investigation plan if the material that will be excavated for the subway tunnels is soil or rock? Cite how (or if) this will affect the site investigation plan.

5 Marks d. Define "accuracy" in terms of the results of your site investigation. How can one determine the extent to which their site investigation is accurate?