DESIGN AND OPERATION OF SEWAGE TREATMENT PLANTS*

By H. A. Whittaker
Director of Sanitation, State Board of Health, Minnesota

BEFORE designing a treatment plant, a careful study should be made to determine the volume and character of sewage to be treated. When the sewers are already in use, actual measurements of the sewage flow should be made, covering a considerable period. A census of the actual number of sewer connections should be taken and a record made of the character and amount of sewage discharged from manufacturing plants, such as creameries, tanneries, gas plants, etc. The ground water flow should be measured or carefully estimated. The plant should be designed in accordance with the above data and with reasonable allowance for future growth. Where a new sewerage system is to be constructed, care should be taken to obtain good grades, whenever possible. Flush tanks should be installed wherever the grade of the sewer is such that it will not be self-cleansing at all times. The sewerage system should be so designed that the sewage will be delivered to the treatment plant in as fresh a condition as possible.

Grit and Screen Chambers

For small plants, where the sewerage system is of the separate type, removing house sewage only, grit and screen chambers may often be omitted to advantage. Grit and screen chambers are necessary where the sewerage system is of the combined type, and, when used, these chambers should be made easily accessible for cleaning.

Imhoff Tanks

(a) Settling Chambers: The settling chambers should be designed to hold the average flow of sewage for a period of two hours. Where the settling chambers are too small, the efficiency of the tank is decreased, and where these chambers are too large, fresh sewage may become septic before leaving the tank. The sloping walls of the settling chamber should be constructed as steep as possible; never less than 1.2 vertical to 1.0 horizontal, and, better still, 1.5 vertical to 1.0 horizontal. The walls should be smooth, with no projections. A baffle should be installed at the inlet end and a scum board at the outlet. These should be located approximately 1 to 2 feet from the inlet and outlet ends of the tank, respectively. They should extend across the tank and to a depth of about 12 inches below the surface of the sewage. The invert of the inlet pipe or pipes should be at an elevation of a few inches above the surface of the sewage. The inlets and outlets should be so located as to distribute the flow as much as possible across the entire section of the settling chamber. Outlet weirs should be relatively narrow. Very wide weirs are not desirable, since it is difficult to keep them clean.

(b) Sludge Compartments: The sludge compartment should be of generous size. For Minnesota conditions, where the winters are long and severe, a part of the sludge must remain in the tank for nearly a year. It is the opinion of the Division of Sanitation of the Minnesota State Board of Health that sludge compartments should have a capacity of at least two cubic feet per capita. In computing the size of the sludge compartment, only that portion should be considered that is below a horizontal plane two feet below the slot or slots in the bottom of the settling chamber. The sludge will not flow a great distance horizontally to the sludge removal pipe. In large tanks, two or more sludge removal pipes should be provided.

(c) Covering: Tanks should be uncovered. Light, easily handled, wooden covers should be provided for winter use. The entire plant should be surrounded by a tight, high ornamental fence, to keep out animals and unauthorized persons.

(d) Operation: The operation of a sewage treatment plant is a very important feature and one which is seldom given sufficient attention. A poorly designed plant under conscientious management will often produce better results than a well designed plant with indifferent management. Plants should be constructed so that all parts are easily accessible to the operator. It is frequently necessary to break up the scum which will collect on the sewage in the vents and to scrape down the walls of the settling chamber and push through the slots material which will adhere to the walls. Readings should be taken frequently to determine the surface of the sludge in the sludge chamber so as to know when and how much to remove. The sludge should be examined occasionally to determine whether or not it is acid or alkaline. An acid sludge is sour and foul-smelling and generally requires a long period for drying. Such a sludge should be treated with lime.

The operator should be provided with necessary tools and apparatus to care for his plant. The tools usually consist of a sludge scraper, used for the purpose of scraping down the walls of the settling chamber; a scum breaker, used for the purpose of breaking up the scum which may collect on the surface of the sewage in the vents; a skimmer, used for the purpose of removing to the vents scum which sometimes collects on the sewage in the settling chamber; and a sludge sampling apparatus, in order to determine the position of the surface of the sludge, and a set of Imhoff tubes with which the operator can determine roughly how the plant is operating. Each plant should be provided with a house of generous size in which the tools can be kept and in which the necessary analytical work can be performed.

Pumping Machinery

Where it is necessary to pump the sewage or the sludge by pumps driven by electric motors, the motors, switch boards, or starting rheostats should be located in a building not directly connected with any part of the sewage treatment plant, since the condensation and moisture in the winter months is very heavy on all parts of the plant directly connected with the settling or vent chambers.

Sludge-Drying Beds

Sludge-drying beds should be located as close as possible to the Imhoff tank. Where it is necessary to conduct the sludge a distance of ten or fifteen feet horizontally to the drying bed, it should be allowed to flow in open channels rather than in pipes, since long sludge pipes are likely to become clogged with dried sludge. Where the sludge is removed from the tank by gravity, the sludge pipe outlet should be at an elevation at least six feet below the sewage in the tank. The sludge should be discharged on to the bed from an elevation at least two feet above the surface of the bed so that the sludge removal pipe can be drained after each removal of sludge. The sludge drying beds should be of generous size, having an area of not less than one square foot per capita.

*Abstracted from recommendations made in a report submitted to the Minnesota State Board of Health.