

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2015 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

14-EN-A1
ENVIRONMENTAL ENGINEERING PRINCIPLES

PART I : CALCULATION (60 %)

QUESTION 1 (20 %)

The municipality of Great Water evaluates the volume of accumulated sludge in its facultative aerated ponds. Following a bathymetric analysis, it finds that the second pond should be drained this year. In an effort to meet the future requirements of the Ministère du développement durable, de l'environnement et des parcs of Quebec, the municipality wants to valorize the sludge in crop-dusting. The municipality asks you to provide a budget for pumping operations, transportation and spreading operations of liquid sludge. In addition, it wants to know the estimated time in hours required by these operations. Finally, you are asked to calculate the amount of dry solids that agricultural parcels will receive if the average dryness of the sludge is 3%.

DATA :

Pond # 2

Dimension of pond at the operation water level (58.600)

Length: 68.6 meters

Width: 45.6 meters

Slope: 3:1

Level at the bottom of the pond: 55.500

Average level of sludge: 56.750

Pumping

A slurry pump flow of 340 m³/h at 130 \$/hr

Transport

Truck capacity: 7000 gallons

Number of trucks available for the operations: 5 trucks at 120\$/h for all

The farmland is located at 14 km from the pond. (Average speed 50 km/h)

Spreading

Spreading equipment at 220\$/h

Spreading operation is performed at the same rate than sludge transportation operation.

Note

1 gallon = 3.7854 m³

QUESTION 2 (20 %)

A developer wants to develop a new residential area near a river. Regarding stormwater management, the “ministère du développement, de l’environnement et de la lutte aux changements climatiques of Quebec” asked to design a rainwater retention pond that will end to the river. The developer of the project wants you to do this task. The rainwater collection system deserves six hectares with a runoff coefficient (C) of 0.55. You opt for a permanent retention pond to create a pleasant living space in the neighborhood. This pond will be divided into two cells connected in series. The first (input cell) contains 20% of the total volume and provide a primary clarifier. You must :

- a) Evaluate the volume and dimensions of second cell of the permanent retention pond;
 - Use the rational method where the intensity of rain (I) in mm/h is $I = 43C + 5,9$.
 - In addition, the depth of the basin must be 3 meters and length/width ratio is 3: 1.
 - The basin retention rate should be 36 hours.
- b) Regarding the input cell, you have to consider a settling rate target of around 25 m³/(m²*d) for suspended solids. If we keep a depth of 3 meters for this first cell, discuss about the size of it. Justify by your calculations.
- c) Identify three pollutants to be removed from rainwater in the permanent retention pond.

QUESTION 3 (20 %)

The NetVac company operates in the field of sewer cleaning. In addition, it possesses a treatment plant of the collected materials. The company currently cleans your local network. Cleaning operations include two vacuum trucks and two sewer cleaner trucks.

Back to the treatment plant, the vacuum trucks unload their convoys to a settling pond. Determine the dimensions of the settling tank if it is desired to obtain a target settling rate of 1 x10⁻³ m³/(m²*s). The plant receives daily 20 vacuum trucks with a capacity of 13,640 liters each.

The settled sludge is sucked by a pump under the pond to be routed to a rotary press. Sludge dryness has an average of 3.5% at the entrance of the press. At the exit of the press, the cakes have an average dryness of 28.4%. The cakes will be valued in agricultural spraying. Receiving agricultural plots usually receive about 100 tons of dry matter per spreading operation. You are asked to determine how long it takes to accumulate enough sludge to make spreading operation.

Once the design and the construction of the settling pond are completed, you return to the plant to check the installations. You analyzed a sample of raw water discharged into the pond and you realize that suspended solids in the sample fall into three distinct groups. This water is composed of 25% of particles having a settling speed of 1.6 m/h, 45% of particles at 2.2 m/h and 30% of particles at 2.8 m/h. We ask you to check if your setting pond dimensions remain 100% of the suspended solids.

PART II : KNOWLEDGE (40 %)
(2% per question except when its indicate)

1. Name three undesirable regulated microorganisms that we must control at the drinking water treatment plant. (3%)
2. Why do the use of chlorine is not appropriate for disinfection of wastewater effluent at the treatment plant?
3. Name two methods used for disinfection of wastewater effluent.
4. Name three factors that influence the concentration of BOD, suspended solids and total phosphorus at the effluents from municipal treatment plants. (3%)
5. Why do we use ferric chloride or aluminum sulfate at the drinking water plant?
6. A water plant has a daily average flow of 432 m³/d and an average night flow of 208 m³/d. What can we conclude about the water distribution system and the requirement of each of the sectors of the municipality served? (3%)
7. Name two benefits of using a septic tank for primary treatment of a sewage treatment train.
8. Does a designer of a drinking water station prefers a raw water from a groundwater source or from a surface water source? Explain.
9. Name three methods of disposal sludge from municipal treatment plant. (3%)
10. Name three main gases responsible of global warming? (3%)
11. The development of resorts around Black Lake has contributed to an increase in total phosphorus concentrations measured at different points on the lake (average at 0.64 mg/L). Identify two potential sources responsible for these contributions.
12. Why do the operator of a sanitary landfill applies a layer of soil over a layer of waste? Name two reasons.
13. What chemical element is essential for aerobic decomposition of organic compounds?

14. The plastic "polystyrene" type is often overlooked by recyclers. Explain.
15. What is a life cycle analysis and what are its principles?
16. Why do we use resins such as activated charcoal or zeolite for water treatment or air treatment?
17. Name three factors influencing the biological nitrification of ammonia. (3%)