The project involves the design and renovation of a water charge piping process. Every group (3 students) must come up with a different design and corresponding cost. Having the same layout for plenty of groups will not be regarded as pure luck by the instructors! The project write-up must follow the outline below.

1. The pledge, stating that you have neither received nor given any help while you prepare the project except team members. Projects without pledge will not be accepted.
2. A cover page including the project title, course name (specify your group, 21 or 22) and your name with ID number.
3. A letter of introduction addressed to the instructor summarizing the project done.
4. Introduction covering the flowchart of the final design and pertinent information.
5. The design. This part includes the assumptions, related data and calculations. Try to be specific and do not miss a single detail. If you use a computer program for especially trial-error calculations, attach it to this section.
6. Discussion. This section evaluates the validity of assumptions made in the calculations or in the data used. Trying other alternatives, using different capacities and diameters of the pipes and market prices will certainly upgrade your work.
7. Conclusion. Summarize the overall design and draw it.
8. References. Give the references used in the text if you referred to any.
9. Appendix. Attach the data sheet i.e. pump operation charts, pipe characteristics, price lists etc. to this section. Use passive voice for the sentences in the text. Using a word processor for write up is encouraged but a neat handwriting will also be sufficient. The computer outputs will be checked for copy-paste sentences, thus be creative!

The project is due on ..........!
Description of the existing system and the problem

WATER TREATMENT PROCESS (Figure1)

Water at 25°C is pumped into the treatment plant from the dam through [1] rotating screens [2].

Alum is added to cause flocculation [3].

After rapid mixing (20-40 minutes), the water remains in [4] the settling basin while sedimentation of floc occurs (2-4 hours). The sediment (sludge) is pumped from the bottom of the pools and stored in holding lagoons to dry.

The softening process [5] involves the addition of sodium carbonate and hydrated lime to remove calcium and magnesium ions that are responsible for water hardness. This process takes an additional 2-4 hours.

After an additional sedimentation process [6], carbon dioxide is added to lower the pH level to approximately 7.8. Water is held in a [7] stabilizing basin for another 2-4 hours.

Water then flows through large dual media rapid sand filters made up of layers of gravel, sand, and anthracite coal [8].

Addition [9] of chlorine to disinfect the water, fluoride to protect teeth and a corrosion inhibitor take place at the end of the process before water enters [10] large underground clearwells to be held until needed by the community [11].
Figure 1. Water Treatment Process
Description of the Pipeline System

Length of the pipeline between:

- Dam – section 2 = 12 m  no elbow
- Section 2- section 3 = 4 m  involves 1 elbow
- Section 3- section 4 = 3 m  no elbow
- Section 4- section 5 = 3 m  involves 1 elbow
- Section 5- section 6 = 3 m  involves 1 elbow
- Section 6- section 7 = 2 m  no elbow
- Section 7- section 8 = 5 m  involves 3 elbow
- Section 8- section 9 = 6 m  involves 4 elbow
- Section 9- section 10 = 13 m  involves 2 elbow
- Section 10- section 11 = 16 m  involves 4 elbow

Important Explanations

- The water is drawn from dam at a rate of 200 m$^3$/h.
- All the sections of the system except section 10 are on the ground and at the same level with dam.
- Section 10 is 11 m under the ground.
- Section E is a schematic representation of water emerging to the ground. Assume that the top and the exit of this section are at the ground level.
- You don’t have to deal with the gas stream for all of the process.
- For the rotating screens in section 2 and the mixer in section 3, the loss of the system could be assumed equal to friction loss for 4 m pipeline.
What to be calculated?

Your goal is to calculate the minimum cost and best configuration with appropriate instruments, i.e. the size and type of the pipes, the type and power of the pumps, the valves, etc.

The goal is to come up with a design to satisfy the least annual total cost. The total cost is the summation of the costs of new instruments, pipeline, handling and excavation of the system, power consumption and down payment (i.e. the cost of the new system/its lifetime, watch out for different lifetime values for pipes!) on annual base. You may advise to use large diameter pipeline with less powered pumps, or use the existing pipeline with more powerful pumps along with an additional pipeline etc. Especially concentrate on pipe diameter and pump capacity, obtain different cost values for different configurations and try to find the solution with minimum cost with a graphical aid.

The considerations/regulations/restrictions in the design

(For cost evaluation, convert all prices including tax to US$ as regularly done by constructors/manufacturers)

1. Get the wholesale price list for PVC and other type pipes for different ID and maximum pressure endurance (with different wall thickness) from retail store (for best and sound market prices, the stores on Rüzgarlı sokak, Ulus, Ankara are strongly advised). For pumps with different power you might have to call or refer to special pump manufacturers in Ostim, Ankara). Demand relevant data or manufacturer’s data sheet from the seller. For valves and fittings also refer to same persons. For pipeline, another alternative is complete housing (continuous) of polyethylene for 100, 200, 300m. Although expensive, this type of pipeline will be sturdier and not require the handling cost for connection of units.

2. The wall thickness of the pipe should endure the maximum available pressure in the pipeline and should bear 40 % more than the maximum occurring line pressure. For friction factors and pressure loses, refer to your textbook or to manufacturer's data sheets if available at all. The friction factor of the PVC or PE pipe can
be taken as 75% of that of commercial steel tubing given in corresponding figure if no information about it is available. If galvanized pipe is used, again refer to the corresponding figure in your textbook and use that of galvanized pipe.

3. The lifetime of a galvanized pipe is approximately 25 years and of PVC/polymer is about 50 years. Consider whichever appropriate in terms of investment and handling costs.

4. The cost of construction/handling of PVC/polymer pipeline is approximately 10% of the material cost while galvanized is 15%.

5. The pumps used in present system are single-staged. However, for the new design you may consider the two-stage pumps if they are feasible. The efficiency of the electric motor is 98% and the pump is 65% maximum.

6. The cost of electricity is approximately 0.13 $/kW-hour. The annual maintenance cost of the pump is 3% of the initial retail price. The pipeline altogether have an annual maintenance cost of 300 $ for PVC/PE and 380$ for galvanized one.

7. Every unit and assembly except those of pipe has an approximate lifetime of 15 years, so annual down payment of the system can be assumed 1/15 th of the initial investment.

8. The charge and discharge of the storage tank should be assumed as steady state. Thus, during your calculations, keep in mind that the storage tank is always considered as full.

9. If additional valves are to be used in the new system, prefer gate valves with the same diameter of the pipeline. Check that these valves are available.

10. You are on your own to make the selection of the pipeline diameter(s) and capacity of pumps. However, of course it is wise to select a pipeline with a larger diameter to decrease the friction and in turn the pump capacity and electricity consumption. Of course, this time pipeline investment cost increases and vice versa.