type of beds, open or closed, character of sludge, and the season of the year.

4. The optimum depth to which to apply wet sludge will vary from 7 in. to possibly 16 in. dependent upon the season of the year, the moisture content and the character of the sludge. This will need to be determined for each plant.

5. Level the sludge beds as frequently as needed.

6. Remove dry sludge from the beds as promptly as possible. Do not try to produce bone dry sludge or keep sludge on beds until very low moisture contents are reached unless large bed areas are available. Remember, the purpose of sludge drying beds is to reduce the moisture content so the sludge can be conveniently removed.

7. For open beds, select sludge dosing times so as not to precede a rain, if possible, and for glass-covered beds avoid drawing during excessively cold periods of the winter.

8. Provide plenty of ventilation for glass-covered beds.

9. Do not draw sludge from the digester at a discharge rate high enough to produce funnelling, thereby loading the bed with excess water to be handled.

OPERATION OF THE NORRISTOWN SEWAGE TREATMENT WORKS *

By Frank B. Altemus

Chief Operator, Norristown, Pa.

The Borough of Norristown, Pa., completed a sedimentation plant, with separate sludge digestion, during the spring of 1932. The sewage to be treated enters through a 30-inch main, equipped with a 30-inch valve. After passing the bar screen, it flows through the grit chamber and then on to the suction well. At this point it must be lifted 20 feet to the settling tanks. From the entrance to the influent end of the settling tanks, the equipment is housed in a single, roofed building—presenting a very compact appearance to the casual observer.

Four primary settling tanks provide a retention period of 2.5 hours at a 5 m.g.d. rate. The present rate of flow is 3 m.g.d., with a morning peak load of 5 m.g. After leaving the settling tanks, the effluent passes into two contact tanks which afford a further 20-minute settling period. The chlorine dispenser is located between the effluent end of the settling tanks and the influent end of the contact tanks. The solids which are left in the settling tanks are pumped to the digestors, from which, after thorough digestion, the material is run onto sand beds by gravity. Upon these it is allowed to dry.

Management and Personnel

The chief operator is directly responsible for the operation of the sewage plant, reporting to the chairman of a councilmanic Committee

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on Public Works by means of monthly and a yearly report. Fixed operating expenses, of course, are: salaries and wages for the personnel, insurance premiums, and power bills. The combined salaries—including in addition to the stipends of chief operator, three shift operators, and a laborer, the cost of whatever extra labor proves necessary—approximate eight thousand dollars annually. Electric power service for a one year period totals five thousand dollars, and included in that figure is a charge of several hundred dollars for gas consumed by pilots on boilers, in the laboratory, and in one hot water heater connected to the shower bath installation. The insurance premiums for one year total $1,000 and cover loss incurred through wind and storm, explosion, and mechanical failures. The total for all the above charges is $14,000. An additional $1,500 takes care of miscellaneous items, such as spare part purchases, maintenance, replacements, lime, etc. Thus, the total of the year's tentative budget is approximately $15,500.

Operation

Bar Screen.—This intricate piece of mechanism does a definite job—and does it well. With the aid of a little electrical relay, it is only necessary to tell the screen to function every 30 minutes and with nothing other than a bi-monthly inspection of its contacts, cables and drums and a weekly greasing and oiling in the way of attention, it will remove screenings from the rushing sewage stream at the rate of 8.5 cubic feet per day. The cables deteriorate in time and must be replaced. During the first year of operation, considerable difficulty was experienced with the copper contacts and pigs on the electrical equipment. This trouble was directly due to the H_2S concentration in the grit chamber. A large contributor to this condition was the supernatant liquor from the digestion tanks. Two factors were involved in bettering this condition; one was the installation of a ventilating fan, and the other was the healthier condition of the digestion tanks.

Grit Chamber.—Grit and cinders are removed by means of compressed air, a circular well, and a washer. The air is supplied by a Nash HyTor unit driven by a 7½ H.P. motor. The well has a conical shaped bottom and a circular rim. When air is applied to the cone, the sewage is forced through a pipe to the washer. The washer, with a de-hydrating screw set at a definite angle, removes the accumulation of grit to a container. Experimentation has enabled the operators to schedule the grit removal for the most opportune time—daily, at average load hour. The original setup permitted too many screenings to flow through the screen. The solution to this problem was the installation of a suitable baffle in the rear of the bar screen. This unit, as a whole, gets weekly inspection.

Suction Well.—An inadvertent omission of an inspection or two so quickly and forcibly demonstrated that the float rods, used to vary motor and pump speeds in relation to sewage flow rate, were subject to caking with fats and greases, that a very rigid weekly inspection

schedule for this unit was immediately inaugurated, for reasons other than those of convenience.

Motors and Pumps.—The two 30 H.P. and the two 20 H.P. motors are air-blown, wiped, cleaned and greased once monthly. Twice yearly a complete oil change in all bearings is made. The Buffalo pumps, two with capacities of 2,100 g.p.m., and two with 1,400 g.p.m.—a total of 10 m.g.d., get a daily inspection for excessive temperatures and water pressure on packing glands. Two interesting changes, from a plant angle, occurred on the 30 H.P. motors and the sewage pumps. Considerable heat and vibration was noticed between the crown bearing and the packing gland on the pumps. The shaft was reinforced with a sleeve, water under pressure was substituted for grease at the packing gland, and the vibration ceased, temperature was normal and only a reasonable amount of packing was required.

The changes required on the motors consisted of new slip-ring heads and brush riggings. The radius of the slip rings was too small, causing the rings to become pitted. The brush rigging was too frail in construction, and would not permit a suitable adjustment of tension on the brushes. After one year of operation and many headaches, we sold the manufacturer on the idea of supplying new heads and rigging free, if the operating force made the necessary changes.

Auxiliary Power.—A 120 H.P., 4 cylinder gasoline motor is used to drive a 70 K.V.A., 440 volt, 60 cycle auxiliary generator. On two occasions, to date, failure of the commercial power supply has forced us to fall back on this unit for operating current. And it responded nobly. However, the periods of interruption were neither embarrassing nor of long duration. As a precautionary measure, weekly test runs of our auxiliary generating system are made.

Settling Tanks.—The four oblong settling tanks, each 90 ft. long, 17 ft. wide and 18 ft. deep, are equipped with Link Belt straight-line sludge collector units. Other than a bi-monthly greasing, cleaning and inspection, these, we find, need little attention. The collectors are started two hours prior to removal of sludge from the tanks, experimentation with shorter and longer periods having demonstrated that this is about right. By means of hoppers and a valve with hydrostatic head, the sludge is removed to wells, approximately 17,000 gallon being taken from a 3 m.g.d. flow of sewage. At present, we use an average of 100 pounds of lime—in a milk of lime solution—every 24 hours.

Digestion Tanks.—In the first year of operation, we called these tanks many names—but never digesters! The fresh sludge, as it enters the well, is automatically pumped to the digestion tank—a 400 g.p.m. pump driven by a 5 H.P. motor proving admirable for the purpose. Our plant is equipped with two batteries of such tanks—three tanks to a battery—and each battery has its 400 g.p.m. pump. The cutters installed on the non-clogging sludge pumps also helped to improve the situation. The tanks are 90 ft. long, 13 ft. wide and 21 ft. deep. Gas collection facilities are provided. We have very good re-

sults with our gas collection and consumption, all things considered. The yield has been very good, and the leaks plentiful. The large amount of water, plus the sulphide content, is our chief aggravation in this department. Due, partly, to our inability to maintain high flue gas temperatures, we have condensation troubles in the flues and boilers. With commercial gas, it is possible to operate the boilers a year with one cleaning. The sewage gas, by contrast, demands a boiler cleaning every three months.

Sand Beds.—There are 16 sand beds, each 125 ft. long and 12 ft. wide, eight of which are under glass and eight uncovered. Digested sludge flows over these from front to rear in a 6-inch deep layer which dries to a thickness of about 2 inches. In 1934 we produced 60 such beds of sludge. The Borough of Norristown is the county seat of an agricultural county, and this causes the disposal of the finished product to become a simple operation. The farmer makes application for one or more beds of sludge, at five dollars a bed. It is understood that this order is for the material in the enclosed house. To show our good faith we include, free, the sludge from one of the open beds with every covered bed purchased. This has a tendency to unload the uncovered beds which would be embarrassing if they could not be emptied, and also promotes sales. We have interested nurseries, golf courses, and care takers of estates. The farmer removes the material with his own laboring force and equipment. If a farmer becomes elated with the results of our product on, say, tomatoes and corn, we will disagree and claim we can't believe such a thing possible. The farmer becomes even more elated, trots in a goodly amount of his vegetables as free samples and proof, and purchases another bed!

Records

A daily log book, in which temperatures, visitors' names, and other data are entered, is religiously kept. The Penna. Dept. of Health report duplicate affords an excellent record on past operation for reference. All meters—gas, flow, elevation and electric—are read daily at midnight and all readings are recorded. Facts gleaned from the records of these readings, plus a power survey made by the plant operating force, made possible an annual saving of $1,100 in the electrical power bill. This survey was based on the known fact that electrical equipment of the induction type with a low power factor may be very inefficient. In our case readings were taken on the electrical equipment every hour. This continued until a representative load curve was made. A capacitor of correct size and voltage was installed by the operating force, and the efficiency read 99.5 per cent. The Philadelphia Electric Company made a check on the operation and rated the power bills accordingly.

When you visit Norristown, visit our plant. Inspection of our equipment will do you a lot more good than anything we can hope to set down on paper. Come around and look us over.