



The degree of civilization in a community may be measured by the availability of sufficient quantity of potable water. Starting from the early civilizations that developed around bodies of water, people have diverted from rivers or drilled wells mainly for drinking and irrigation purposes. Water was stored in closed or open-surface chambers for domestic purposes, but failed to deliver it to individual consumers. With the advances in civil engineering profession, water supply facilities composed of *large and long pipeline systems* having several appurtenances are now being designed, constructed and operated. To visualize pipeline systems, a photo from Ivedik Water Treatment Plant is given in Figure 1.



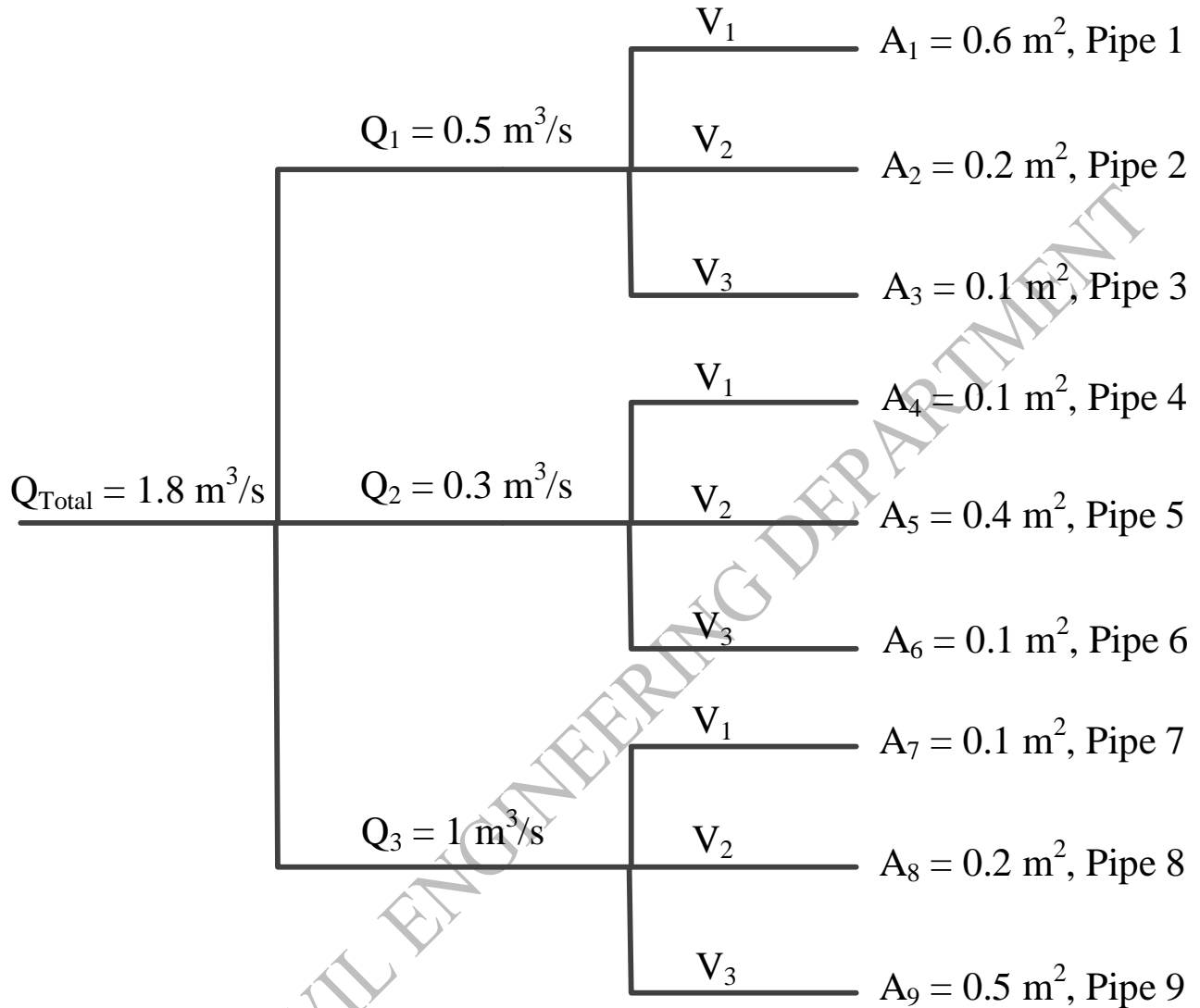
Figure 1: Ivedik Water Treatment Plant

The *CE305 Ltd.* is a company whose one of the working area is pipeline systems. To maintain the pipeline system given in Figure 2, flow velocities of Pipes 1-9 are measured periodically. Due to power cut problem, the velocities cannot be measured for a period. Your task is to find flow velocities in each pipe assuming flow velocities in Pipes 1, 4 and 7; Pipes 2,5 and 8; Pipes 3-,6 and 9 are equal using:

- Gauss-Jacobi Method
- Gauss-Seidel Method

Error tolerance is given as 10^{-5} and error is defined as: $\text{Error} = \max(|x_j^{k+1} - x_j^k|), j = 1, 2, 3$

Initial guess is given as $X_0^T = [0 \ 0 \ 0]$.

**Figure 2:** Pipeline System

Hint: For this pipeline, conservation of mass (continuity) can be written as:

$$Q_1 = V_1 \cdot A_1 + V_2 \cdot A_2 + V_3 \cdot A_3$$

$$Q_2 = V_1 \cdot A_4 + V_2 \cdot A_5 + V_3 \cdot A_6$$

$$Q_3 = V_1 \cdot A_7 + V_2 \cdot A_8 + V_3 \cdot A_9$$

Reference: Yanmaz, A. M. (2006). *Applied Water Resources Engineering*, METU Press