ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2022 SESSION

*** YOU MUST HAND IN THE QUESTION BOOKLET WITH YOUR ANSWER SHEET ***

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

16-CI-A5 HYDRAULIC ENGINEERING

Question 1 (30 points)

You observe the water level in a rainwater sewer through two separate manholes connected by a concrete pipe that measures 58m in length.

You determine that there is water accumulated in the upstream manhole 400mm above the crown of the sewer pipe. With the help of a land surveyor, you determine that the elevation of the invert is 23.781m.

In the downstream manhole, you note that there is only a 100mm accumulation above the crown of the sewer pipe. The invert elevation for this pipe is 23.501m.

Considering that the measured flow at that very moment is 556 liters/second, you must:

a) Produce a figure of the described situation (longitudinal profile from manhole to manhole) (5 points)
b) Calculate the slope of the energy grade line and visually identify it on your previous figure. (5 points)
c) Calculate the value of the Manning coefficient for the concrete pipe if it has a diameter of 610mm. (10 points)
d) If this same pipe is full but no longer pressurized, what would the flow rate be? (10 points)

Question 2 (20 points)

The water distribution network presented on figure 1 carries a total flow of 161.5 liters/second between points A and B.

You know that the head loss between points A and B represents 0.5m of energy and that the Hazen-Williams coefficient for the all the pipes is 130.

L_1= 10m L_2= 30m L_3= 30m L_4= 40m

D_1= 0.3m D_2= 0.1m D_3= 0.1m D_4= 0.3m

You must determine the flows and head losses for each pipe (1, 2, 3 and 4)

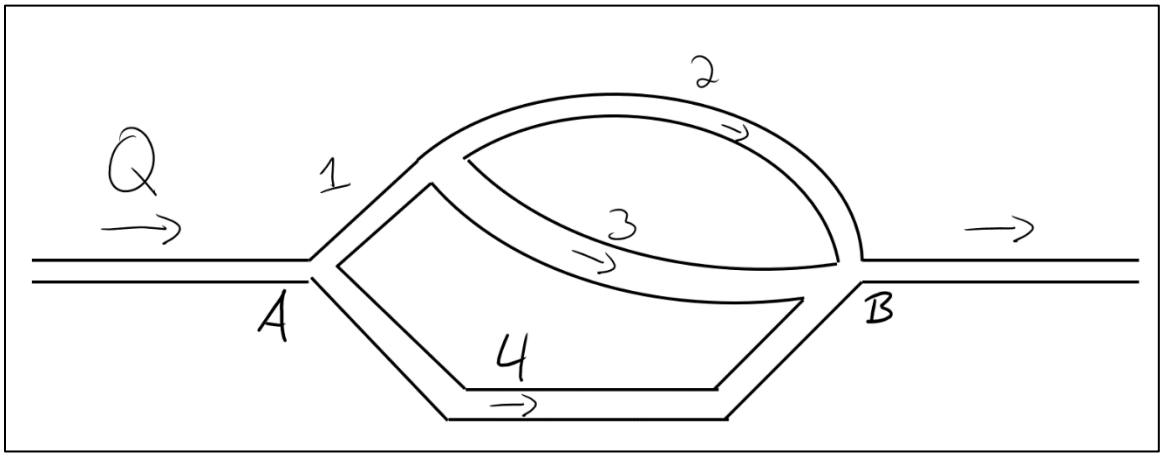

Figure 1. Water distribution network

Question 3 (20 points)

You must select a submerged centrifugal multicellular electropump for clear waters in 4" drillings from those presented on figure 3.

a) Your selected pump must supply at the very least 0.5 liters/second for the use case presented on figure 2. You must annotate figure 3 to show your selection process. (6 points)

You will also have to identify

b) the operating point and annotate figure 3 to identify it; (6 points)
c) the power output; (4 points)
d) the power input. (4 points)

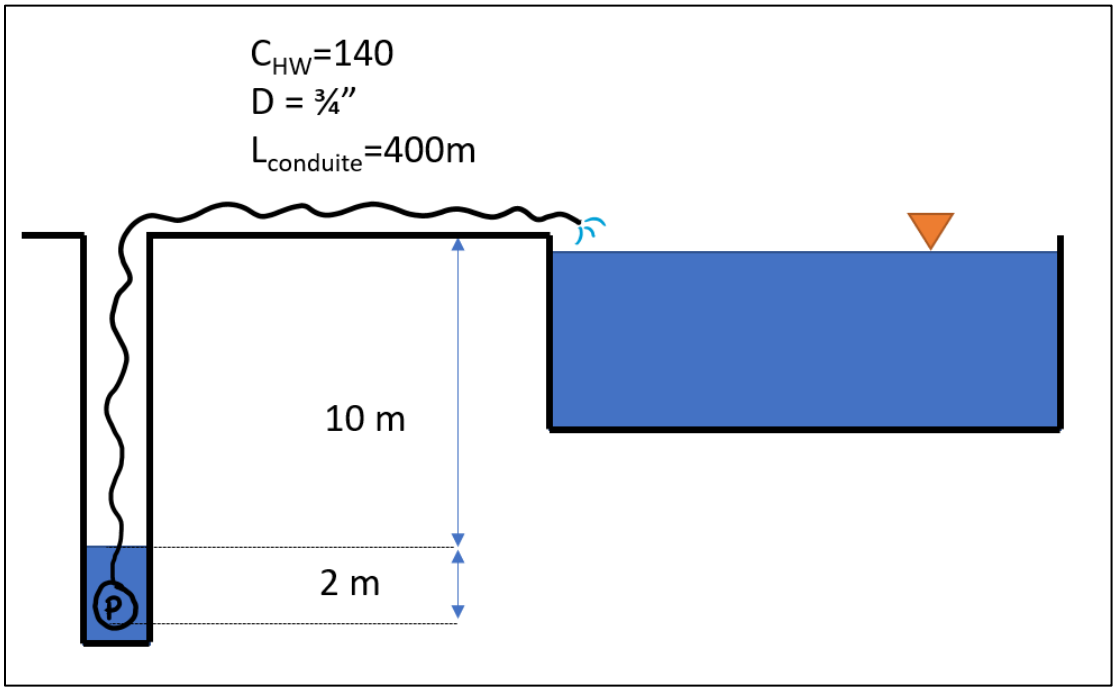

Figure 2. Pump use case

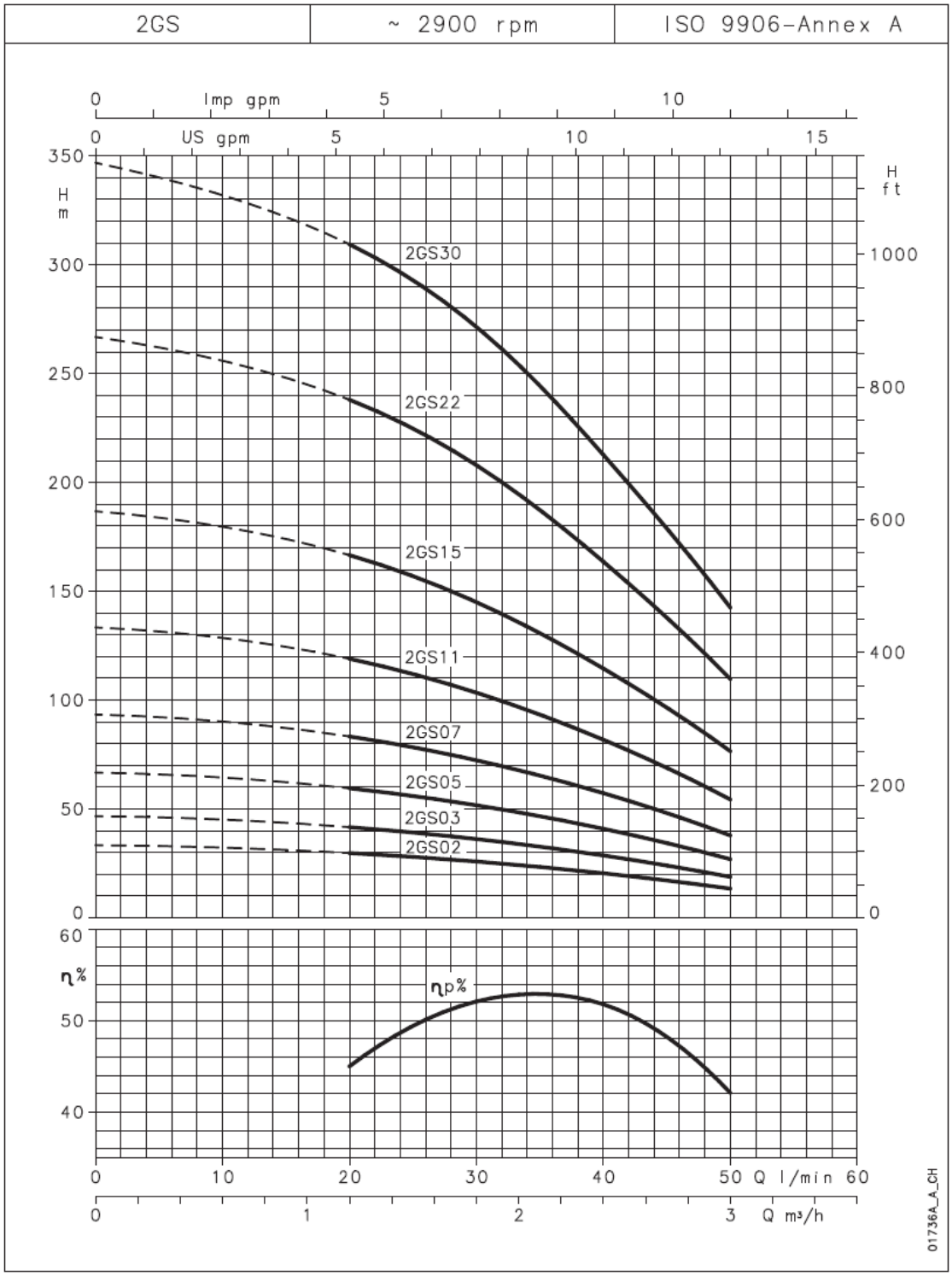

Figure 3. Pump catalog excerpt

Source : Catalogue Technique POMPES ET SYSTÈMES DE OMPAGE POUR LE GÉNIE CLIMATIQUE, L'ADDUCTION, LA SURPRESSIOND'EAU ET LE RELEVAGE DES EAUX USÉES, XYLEM (P.615)

Question 4 (30 points)

A 5-meter-wide rectangular canal has a flow depth of 2m and a slope of 0.0001. The Manning coefficient is 0.015 for the entirety of the canal.

You may consider that the flow depth is the normal depth and the flow is uniform and permanent in the initial conditions.

Following an unfortunate landslide incident, the bottom of a portion of the canal downstream has been raised, as shown on figure 4.

You must:

a) Calculate the flow in the canal for the initial condition; (6 points)
b) Determine if the flow is considered critical, sub critical or super critical; (6 points)
c) Calculate the new depths at points 1 and 2 if the flow is constant. You must annotate figure 4 and identify a new water profile for water surface. (18 points)

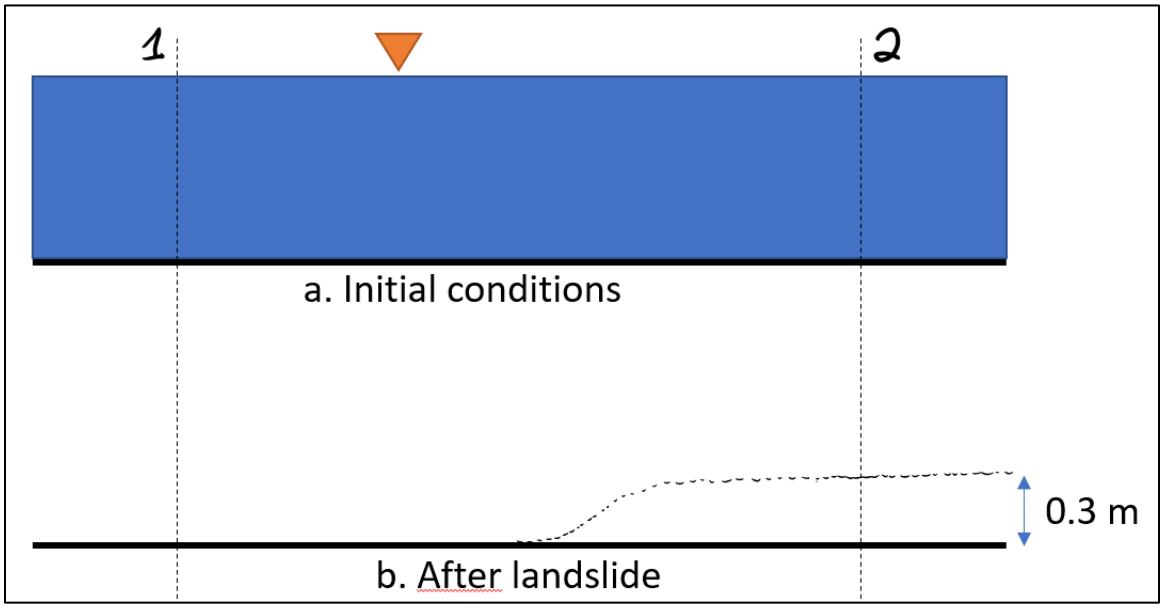

Figure 4. Longitudinal profile before and after landslide