would therefore be appreciated that the accuracy obtained by the method was sufficiently close for that particular purpose. The fact that the survey only recorded the state of the estuary at a certain time (low water, ordinary spring tides) was not a material disadvantage to the model-work, although admittedly it made the task of assessing the accuracy of the map more difficult. It was with that in mind that the laboratory work described in the Appendix to the Paper was undertaken, when an attempt was made to assess the accuracy obtainable under ideal conditions.

The angles of inclination given in the Appendix referred to those laboratory photographs, when the camera was supported on a tripod; the aerial photographs were taken with the camera held in the hand, and no measurements of any kind were made. The actual inclination of 5 degrees mentioned in the Paper was deduced from the angle of the tracing sheet after alignment had been completed.

Paper No. 5131.

"The Treatment of Septic-Tank Effluent from a Small Community by means of an Enclosed Biological Filter at Bloemfontein, South Africa." †

By HUGH VAUGHAN DAVIES, Assoc. M. Inst. C.E.

Correspondence.

Mr. N. Paul Jasper could not agree with the Author that the type of plant described was ideal for villages of up to 500 inhabitants. For a small population the Author's scheme appeared to have too many working parts that required attention: (1) the pump for throwing the effluent up into the filter; (2) the fan for blowing air through the filter; and (3) the revolving distributor. That method of purification was satisfactory provided that the installation was large enough to allow a man or men to be employed daily to attend to the pumps, sprinklers, sludge- and humus-beds, and sedimentation-tanks. In small schemes it was unusual for one man to be daily employed, and, as a result, the installation was neglected and soon got out of order.

Mr. Jasper considered that the site should always be examined for the purpose of ascertaining the nature of the soil, and also the relative gradients of the surfaces, but the Author did not refer to those essential factors. If the soil were suitable for irrigation, with plenty of land available and

† Journal Inst. C.E., vol. 10 (1938–39), p. 55 (November 1938).

with satisfactory gradients, treatment of the sewage by either broad or sub-soil irrigation would be advisable. If the soil were unsatisfactory—being, for example, clay—but the gradients were satisfactory, then biological filters should be installed.

The Author found that the best effluent could be obtained if the tank were made to hold 1 day's flow of sewage. Further, he arranged his tank to contain three separate compartments, and to have a level bottom. Mr. Jasper's practice was to make provision for $\frac{3}{4}$ day's flow of domestic sewage, free from surface and rain water, with the object of not getting the effluent too septic, and hence too odorous; further, he did not use separate compartments, but advocated one long tank with baffles at intervals, with a 3-inch open space between the bottom of the baffles and the floor, with the latter laid to a gradient of about 1 in 7 (the deep end being at the inlet end). Assuming the tank to be 50 feet long by 4 feet 6 inches wide, with an average depth of 5 feet 6 inches the inlet end would be 9 feet deep and the outlet end 2 feet deep. The baffles, in addition to the open spaces of 3 inches below them, would have 1-inch horizontal slots at various levels between the floor and the water-line.

The first baffle would be 4 feet 6 inches from the inlet pipe. In that compartment the greater bulk of the solids of the sewage was collected and formed a scum, which, after it had got rid of its gases, fell to the bottom of the tank as sludge.

The bottom of the first compartment was constructed somewhat in the nature of a cone, from the bottom of which a 4-inch cast-iron pipe was carried up on the side of the tank to an outlet junction 2 feet below the water-line, from where it was carried through the wall of the tank and fitted with a valve in an inspection chamber. At intervals of 2, 3, or 4 months, as was found best by experience, the valve was opened, with the result that the water-level of the tank fell and forced up the accumulated sludge, which then travelled to the sludge-drying beds if sufficient fall were available. As soon as sludge ceased to flow, and liquid only was escaping, the valve was again shut, and the work of sludging was over for another 2, 3, or 4 months.

The second baffle was 15 feet away from the first, and the third another 15 feet away, so in all there would be three compartments of 15 feet and one of 4 feet 6 inches, and the thickness of the baffles made up the total of 50 feet. The baffles were constructed of creosoted planks fixed loosely in vertical channels and pinned down to prevent them from floating. That method of dealing with the sludge obviated the objectionable manual removal of the sludge (p. 56§). The scum and sludge which collected in No. 2 compartment was thinner and less in volume than that in compartment No. 1, and that Nos. 3 and 4 was again very much less; the sludge was removed, if necessary, by squeegees, operated from manholes

§ Page numbers so marked refer to the Paper (Footnote (†), p. 273).—SEC. INST. C.E.

placed in the tank cover mid-way between the baffles, pushing it back into No. 1 compartment. In suitable positions the tanks might be covered with 9-inch by 3-inch planks laid across the width of the tanks so that the planks could be removed for easy working of the squeegees.

The inlet-pipe to the tank was similar in construction to that shown by the Author, but it only dipped 3 inches below the water-line, and immediately beyond was fixed a board dipping 4 inches below the invert of the inlet-pipe, with the object of spreading the incoming sewage across the whole width of the tank. At the outlet end of the tank a level weir was fixed, and immediately in front of it a scum board was placed dipping 6 inches below the weir-level. The object of the weir, the scum boards, and the slots in the baffles was to allow, as far as possible, the sewage to flow across the whole width of the tank, and so to prevent any "dead" spots.

Mr. Jasper usually arranged such a tank to deliver into a chamber fitted with an automatic siphon, or siphons; if the gradients would allow, that chamber might be 8 feet square and the effluent 17 inches deep, so that the chamber would hold 542 gallons, or little over one-eighteenth of a day's flow. If the gradients would not allow of the 17-inch depth of effluent it could be reduced by as much as 5 inches. In that case the superficial area of the siphon chamber could be increased to give the required volume, and two 7-inch siphons, working simultaneously, could be fixed instead of one 10-inch siphon.

On the discharge of the tank by means of the automatic siphon, or siphons, the effluent was delivered into a channel at right angles to the tank, 35 feet long and 3 feet deep with a 6-inch half-channel at the bottom, and concrete benchings, so that the channel at the top might be 1 foot wide.

At right angles to that channel 4-inch cast-iron pipes were fixed through a funnel-shaped opening, and carried through the enclosing wall of the channel and laid horizontally across the filter. The pipes were each carried through the far end of the filter-bed enclosing wall, and were fitted with a screwed plug. Those pipes were drilled at 6-inch intervals, the holes being above the horizontal diameter and $\frac{1}{4}$ inch in diameter internally, increasing to $\frac{1}{2}$ inch diameter externally.

The filter bed itself was composed of hard clinker of varying sizes, coarse at the bottom and finer towards the top. The bed was 35 feet long by 25 feet 6 inches wide on the inside of the enclosing walls, and the clinker media had an average depth of 4 feet 9 inches, and was deposited on the usual draining tiles laid with a fall of 6 inches across the width of the bed to a number of 4-inch pipes carried through the outlet end wall of the filter, to deliver to the land for final treatment.

The channel into which the contents of the automatic tank was delivered was provided with framed wooden covers or with cast-iron grease-seal manhole covers. The distributing pipes were also covered with boards laid parallel on top of the pipes and covered with small-size clinker to a depth of 9 inches.

On the discharge of the siphon in the automatic tank, the effluent ponded up in the channel and provided a head which caused the effluent to discharge through the holes in the distributing pipes, in the form of a cascade over the whole of the surface of the bed, which, if held up, would have a depth of approximately 1½ inch. The effluent falling through the media drove the air enclosed in the bed before it, and out through the 4-inch pipes, and atmospheric pressure forced air through the fine clinker and open joints of the boards of which the bed was covered. In that manner the bed was supplied with air to carry on its work of purification of the effluent. No objectionable smell was observed from the filter, as even when the siphon was discharging the channel covers and boards covering the filter and clinker over them prevented the escape of objectionable odours.

The effluent passing through the 4-inch outlet pipes of the filter was made to deliver, if the gradients allowed, into a system of sub-irrigation drains surrounded with rubble or clinker and covered with soil to a depth of from 2 to 3 feet, and in that manner the effluent received its final treatment. If sufficient area of land were not available for that final treatment, the effluent had to discharge direct into a ditch, stream, or river. In such a case, if the gradients allowed, two beds should be provided; if, for example, 10,000 gallons of sewage were to be dealt with, two filters each having half the capacity of the filter described should then be installed, and the effluent from the first filter should deliver into a second automatic siphon-chamber, complete with channel and distributing pipes, so that the effluent might pass through two bacterial filters before discharge.

It would be noticed that there were no moving parts, and, instead of having only a few sprinkling holes in the revolving distributor described by the Author, there were approximately 1,600 sprinkling holes, and those were so formed that with the minimum of attention they never became choked with colloidal matter. The enclosed filters were free from objectionable odours and flies, and were not prevented from working during periods of severe frosts, as were small open revolving distributors.

The percolating filters could be free from enclosing walls if the gradient of the ground were sufficient, but in such cases channels would have to be provided for holding up the effluent from the siphon-chambers, in order to provide a head on the effluent, and to allow the pipes to discharge as a cascade over the area of the filters; further, piers would have to be provided for holding up the sprinkling pipes so as to keep them level.

The "Prüss" filter described by the Author contained 50 cubic yards of media for the treatment of 10,000 gallons of effluent per day; that was to say, 200 gallons of effluent per cubic yard per day, whereas the filter Mr. Jasper had described could treat 60 gallons of effluent per cubic yard per day, the effluent being from domestic sewage free from surface water or rain.

The Author made no reference to the disposal of rain- or stormwater, and Mr. Jasper concluded that he provided only for the purification of the water-borne domestic sewerage of the military encampment of 500 men on the outskirts of Bloemfontein. In the type of plant described by Mr. Jasper, stormwater tanks and sewers would be provided to comply with the requirements of the Ministry of Health, and to prevent scouring of the sedimentation tank, which would have passed the accumulated sludge in the tank on to the filter bed and choked it.

⁂ Owing to the outbreak of hostilities, the Author's reply has not been received in time for insertion here. It is hoped to publish it later. —SEC. INST. C.E.

Paper No. 5156.

"Model-Experiments on Bellmouth and Siphon-Bellmouth Overflow Spillways."†

By GEOFFREY MORSE BINNIE, M.A., Assoc. M. Inst. C.E.

Correspondence.

Mr. W. J. E. Binnie, President, observed that, owing to the rare occurrence of floods of any great magnitude, it was seldom that an opportunity arose of comparing actual results with those predicted by model-experiments, and therefore the following information might be of interest.

A bellmouth overflow discharging into a tunnel was constructed to dispose of flood water at the Burnhope reservoir, the overflow being designed to deal with a maximum quantity of 2,670 cusecs, whilst the effective length of the crest was 154 feet. When the reservoir overflowed the water passed over a weir 200 feet in length and entered the channel leading to the bellmouth. The water flowing from the tunnel entered a basin, finally discharging into the river over another weir 110 feet in length. Self-recording instruments were established so that H was measured for both weirs and the bellmouth.

Model-experiments were carried out to determine the coefficient C in the formula $Q = CLH^{\frac{3}{2}}$, where L denoted the length of the crest and H the depth of overflow. A flood occurred on 24th and 25th October, 1936, when the maximum value of H recorded at the bellmouth reached 1·7 foot. The crest of the 200-foot weir was similar to one which had been tested in America * and the crest of the 110-foot weir was similar to one which had been tested in Egypt ‡. The coefficients determined by those experiments were therefore adopted, and the mean value of the

† Journal Inst. C.E., vol. 10 (1938–39), p. 65 (November 1938).
* "Water Supply and Irrigation," U.S. Geological Survey, Paper No. 200, p. 109.
‡ Report on Submerged Weirs and Standing Wave Weirs, Diagram VII, Type No. 9. Government Press, Cairo, 1923.