

Aqueduct Design

Around the year 500 AD, the Romans built a system of aqueducts to bring fresh water from the hills around Rome into the city to supply the million or so people who lived there. The aqueducts were, for the most part, open masonry channels down which water flowed under the impetus of gravity.

A schematic picture of a run of aqueduct is shown in Figure 1. Along reasonable level sections of terrain, the open channels were built at ground level. When a hill intervened, they tunneled through it to keep the slope of the aqueduct approximately constant. Over shallow depressions, the aqueduct was elevated on arched bridge structures.

Deep depressions posed a serious problem, since Roman bridge building capability was limited. To get the water across a deep depression, they utilized what is called today an inverted syphon. The syphon system consisted of a feed tank at the upstream end, a pipe, or series of pipes supplied with water from the feed tank which carried the water down into the depression and up the other side, and a receiver tank at the pipe outlet which collected the water from the pipe(s) and fed it into a continuation of the open channel to continue its journey to Rome.

The pipes they used were made of lead, and the largest they could make appear to be about 25 cm in inner diameter with a wall thickness of about 2 cm.

Consider the case of an aqueduct system carrying one-half million gallons of water per hour crossing a depression three kilometers wide and 100 meters deep. The feed tank of the syphon system will be about 10m in elevation above the receiver tank.

You are asked to design the piping part of the system. In particular, you should specify the diameter of pipe required to maintain the flow across this depression. Recall that the maximum diameter available is 25 cm.

Plan out your approach to this design problem. Also consider why the pipe diameter was limited to 25 cm.

Reference: Smith, Norman; "Roman Hydraulic Technology; The Origins of Technology;" *Scientific American* (1997).

