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FEDERATION OF SEWAGE WORKS ASSOCIATIONS

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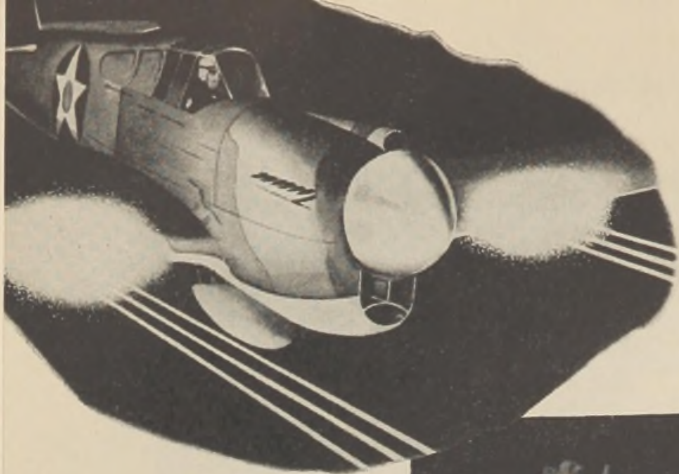

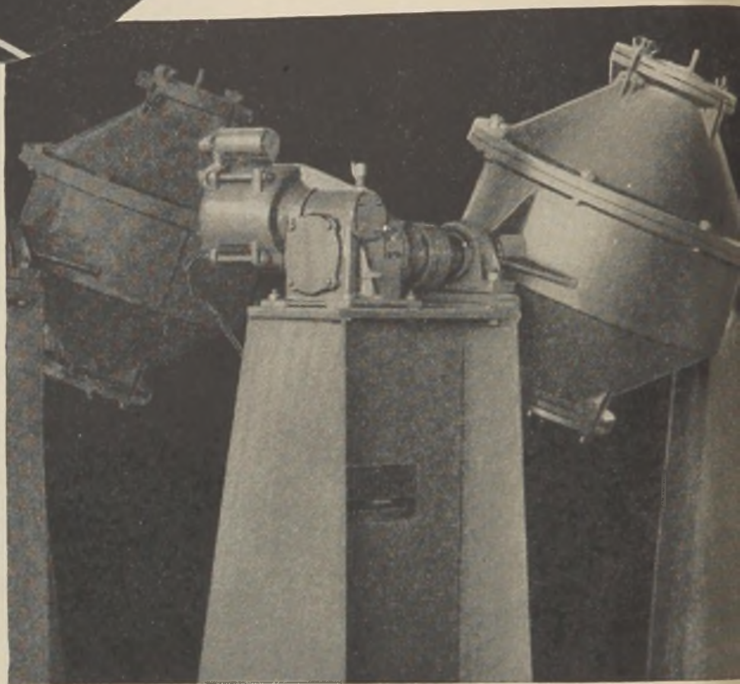

sion Office was created and the South Atlantic Division Office moved from Richmond, Virginia, to Atlanta, Georgia. In the near future the Southwestern Division and Ohio River Division Offices will probably be moved to the city having Service Command Headquarters.

On July 15, 1942, the basic reorganizational directive took effect. The Corps Areas became the Service Commands. Under this reorganization the Division Engineer has been placed on the Staff of the Service Commander as Director of Real Estate, Repairs and Utilities. All directives pass through the Service Command. The Services of Supply Organization Manual includes Army Regulations No. 100–80, revised August 10, 1942, on Repairs & Utilities. The regulations include the assignment of responsibility at Army Posts within the Continental United States, authority for emergency work, annual estimates, request for funds, distribution of funds, military and civilian personnel, records and reports, accountability, purchasing and contracting, construction and maintenance, equipment and special purpose vehicles and channels of communications.

The Tentative Repairs and Utilities Regulations comprising Chapter XII, Orders and Regulations, Corps of Engineers, were revised on July 28, and several revisions have occurred since then. Duties and responsibilities have been clarified as based on some seventeen (17) months' experience all in keeping with a decentralized policy. The regulations carry a provision setting up the sections of the Division Engineer Office similar to those in the Office Chief of Engineers. Greater stress has been placed on close contact of the officers and engineers of Division Offices with the Posts to "shoot trouble" rather than "trouble shoot." Authority for recommendation and action is being decentralized to save time, reduce paper work and permit the engineer, if he is competent to make the field study originally, to cause the necessary action to be initiated.

Since the authority for new construction by the Corps of Engineers does not rest with the Service Command, a policy has been established which is as follows: When the Area Engineer certifies that construction and utilities of military cantonments is complete and the Division Engineer takes over the operation of the post, no arguments ensue as to whether the job is completed or not, although some deficiencies may be filed. If construction is found unsatisfactory, it is the task of R & U (the Post Engineer) to alter the physical plant so it will function properly; Engineer Service Army funds are used for this work. In the present fiscal set-up the Office Chief of Engineers authorizes expenditure of funds allotted to the Division Office for non-recurrent items above $10,000. Recurring items are administered entirely within the Division Office.

The R & U Branch, OCE, is continuing engineering investigation on special operating problems common to or confronting a number of posts and rendering technical assistance to the Division Offices when requested. Every effort is being made to operate the Washington Office with a small number of officers, engineers and professional men.

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Plant Operation

SHORE POLLUTION REDUCTION AT SAN FRANCISCO *

By Charles Gilman Hyde

Consulting Sanitary Engineer, Department of Public Health, San Francisco

Foreword.—Sewerage improvements, including sewage treatment and disposal, are presumably undertaken with the expectation that some definite benefit will accrue. Without such a salutary result the effort and expenditure involved would not only be meaningless but would represent a positive loss. Fortunately, in most instances, the benefits are positive, although perhaps incapable of being calculated in money terms. Rather are they to be reckoned in terms of greater hygienic safety, or a cleaner environment, or both.

It is wise for any community which has made its investment in improved sewerage, and undertaken to meet the annual costs of the thereby increased obligations, to review the results from time to time and determine what advantages have been secured and what sort of a dividend is being obtained. This paper attempts to indicate the sewerage improvements which have recently been made in San Francisco, to state the immediate purpose thereof, and to show what results have been achieved.

This writer has been able to discover little or no positive evidence that typhoid fever or other water-borne diseases, or ill health in general, have followed the use of sewage polluted water for swimming or other recreational purposes. That the theoretic possibility exists must be conceded. It probably is in the public interest to assume that danger lurks in such practices.

Quite aside from such considerations, a clean environment is worth having for its own sake. There is no cleaner large group of people in the world than that resident in the United States. Enormous amounts of money are spent annually by Americans on soap for laundry and bath, and on the dry cleaning and pressing of wearing apparel. People who are willing to spend such enormous sums for personal cleanliness and appearance are or should be willing to spend the amounts necessary to provide for that degree of environmental cleanness which is obtainable through adequate sewerage and rational sewage treatment.

History of Sewage Conditions and Improvements

From the beginning of sewerage in San Francisco the sewage has been disposed of by dilution in Pacific Ocean, Golden Gate Strait and

* Presented at the Fifteenth Annual Fall Convention of the California Sewage Works Association, Los Angeles, Sept. 21, 1942.

San Francisco Bay. Prior to 1899 when C. E. Grunsky, as City Engineer, made his justly famous study and report on sewerage conditions, with recommendations as to improved sewerage (1), the sewers generally had been built in haphazard fashion and carried to the most convenient points of outfall regardless of esthetic or sanitary considerations. It has been stated that there were some 125 separate sewer outlets at that time (2). Under the Grunsky plan the sewage of the city was to be concentrated at six main outfalls located between China Point, at the extreme southeast city limit on San Francisco Bay, and Mile Rock, at the extreme northwesterly limit of the city near Point Lobos. Point Lobos may, perhaps, be considered as the place of demarcation between Pacific Ocean and Golden Gate Strait.

The Grunsky report served to call the attention of the citizens to the gross mistakes and inadequacies of the existing sewerage systems, if indeed they could be called systems. It also served as a guide to new construction and the rehabilitation and reconstruction of the older sewers.

During the 20-year period ending in 1935 approximately $17,500,000 was expended on the construction of new sewers and the replacement and extension of old sewers (2). None of this money was expended for sewage treatment. Shore conditions were, however, improved by the elimination of numerous outfalls. The situation at Bakers Beach was temporarily bettered by conveying the sewage concentrated at this point to deep water through an 18-inch cast-iron outfall 800 feet long. Unfortunately this pipe line developed a number of breaks which essentially destroyed its utility.

In 1938 the City Engineer, John J. Casey, reported that a program designed to satisfy only the more pressing needs of the sewerage system with respect to the extension of necessary main sewers, and the replacement of obsolete existing sewers, would entail an expenditure of not less than $13,000,000.

At that date many of the existing sewers were still inadequate, many were in a deplorable physical condition, and the separation of sanitary sewage from storm drainage was greatly needed in certain sections of the city. That situation still obtains.

On November 7, 1933, the citizens voted P.W.A. sewer bonds in the sum of $2,625,000 to provide certain essential sewerage improvements and a limited amount of sewage treatment. The sum nominally available for the latter undertaking, including the elimination of certain outfalls by pumping the sewage to other points, was $1,300,000. The actual sum finally expended was approximately $1,580,000.

Under a Department of Public Works Order approved July 25, 1934, a board of consulting engineers was appointed to determine and recommend the most suitable program of sewerage improvements and sewage treatment which would restore the beaches and coastal waters to a safe and attractive condition. This board, consisting of the late Harrison P. Eddy, Charles G. Hyde, Clyde C. Kennedy and Leon B. Reynolds, rendered its report in May, 1935 (3). Its work was ably assisted by the City Engineer, John J. Casey, by W. H. Ohmen, Chief of Design, and by Benjamin Benas, Sanitary Engineer.

The Board reported that the sewage of the city was being discharged from six sewerage districts with many points of outfall. As a matter of fact there were 31 outlets discharging sewage at the shore line or into small estuaries and channels. The latter were located along the east shore on San Francisco Bay. Of the 31 outfalls, there were 19 along the Bay shore, 11 along the north shore on Golden Gate Strait, and but one on the west coast, Pacific Ocean. This was located at the extreme southwesterly corner of the city's incorporated area, later herein referred to as the Vista Grande outfall.

The Board of Consulting Engineers recommended a program of sewage treatment and disposal which, if adopted, would reduce the number of outlets to four and would provide adequate treatment at each of these locations. The four selected outfall and treatment sites were as follows: (*a*) a treatment plant in Golden Gate Park with discharge through the existing Mile Rock outfall; (*b*) a treatment plant in the vicinity of Piers 37 and 39, with discharge into San Francisco Bay through a submerged outfall with terminal diffuser-nozzle field in 60 feet of water 2000 feet off shore; (*c*) a treatment plant at Hunter's Point with deep outfall off shore; (*d*) a treatment plant and off-shore outfall at Visitacion Valley (China Point). The Board advanced the conclusion that, with the completion of the recommended works and their faithful and efficient operation, the sewage of the city would be disposed of in as effective and economical manner as possible having due regard for the suitable protection of the beaches and shore waters from sewage pollution.

In view of the fact that the nominal sum of $1,300,000 was then available for sewage treatment, or its equivalent in terms of removal from shores which were in immediate need of pollution abatement, the Board recommended that the money be expended for pumping the sewage of the Marina district eastward to a point of discharge in the slip between Piers 37 and 39 at North Point, so called, and that all of the sewage of the Bakers Beach, Richmond and Sunset districts, comprising nearly all of the northwesterly and westerly portion of the city, be concentrated in the southwesterly corner of Golden Gate Park, there be treated suitably, and the effluent be discharged through the existing Mile Rock outfall situated about midway between Point Lobos and Lands End.

As the next step, urgently required but for which no funds were then available, the Board recommended the treatment of the sewage concentrated at North Point and its disposal in San Francisco Bay as indicated above. This project was estimated to cost $2,250,000. Later, but less immediately urgent, the concentration and treatment of the sewage of the southeasterly portion of the City at two locations, as previously described, was recommended.

At that time the sewage of Daly City, Colma and a small section in the extreme southwesterly part of the city, was being discharged directly at the shore line through an outfall known as Vista Grande.

This condition still exists and doubtless causes shore pollution through a limited distance northward along the San Francisco coast line. Fortunately, from a sanitary standpoint, this section is restricted as to public use since it forms the western boundary of a military reservation. It is proposed eventually to pump this sewage into mains leading to the Richmond-Sunset sewage treatment plant.

Under the bond issue above mentioned the city has constructed the Marina pumping plant and force main to North Point, the Richmond-Sunset sewage treatment plant (4), (5), (6), and the Sea Cliff pumping station and force main. Sewage from the Bakers Beach district is diverted for the most part by gravity through a tunnel and connecting sewer to the Richmond-Sunset plant. The Sea Cliff pumps discharge into that tunnel the last remaining relatively small volume of sewage which formerly had fouled the shore waters and strand of Bakers Beach.

A sewer bond issue for $5,000,000 was lost at the polls in 1937 and another for $4,200,000 was defeated in 1938.*

Use of Shores and Beaches

San Francisco's shore line has a length of approximately 23 miles. Scattered along this reach are some 16 recreational beaches, large and small. Only two of these are on San Francisco Bay. There are 13 on Golden Gate Strait, east of Point Lobos.

Some of these beaches are relatively large and accessible. One in particular, that extending in an unbroken stretch for five miles southward from the Cliff House, is truly magnificent. In its northerly portion it is flanked by the Esplanade and Great Highway and has become famous as one of the truly great recreational beaches of the world.

These beaches are places of resort on all pleasant days throughout the year, but naturally and more particularly during the warmer season from April to October, a period of seven months.

Because of the low temperature of the water the extent of swimming is relatively small in comparison with that from the beaches of Southern California. However, swimming is indulged in as a sport and is especially favored from the beaches and coves of Golden Gate Strait and San Francisco Bay where the water is somewhat warmer, or is thought to be, the undertow less, and the protection from wind better. Otherwise all of the beaches are used for wading, fishing, boating, sunbathing and picnicking.

Investigations of Shore Water Conditions

Long before the sewerage improvements herein described were undertaken, it had of course been realized that the shores and shore waters were grossly polluted. This was manifest from the fecal and other sewage matters to be found on the beaches and in the coves and because of the very noticeable sewage fields offshore. These conditions

* Neither of these issues made provision for sewage treatment at North Point.

had been so long existent that the citizens had grown complacent about them. Moreover, they had never known anything better.

Realizing that such foul conditions were not in the public interest, Dr. J. C. Geiger, Director of Public Health, determined to attempt to rouse the city from its lethargy in this matter. In 1931 the principal beaches and coves were quarantined against swimming and warning notices were published in the daily papers. This excited some interest but not enough. It was therefore determined: (*a*) to conduct a year's study of the bacterial condition, as related to sewage organisms, *Bact. coli,* of the coastal waters along the west and north shores, where most of the utilized beaches are located, in order to have positive and irrefutable evidence of the nature and degree of pollution; (*b*) to publicize the findings as these accrued.

Under the immediate direction of A. B. Crowley, Chief Inspector, 18 representative sampling stations were carefully selected between the Funston Life Guard Station on Pacific Ocean and Pier 45, east of Fishermans Wharf, at the extreme easterly end of Golden Gate Strait. Shore samples were collected weekly at each station for a period of 52 weeks from February 6, 1933 to February 7, 1934. The results of this survey, which demonstrated gross pollution, particularly along the north shore, were widely heralded and at length succeeded in rousing the citizens to action. The effect was manifest in the ballots cast for the P.W.A. Sewer Bond election of November 7, 1933, above referred to (7) (8).

The Marina pumping plant was completed on May 18, 1937, and went into full and uninterrupted operation on July 1 of that year. The Richmond-Sunset sewage treatment plant was completed on January 30, 1939, began operating on March 1, and went into full and uninterrupted operation on May 1, 1939. The Sea Cliff pumping station began continuous operation on March 16, 1941.

In order to determine the effectiveness of these sewerage improvements, particularly as related to the Pacific Ocean beach, the Department of Public Health inaugurated a series of shore water samplings at five of the 18 stations previously employed in the 1933–34 survey. These were begun on March 5, 1940 and are still being continued. To date, 105 sets of samples have been collected and analyzed in the Health Department's laboratory. Military restricted areas were set up early in the current year which reduced the number of these sampling stations from five to three.

Improvement in Bacteriological and Other Conditions

The present discussion of the specific improvement of shores and shore waters will be restricted to the Pacific Ocean strand. The reason for this lies in two facts. A patent one is that the bacterial sampling of 1940–41–42 has been confined to that stretch of shore line. The second reason, which has also determined the current sampling schedule, is that the proposed North Point treatment and disposal works are still a matter of future design and construction. The population now sewering to that location is approximately 460,000. This figure does not include the transient population represented by the large registry in hotels nor the important suburban groups employed in the commercial and manufacturing establishments of the district. As already stated, the sewage from this large population is discharged at the shore line and is carried by the tides back and forth along the north shore, probably causing more or less serious pollution as far westerly as Fort Point and the Golden Gate bridge. Until the sewage treatment and disposal project recommended for this district is carried through, completely satisfactory conditions as related to shore and shore water pollution in the reach under consideration cannot be expected. However, in this connection it truthfully can be stated that the conditions along the north shore as far east as Fort Mason, and including the Marina district, have been vastly improved due to the undertakings above described as having been carried through under the recommendations of the Board of Consulting Engineers in its Report of May, 1935 (3).

The studies of the period February 6, 1933 to February 7, 1934, for the five sampling points along the Pacific Ocean shore from the Funston Life Guard Station on the south to a point near the Cliff House on the north, gave results, as related to the presumptive presence of *Bact. coli*, as shown in Table I.

TABLE I.—*Presumptive Numbers of Bact. coli per Cubic Centimeter in Pacific Ocean Shore Waters, San Francisco, Prior to Recent Improvements in Sewerage and Sewage Disposal*

Representing 52 Weekly Samplings, February 6, 1933 to February 7, 1934. Sampling and Laboratory Analyses by San Francisco Department of Public Health.

No.	Station Location	Numbers of *Bact. coli* per c.c.		
		Average	Maximum	Minimum
1	Funston L. G. Station	9.6	69	0.0
2	Sloat Boulevard	18.1	240	0.0
3	Quintara Street	68.0	2400+	0.1
4	Lincoln Way	102.6	2400+	0.0
5	Balboa Street	128.8	2400+	0.0
All		65.6	2400+	0.0

The studies of the period March 5, 1940, to date have shown the presumptive presence of *Bact. coli,* reported as numbers per cubic centimeter, by years and for the entire period, as presented in Table II.

As already indicated the greater use of the beaches and shore waters in the San Francisco area occurs during the warmer dry season, a seven-months period from April to October. For this reason it is of interest to examine the bacterial condition of the Pacific Ocean shore water during that specific period. This has been done and with results which are presented in Table III.

TABLE II.—*Presumptive Numbers of Bact. coli per Cubic Centimeter in Pacific Ocean Shore Waters, San Francisco, Subsequent to Recent Improvements in Sewerage and Sewage Disposal*

Representing 105 Series of Sampling in 1940, 1941 and 1942. Sampling and Laboratory Analyses by San Francisco Department of Public Health.

Year	*Bact. coli* per c.c.	Stations *					
		1	2	3	4	5	All
1940	Aver.	2.7	1.7	16.5[a]	0.6	2.0	4.7[b]
(43 samplings)	Max.	69.0	24.0	690.0	6.9	69.0	690.0
	Min.	0.0	0.0	0.0	0.0	0.0	0.0
1941	Aver.	13.3	6.4	15.5	7.2	20.4[c]	12.6[d]
(45 samplings)	Max.	69.0	69.0	240.0	69.0	690.0	690.0
	Min.	0.0	0.0	0.0	0.0	0.0	0.0
1942	Aver.	—	9.7	5.2	—	4.3	5.6
(17 samplings)	Max.	—	69.0	24.0	—	24.0	69.0
	Min.	—	0.2	0.2	—	0.2	0.2
The Period	Aver.	8.1	4.9	14.4[e]	4.0	10.3[f]	8.4[g]
(105 samplings)	Max.	69.0	69.0	690.0	69.0	690.0	690.0
	Min.	0.0	0.0	0.0	0.0	0.0	0.0

[a] Average = 0.5, omitting a single high count in 43 samples.
[b] Average = 1.5, omitting a single high count in 215 samples.
[c] Average = 5.2, omitting a single high count in 45 samples.
[d] Average = 9.5, omitting a single high count in 225 samples.
[e] Average = 7.8, omitting a single high count in 103 samples.
[f] Average = 3.7, omitting a single high count in 104 samples.
[g] Average = 5.6, omitting two high counts in 487 samples.
* For location of stations see Table I.

No total counts of bacteria growing on standard agar at 37 degrees C. were made on samples collected during the 1933–34 survey. These determinations have been included in the survey begun in 1940 and now continuing. Although it is recognized that the bacteria in question have little, if any, direct sanitary significance, their absence, or presence in relatively small numbers, implies a clean water. On the other hand, if a water contains great numbers of such organisms, the implication may well be that it is at least dirty, speaking bacteriologically; if not actually harmful. As a matter of interest, perhaps academic in this case, Table IV, herewith, has been prepared to present the results of the counts of total 37-degree bacteria in the entire group of samples collected during the period under review and, also, the results of counts on samples collected only during the April–October periods of the three years 1940–42.

Discussion of Bacteriological Findings

The survey of 1933–34, whose general results are summarized in Table I, was made prior to the sewerage and sewage disposal improve-

TABLE III.—*Presumptive Numbers of Bact. coli per Cubic Centimeter in Pacific Ocean Shore Waters, San Francisco, Subsequent to Recent Improvements in Sewerage and Sewage Disposal*

Representing 76 Series of Samplings During the Seven-Months Periods, April–October, of the Years 1940, 1941 and 1942. Sampling and Laboratory Analyses by San Francisco Department of Public Health.

Season Apr.–Oct.	*Bact. coli* per c.c.	Stations					
		1	2	3	4	5	All
1940	Aver.	2.9	1.4	0.4	0.3	0.3	1.0
(31 samplings)	Max.	69.0	24.0	2.4	2.4	2.4	69.0
	Min.	0.0	0.0	0.0	0.0	0.0	0.0
1941	Aver.	12.5	5.7	16.7	9.0	27.0[a]	14.2[b]
(29 samplings)	Max.	69.0	69.0	240.0	69.0	690.0	690.0
	Min.	0.1	0.0	0.1	0.1	0.1	0.0
1942	Aver.	—	8.7	3.9	—	4.1	5.6
(16 samplings)	Max.	—	69.0	24.0	—	24.0	69.0
	Min.	—	0.2	0.2	—	0.2	0.2
3 Seasons	Aver.	7.5	4.5	7.4	4.5	11.4[c]	7.2[d]
(76 samplings)	Max.	69.0	69.0	240.0	69.0	690.0	690.0
	Min.	0.0	0.0	0.0	0.0	0.0	0.0

[a] Average = 3.3, omitting a single high count in 29 samples.
[b] Average = 9.5, omitting a single high count in 145 samples.
[c] Average = 2.2, omitting a single high count in 75 samples.
[d] Average = 5.2, omitting a single high count in 344 samples.

TABLE IV.—*Total Numbers of Bacteria per Cubic Centimeter at 37 Degrees Centigrade in Pacific Ocean Shore Waters, San Francisco, Subsequent to Recent Improvements in Sewerage and Sewage Disposal*

Representing 105 Series of Samplings in the Years 1940, 1941 and 1942 and 76 Series During the Seven-Months Periods, April–October, of Those Years. Sampling and Laboratory Analyses by San Francisco Department of Public Health.

Period	Total Bacteria	Stations					
		1	2	3	4	5	All
Entire	Aver.	91	145	1,070[a]	114	189	327[b]
	Max.	1,500	5,000	100,000	1,000	5,000	100,000
	Min.	1	1	1	1	1	1
7-Mos.	Aver.	75	156	1,430[c]	77	196	410[d]
	Max.	1,500	5,000	100,000	1,000	5,000	100,000
	Min.	1	1	1	1	1	1

[a] Average = 96, omitting a single high count in 104 samples.
[b] Average = 122, omitting a single high count in 487 samples.
[c] Average = 75, omitting a single high count in 75 samples.
[d] Average = 120, omitting a single high count in 344 samples.

ment whose benefits, as related to a clean shore water and shore environment, it is the purpose of this paper to explore.

The results of this survey will first be reviewed as a whole. The figures in Table I disclose the general fact that the pollution of the

Pacific Ocean shore water, as indicated by the average presumptive numbers of *Bact. coli* per cubic centimeter therein for each of the five sampling stations, was progressively greater according to the proximity of the Mile Rock sewer outfall. While the average condition of the water at the Funston Life Guard Station, Station 1, was within the usually accepted standard for salt water outdoor bathing, this average was very far above that standard at Balboa Street, Station 5, a point about 5,000 feet, by way of the shore line, southwesterly of the Mile Rock outfall.

However, a review of the laboratory findings on each of the samples collected during the survey shows that the increasing averages of *Bact. coli* numbers, from Station 1 to Station 5, was due to a few samples only which showed heavy pollution.

A striking condition, apparently without any obvious explanation, was found to exist during the seven months period, April to October, 1933. During this time no increase was found in the numbers of *Bact. coli* present in the water as the Mile Rock sewer outfall was approached, with the exception of Station 5, at Balboa Street, where a single sample, indicating 2400 + *Bact. coli* per cubic centimeter, raised the average very materially. Omitting this sample, the average number found at Station 5, Balboa Street, was no greater, for example, than that at Station 2, Sloat Boulevard, much further south.

Including the findings on all samples collected at the Stations under review, it will be seen from the figures presented in Table II that there has been a marked reduction in station averages of *Bact. coli* numbers per cubic centimeter during the period March 5, 1940 to date as compared with the average 1933–34 survey figures. This statement considers the surveys of 1933–34 and of 1940–date as two complete units. For some reason not apparent the conditions in the years 1940 and 1942, each taken as a whole, are shown to be considerably better than in 1941. This condition obtained, also, during the April–October period of 1940, and the April-date period of 1942, as compared to the April–October season of 1941.

It seems to be safe to say that, with the exception of some apparently temporary badly polluted conditions, the Pacific Ocean shore waters of San Francisco were so good, prior to the recent sewerage and sewage disposal improvements, that the opportunity for betterment was not large or striking. However, a material betterment in terms of uniformly good conditions has been effected. Including all samples of the 1940–42 period the average presumptive numbers of *Bact. coli* for all stations under review has been well below the generally accepted standard of 10 per cubic centimeter for outdoor salt water bathing purposes. The conditions during the April–October periods were even better. The general average numbers of *Bact. coli* per cubic centimeter were 8.4 and 7.2, respectively.

Moreover, it is significant that, excluding very high numbers (690 per cubic centimeter) in two out of the 487 samples represented in the

1940–42 series, the water was practically uniform as between the several stations. See Tables II and III.

With our present knowledge it is difficult to interpret the significance or implication of the total numbers of bacteria developing on agar at 37 degrees Centrigrade. The figures are presented in Table IV. It would appear that these numbers, with one exception, have been satisfactorily low.

Physical Conditions of Shores

The physical condition of all of the north and west shore line of San Francisco from Aquatic Park to Fleishhacker Pool has been rendered vastly better, in fact fairly satisfactory, due to the sewerage and sewage disposal improvements described herein. As for the Pacific Ocean beach its physical condition, in relation to pollution by the city's own sewage solids, would seem to be well nigh ideal.

Items for Consideration and Discussion

The general problem of the determination of the values which accrue from improved sewerage and the introduction of sewage treatment works and, further, the proper methods of approach to that problem, would seem to be matters which might well be reviewed by a group such as our California Sewage Works Association. Some of the questions which could perhaps be considered and discussed with profit are:

(*a*) How much is a clean public environment (in contrast with the personal or private environment) worth, expressed in both social and economic terms?

(*b*) Are citizens willing to make large expenditures for environmental cleanness, as related to their communities, for the same fundamental reason that they willingly expend large sums and much personal energy, upon keeping themselves, their apparel and their domiciles clean; or is the public environment too remote?

(*c*) To what extent are polluted outdoor salt bathing waters concerned with the public health, and what are the corroborative data?

(*d*) Is it in the public interest to argue a public health menace due to shore and shore water pollution in the absence of substantiating vital statistics; or are such data available?

(*e*) Is a standard of 10 *Bact. coli* per cubic centimeter in such waters most rational; and to what extent has it been definitely tested?

(*f*) Does the total bacterial count on standard agar plates incubated at 37 degrees centigrade have any relationship to what may be termed the general cleanness of the water; and, if so, what are the tolerable limits?

(*g*) To what extent have bacterial surveys been made to determine shore water pollution reduction through sewage treatment and improved outfall conditions; and what have been the results?

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THE BIOLOGY OF SEWAGE SPRINKLING FILTERS *

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As everyone familiar with sprinkling filter operation knows, the filter bed is teeming with life. The society of organisms making up the biota of a filter bed is as complex and sometimes almost as fathomless as our own human society. Yet, if we study the individual components of the filter, we may better understand the process. Then, with a knowledge of the organisms doing the work expected of a filter bed, we will not only have the academic satisfaction of realizing what is going on, but we will be better equipped to meet filter bed troubles as they occur.

The organisms concerned are represented by the *Bacteria, Fungi, Algae, Protozoa, Nematoda, Rotatoria, Chaetopoda, Crustacea, Arachnida* and *Insecta.* Each group is represented by one or many types which are in turn represented by further subclassifications. The interrelationships between the various organisms are of several kinds. There is not only a keen competition for the available food in sewage, but for the food concentrated in the forms of the next smallest or weakest organism. The products given off by one organism may be toxic for a second organism or it may be a stimulant to a third organism in the form of a food supply. Furthermore, one organism may live directly on or even in another organism and either help it or kill it. In general, then, each group must play its part lest the preceding or following group be affected.

What is the composition of this complex society of organisms? This may be answered by noting the changes that occur when a bed is first put into operation. After sewage has flowed over the stones for some time, a slippery, thin, transparent gray or tan film appears. Microscopic examination of the film reveals that the film is made up of countless bacteria embedded in a clear gelatinous matrix. Investigation has shown that 300 million (1) bacteria are present in a cubic centimeter of some filter growths. Some masses will apparently be shapeless, but in others the examiner will note under the microscope that the mass has a primitive organization in that finger-like projections are present. Figure 1 shows a mass having a peculiarly high type of organization. Incidentally, the same zoogloeal type of bacteria plays an important role in the activated sludge process, but there the bacteria move through the sewage, while in a filter bed the sewage flows around the stationary bacteria.

The zoogloeal bacteria are aided by various other bacteria which have specific functions and are located at levels in the bed where specific environmental conditions suit them. For example, there are sev-

* Reprinted from the Proceedings of the Twenty-seventh Annual Meeting of the New Jersey Sewage Works Association, held March 5–6, 1942.

eral sets of bacteria largely responsible for the breaking down of nitrogenous compounds and for the stabilization of the by-products and end products of these bacteria. In the filter the real nitrification occurs when the essential food, ammonia, is available to specialized bacteria. *Nitrosomonas* oxidize the ammonia to nitrites. The final step is accomplished by *Nitrobacter,* which further oxidize the nitrites to nitrates. This latter step will take place only when all putrescible matter has been removed from the vicinity of the *Nitrobacter.* It is logical to assume that these nitrifying bacteria occur in vertical steps or zones in the filter. A similar set of associations exists in stabilizing the sulfur compounds with specific sets of bacteria attacking sulfur, sulfides and sulfates. Add to the above the bacteria involved in the assim-

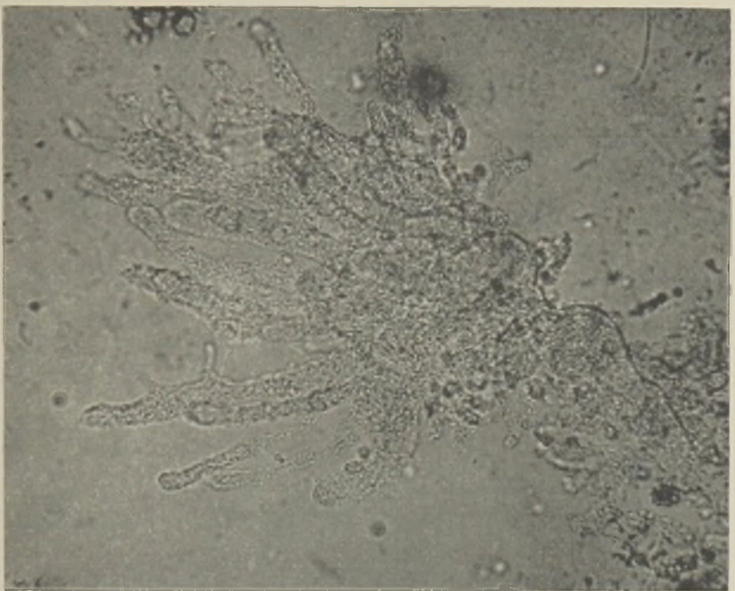

FIG. 1.—Zoogloeal mass of bacteria.

ilation of or close relationship with iron and manganese and those bacteria especially suited for breaking down cellulose and other compounds.

To continue with the building up of the stone film, we notice that as sewage comes into contact with the zoogloeal film, colloids and small particles of solids are attracted and become attached to the film. Since bacteria are able to utilize only dissolved solids, enzymes are exuded from the bacterial cells which liquefy the solids. The material thereby dissolved is then utilized by the bacteria after passing through the cell wall. This process accounts, in part, for the reduction of non-settling fine solids in the filter. It must be understood, however, that not all the zoogloeal bacteria are attached. Some masses move through the filter with the sewage flow and enmesh solids, colloids and bacteria.

Filamentous bacteria such as the sulfur bacteria, *Beggiatoa,* the iron bacteria, *Sphaerotilus* and *Cladothrix,* and related stringy growths soon attach themselves to the sewage solids. Figure 2 shows *Sphaerotilus* filaments attached to a solid accumulation. This cottony layer of filamentous bacteria causes clumps which, if conditions are right for rapid growth, will tend to clog the filter.

Patches will occur in certain spots where velocity of flow, food, light, etc., are satisfactory. These growths form micro-strainers through and around which sewage must pass and certain suspended and dissolved sewage constituents are removed. Figure 3 is that of *Sphaerotilus.* Some idea of the size may be had by knowing that each filament has a diameter of about one micron or 1/25,000 of an inch. Literally, millions of these small filaments may be present in a fraction of a cubic

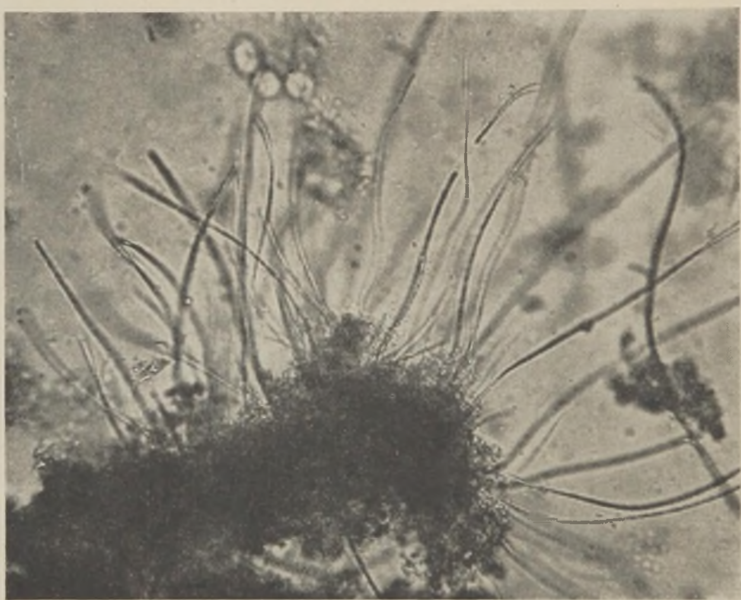

FIG. 2.—Sphaerotilus filaments attached to solids.

centimeter of slime. This photo was made at a magnification of 280 times.

Figure 4 of the same organism made at a magnification of 700 times shows the simple organization of the bacteria placed end on end to form the filament. The separations between the cells are not too apparent, but can be made so by staining with an iodine solution. This is shown in Fig. 5.

Thus far, only bacteria have been considered. When the sewage introduces the spores and mycelia of fungi, including molds and yeasts, we have keen competitors for a place in the filter. Both the type of bacteria present and the fungi are stimulated by continuous aeration and use, in general, some of the same food materials. Which of the two—bacteria or fungi—will take the ascendency is probably a function of the temperature, or of certain intermediate decomposition products of bacteriological action or the combination of the two. At any rate,

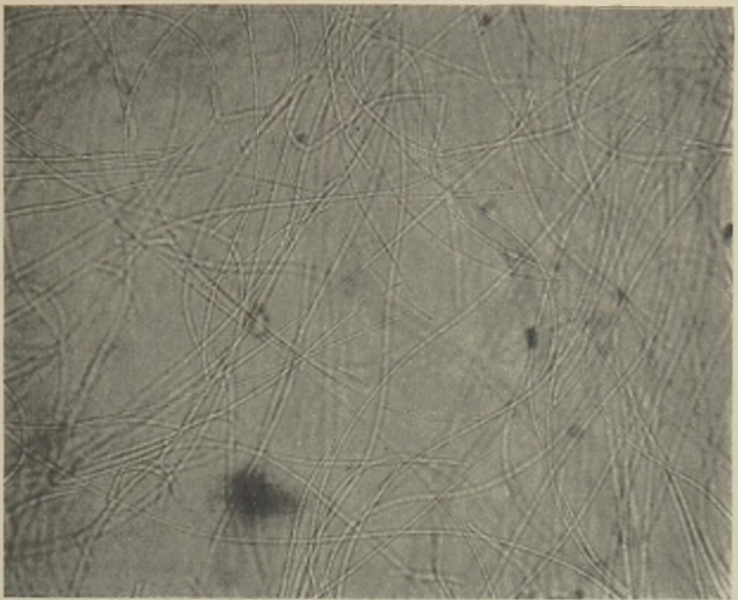

FIG. 3.—Sphaerotilus magnified 280 times.

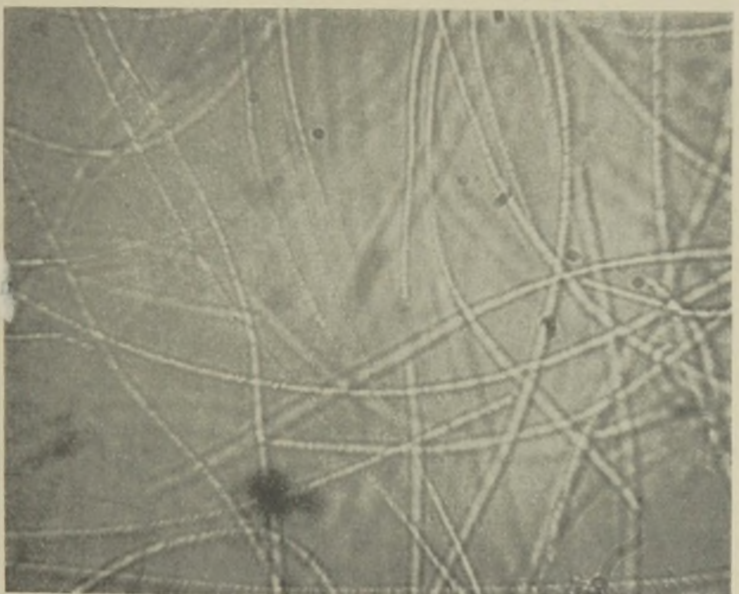

FIG. 4.—Sphaerotilus magnified 700 times.

operators have observed that fungi are nearly always present in the winter but scarce in the summer. Fungi play an important role in holding the zoogloeal film together by growing their branched mycelia through and around the film. Thus, as the weather becomes colder in the fall of the year, fungi reproduce and grow at an accelerated rate at the expense of the bacterial population, which is normally reduced in activity two or three fold for each 10° C. drop in temperature. With reduced biological activity, solids accumulate in the stone film. It would be expected that the thick and heavy film would loosen from the stone, but this is prevented by the fungal holding net. However, in the spring the warmer weather favors the bacteria at the expense of the fungi, and the net gradually gives way and sloughing occurs. Of

Fig. 5.—Cells of sphaerotilus filaments.

course other organisms take part in the sloughing process, but it is believed that fungi play the leading role.

Figure 6 shows *Fusarium,* a mold that is usually found in the upper parts of the filter just beneath the surface stones. The magnification is 280 times.

The mold shown in Fig. 7 is a species of *Leptomitus,* which is identified easily by the characteristic pinching-off of the hyphae which are thin and at times ribbon-like.

Another species of *Leptomitus* is shown in Fig. 8 at a greater magnification to show the pinched hyphae. This is a method of forming new hyphae.

Nature has provided still another competitor in the form of protozoa. These one-celled animals are of three general groups. They first obtain food by ingesting living organisms as well as small organic

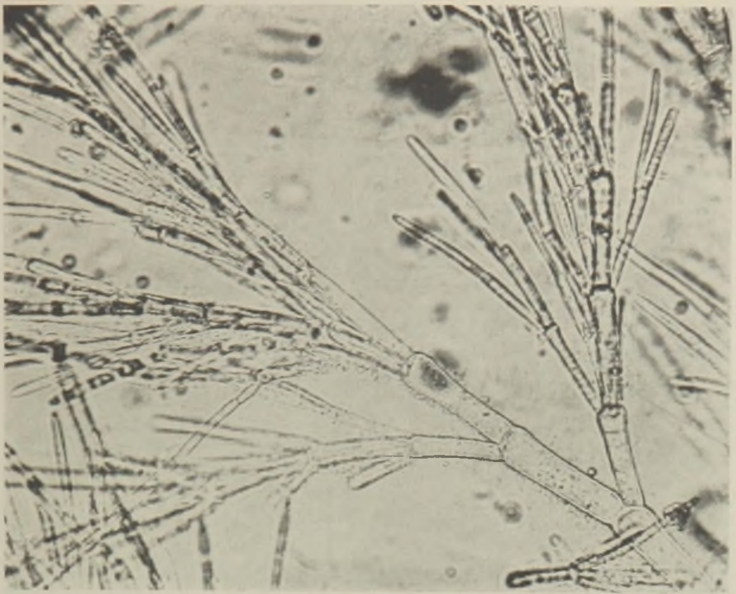

FIG. 6.—Fusarium.

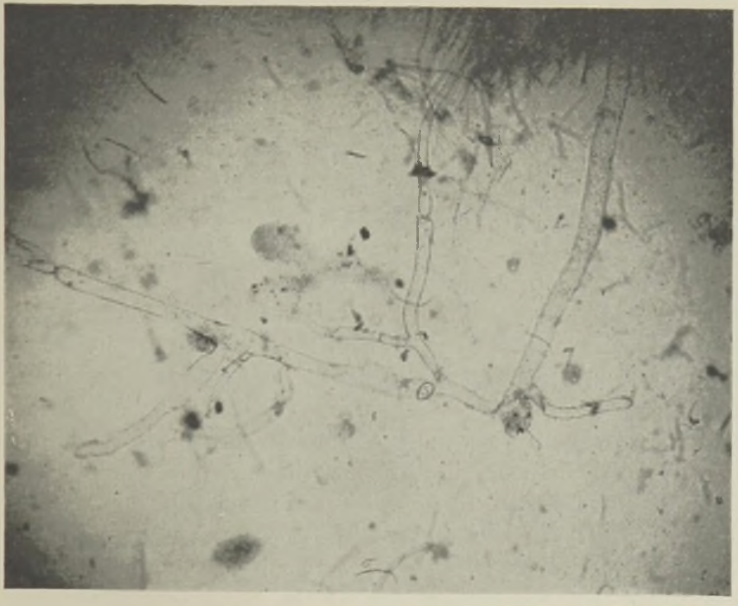

FIG. 7.—Leptomitus.

particles. These are the holozoic feeders. The second group, the saprozoic feeders, can utilize only that material which is already in solution. The third group, the holophytic feeders, derive food and energy by the manufacture of chlorophyl in the presence of sunlight. To insure the protozoans of a place in the competition, nature has also provided another super group whose members can obtain food in the manner of the last two groups.

All groups are represented by three classifications of protozoa found in filters; namely, the classes *Ciliata, Mastigophora,* and *Sarcodina.* The numbers and types of these protozoans vary from season to season in the filter bed and generally prefer the upper levels. The protozoans most often observed in filter slime samples are usually *Epistylis* and

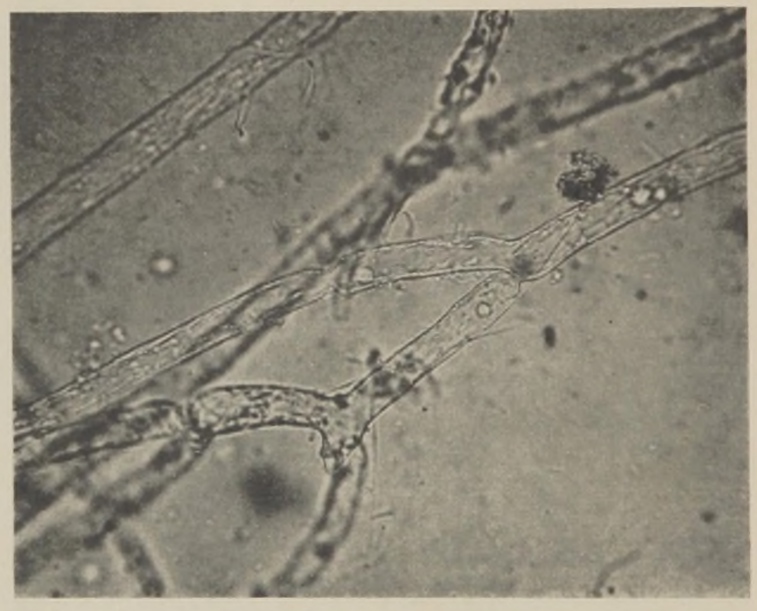

FIG. 8.—Pinched hyphae of Leptomitus.

Opercularia, both ciliates. The protozoan in Fig. 9 is *Epistylis,* a colonial ciliate. Notice the oral groove through which the bacteria and other material pass into the zooid. When open, the zooid takes on a bell shape.

Figure 10 represents a small colony of *Epistylis.* Some colonies cover the entire microscope field at this magnification—56 times.

Figure 11 shows a zooid group of another colonial ciliate, *Opercularia,* with one of the zooids having its operculum extended. The difference between *Epistylis* and *Opercularia* lies, among other characteristics, in the fact that the operculum of the latter occupies only a small portion of the opened end of the zooid, while *Epistylis* has an operculum extended full across the open end.

Another characteristic of *Opercularia* is the pucker of the front end of the zooid (Fig. 12).

TABLE VIII.—*High Capacity Filter Sewage Treatment Plant, Post XXVI*

Biochemical Oxygen Demand Analysis

Date	Flow M.G.D.	Recir. Flow M.G.D.	Total Flow M.G.D.	Pop. Equiv.	5 Day Biochemical Oxygen Demand								
					Raw			Settled		Filtered		Final	
					P.P.M.	Lbs.	Lbs. Cap.	P.P.M.	Lbs.	P.P.M.	Lbs.	P.P.M.	Lbs.
Mar. 3	0.664	0.858	1.522	9,582	310	1,710	0.178	138	1,750	139	1,760	35	193
6	0.807	0.897	1.704	9,571	228	1,530	0.160	103	1,460	99	1,400	67	450
9	0.743	0.887	1.630	9,551	244	1,510	0.158	135	1,830	78	1,060	54	334
12	0.665	0.877	1.542	8,466	340	1,880	0.222	133	1,700	124	1,590	51	282
15	0.589	0.916	1.505	8,615	286	1,400	0.163	81	1,010	38	475	20	98
18	0.797	0.897	1.694	9,862	294	1,960	0.197	125	1,760	55	775	26	172
21	0.715	0.858	1.575	10,128	165	980	0.097	71	930	38	497	30	178
24	0.702	0.858	1.560	9,974	238	1,385	0.138	124	1,610	66	855	40	233
27	0.665	0.877	1.542	8,728	281	1,550	0.178	112	1,440	45	580	28	155
30	0.706	0.916	1.622	9,000	252	1,480	0.165	180	2,430	112	1,510	51	299
Average	0.705	0.884	1.589	9,347	264	1,539	0.165	120	1,592	79	1,046	40	239
Jan. Ave.	0.640	0.844	1.484	6,922	270	1,439	0.206	138	1,697	109	1,336	46	252
Feb. Ave.	0.688	0.895	1.583	8,909	304	1,730	0.193	151	1,996	101	1,322	48	258

Suspended Solids Analysis

Date	Suspended Solids								
	Raw			Settled		Filtered		Final	
	P.P.M.	Lbs.	Lbs. Cap.	P.P.M.	Lbs.	P.P.M.	Lbs.	P.P.M.	Lbs.
Mar. 3	420	2,310	0.241	142	1,800	121	1,530	56	310
6	345	2,310	0.241	129	1,830	200	2,830	33	220
9	450	2,780	0.291	140	1,900	220	2,980	40	247
12	280	1,550	0.183	120	1,540	300	3,850	46	254
15	370	1,810	0.210	132	1,650	286	3,580	41	200
18	395	2,610	0.265	140	1,970	302	4,260	40	265
21	410	2,400	0.240	138	1,810	200	2,620	48	286
24	380	2,220	0.222	140	1,810	289	3,750	42	245
27	400	2,200	0.252	128	1,640	200	2,570	30	166
30	390	2,290	0.255	132	1,780	275	3,720	38	223
Average	384	2,248	0.240	134	1,773	239	3,169	41	242
Jan. Ave.	322	1,713	0.245	172	2,134	226	2,791	44	238
Feb. Ave.	316	1,792	0.202	128	1,687	175	2,306	51	295

tion. Aerobic digestion of solid matter must be taking place on the rocks of the filter.

With this type of flow diagram, using recirculation of all final settled sludge, it appears that the correct design and operation of settling tanks

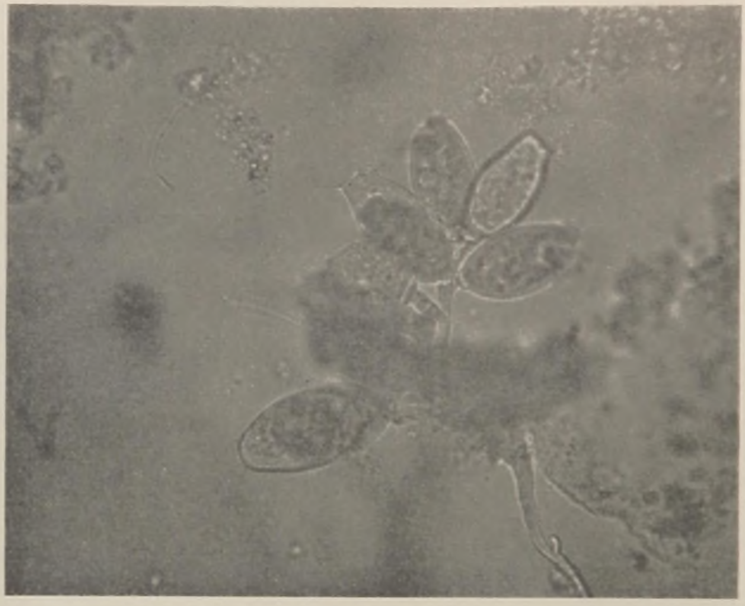

FIG. 11.—Opercularia showing operculum.

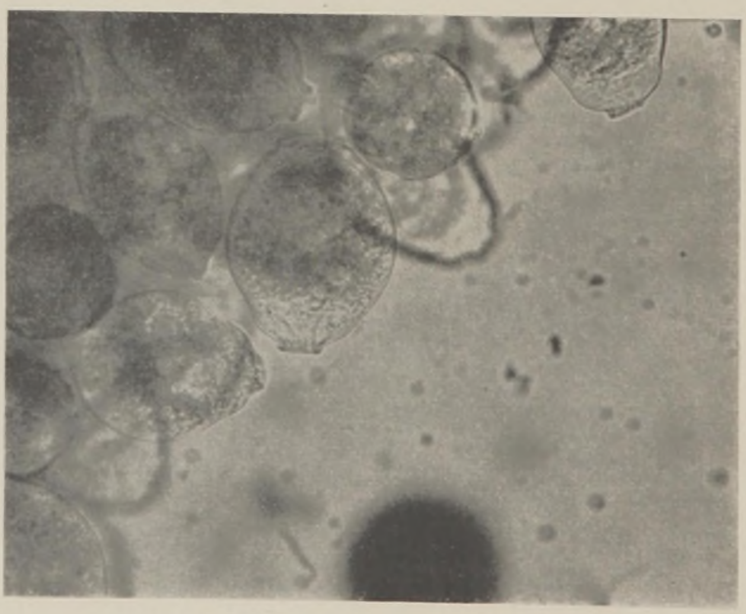

FIG. 12.—Opercularia showing pucker at front end.

Opercularia has been found in numbers reaching hundreds of thousands per cubic centimeter (2) of filter slime, particularly in the colder months of the year. Figure 13 shows a number of free swimming protozoans, of which there are many usually present at one time or another of the year in the filter bed. The photo was taken to illustrate the alga spread through the foreground, but the focus was better on the protozoans.

Since the protozoans ingest bacteria and solids, they play a role in purification. The chief purification factor involved lies in the ability of these protozoans to cause a rapid turnover in the bacterial population. Through various effects, such as toxic by-products, strain senility, etc., the bacteria tend to reach a numerical limit in a specific environment after which little or no bacteriological oxidation occurs.

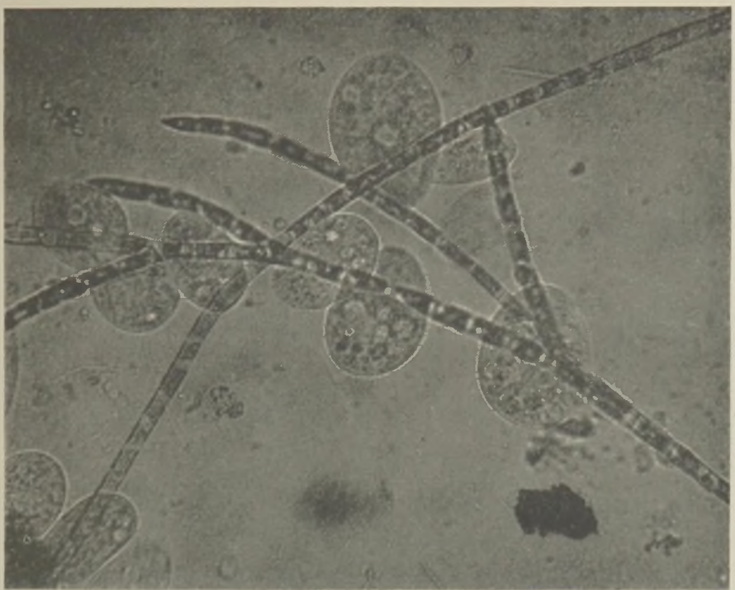

Fig. 13.—Free swimming protozoa.

The reduction of bacterial numbers by protozoa causes increased bacterial reproduction and multiplication, and, therefore, an increased rate of oxidation. Here again, is nature's way of assisting the weakened winter bacteria population, since the chief bacteria ingesting protozoa maintain their highest general level of numbers in the cold months.

We still have not accounted for the worms in the filter. The most prolific worms are the nematodes, the so-called thread worms or round worms (Fig. 14). These are more or less cylindrical, unsegmented worms and are rarely longer than two or three millimeters, or approximately ⅛ of an inch. The worms are comparatively colorless and transparent and exhibit a continuous lashing motion from birth to death. They are natural inhabitants of the soil, but find an excellent habitat in a sewage filter. Soils experts (3) estimate that the top 6 in.

of an acre of ordinary soil is shown by statistical calculations to reach thousands of millions of individuals. Furthermore, a single female may produce hundreds of thousands of eggs. The sewage filter probably harbors equivalent numbers of worms and eggs. The amount of organic matter that is undoubtedly stabilized by the nematodes must be considerable when the great numbers and unceasing activity are taken into account. On the whole, their presence in a filter is beneficial.

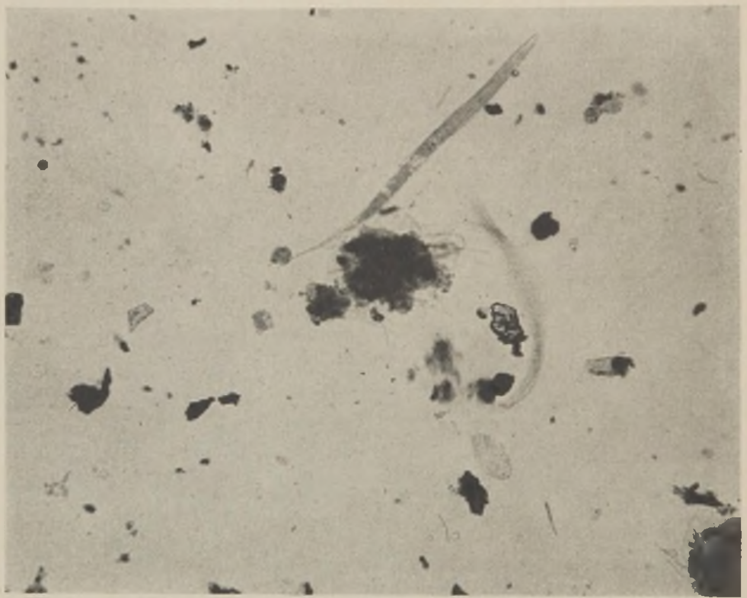

FIG. 14.—Nematodes.

The *Nematoda* should not be confused with the *Chaetopoda* (Fig. 15), otherwise known as bristle-bearing worms or aquatic earthworms. This type of worm is segmented and equipped with tufts of bristles on most segments. They are generally larger than the nematodes. Different species prefer special food, such as zoogloeal masses and decaying vegetable matter. These worms act in a manner similar to micro-comminutors with an almost continuous stream of material with its organic content passing through their bodies. Two well-known worms of this category are *Limnodrilus* and *Tubifex.* The former has been shown to have excreted pellets forty-five times (4) its own length in twenty-four hours in the bottom of a polluted stream. These two worms have been found in filters, but probably at times when the filters were grossly overloaded.

The large reddish-brown worms that are seen on the filter and those sloughed out in the spring and fall are true earthworms. Like most other worms on the filter, the original habitat is the soil. They are responsible in part for the destruction of clogging growths of algae and fungi and aid in the sloughing process.

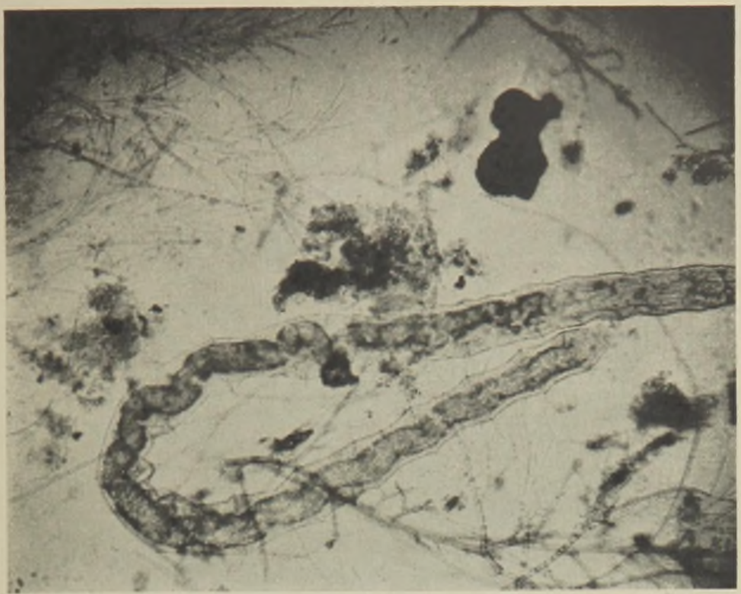

FIG. 15.—Chaetopoda.

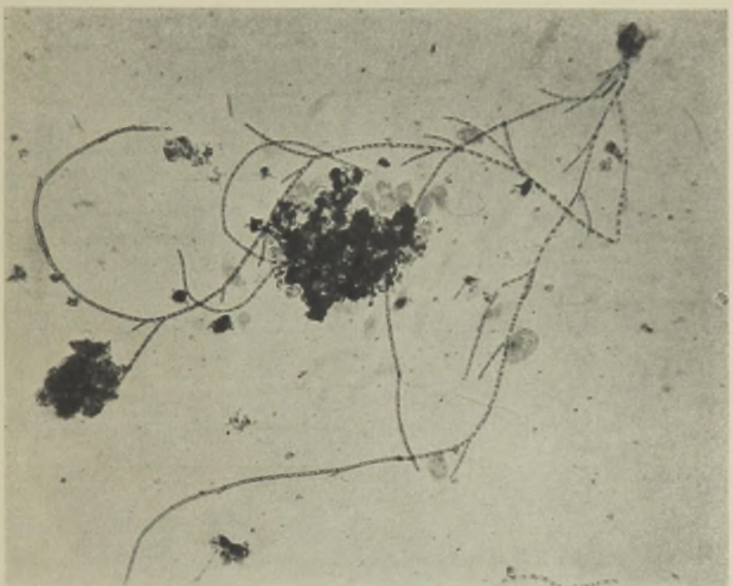

FIG. 16.—Stigeoclonium.

(5) A species of earthworm, *Lumbricillus,* was shown to be present on a filter in England 100,000 to 150,000 per cubic foot of medium. This worm is about ⅝ in. long, is reddish-brown, and reacts negatively to light. In the spring the worms become abundant and work over the surface algae growths, and cause it to slough. The worms follow the sloughed material through the filter and are finally discharged from the bed.

The algae growths just mentioned are confined to the portions of the filter bed where sunlight may penetrate. The growths on the stones may be a bright green color in which case the alga is probably *Stigeoclonium* (Fig. 16). Only one plant thallus has been photographed here and gives no indication that the alga forms a thin mat which may at times interfere with percolation.

If the algae mass is a greenish-black color, it is probably one of the so-called blue-green algae, *Oscillatoria* or *Phormidium.* Figure 17

Fig. 17.—Blue-green algae.

shows the edge of a solid mass of these algae at a magnification of 56 times.

Details of individual filaments may be shown in a higher magnification of 280 times, as is indicated in Fig. 18. This figure illustrates how the filaments tend to group themselves. These groups at times intertwine with others to form an almost impenetrable mat stretching across the filter stones.

The next organism (Fig. 19) is, I am certain, familiar to all sprinkling filter plant operators. It is that eye, ear, nose and throat specialist—the *Psychoda* fly.

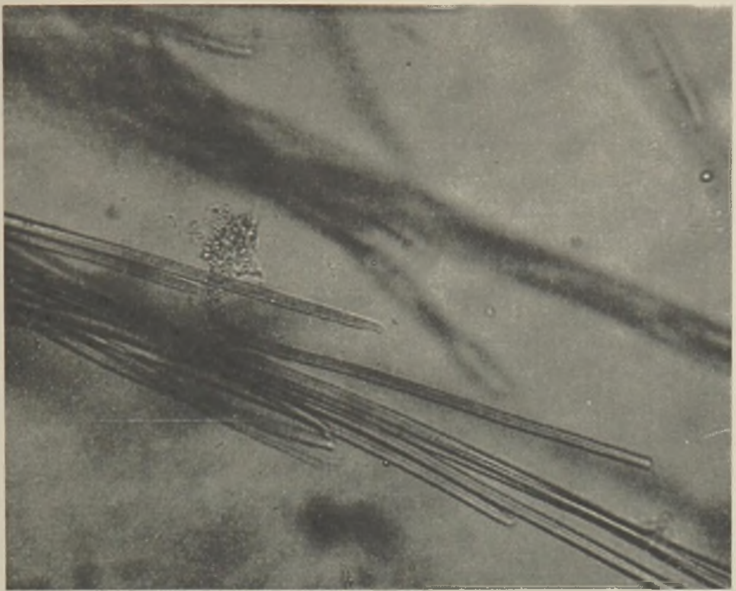

FIG. 18.—Filament group of blue-green algae.

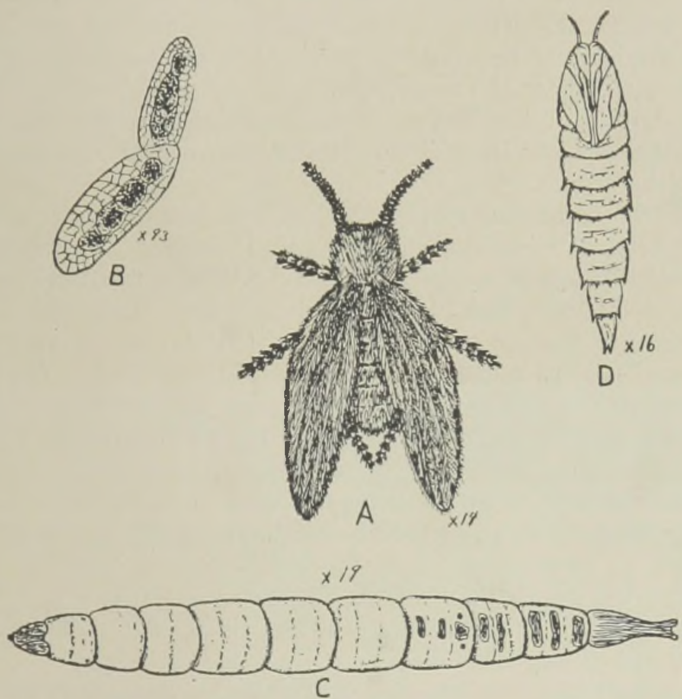

FIG. 19.—Life stages of the sprinkling filter fly. A, Adult; B, Eggs (After L. Haseman); C, Larva; D, Pupa.

The flies may be expected to emerge in large numbers as adults before and after the warm season, but they persist throughout the year in and around the filter in varying numbers. They are not strong fliers and may be wind-carried for three quarters of a mile or more. Thus far, the flies have not been proven to carry any disease-producing organisms, either internally or externally.

The life history (6, 7) of the fly consists of four stages: eggs, larvae, pupae and adults. The adult lays her eggs on the filter film in small whitish or transparent batches numbering as high as 100. Within two days, in warm weather, the eggs hatch and the white worm-like larvae burrow into the film. The larvae feed ravenously on almost any living or decaying material available and devour bacteria, algae, fungi, and protozoa. Just prior to sloughing when the film is heavy, the larvae may be submerged in the film with only the breathing tube protruding. At this stage the larvae may be as long as one centimeter and may occupy from 8 to 15 days in its development, according to prevailing temperature. The pupae develop from the larvae and become yellowish, much shorter, and fatter. Within two days, during which time the pupa rests in the slime with only two breathing horns protruding, the forward part of the pupa case bursts open and the adult emerges. Almost within an hour the adult goes about the business of reproducing itself.

The presence of the filter flies, particularly in the larvae stage, is probably beneficial. First, a considerable amount of stabilization of organic matter must be credited to the larvae, particularly when the rate of productivity may run into millions per acre per day. Secondly, the eating habits of the larvae probably accelerate the final stages of the sloughing process in that the film is perforated and possibly loosened from the stones.

Despite the somewhat problematical beneficial effects, most operators would settle for less stabilization and less flies. At any rate, measures are usually taken to control the fly. Where feasible, flooding the bed for 24 to 36 hours has been most successful. It is effective in that (1) the eggs are flushed out of the filter, (2) the larvae and pupae are drowned, and (3) the adults are forced out of the filter. The last effect may or may not be beneficial to the surrounding territory. The flooding operation should be repeated within ten days until the flies are reduced, lest the eggs, larvae and pupae develop to the adult stage. Care must be exercised in, first, limiting the time of flooding to a maximum of 36 hours in order to preserve the efficiency of the aerobic filter biota, and second, in preventing excessive flushing and scouring velocities. Incidentally, the New Jersey State Department of Health's Rules and Regulations, state the desirability of providing for means of flooding sections of sprinkling filter beds.

At those plants where flooding is impossible, operators have worked out their own pet schemes of filter fly control and have used gasoline torches, drying methods, repellent insecticides, and contact insecticides. No one method except flooding has been really effective. The most effective method seems to be a matter of local filter conditions. In order to have lasting results, the method must penetrate to the level where most of the larvae and pupae abound; that is, between 3 in. below the filter surface and 12 in. to 18 in. below the filter surface.

In the few years I have been employed in the State Department of Health, I have been privileged to visit many of the water and sewage treatment plants in this state. From many conversations on the subject I conclude that among most operators and engineers there is a definite phobia of the long and seemingly unpronounceable Greek and Latin names given most organisms. As a result, the biology of many worthwhile projects has been neglected. It has been my purpose, both in the subject matter and in the use of photomicrographs, to give you a new angle on the subject and to familiarize you with the organisms that do the work for you.

Mr. Enslow: When you have a sprinkling filter bed which you cannot flood, what is your recommendation?

Mr. Holtje: I scarcely touched that in my paper as you noticed. If I gave one method, another operator would say that would not work for him. The State Department of Health has no one method to recommend but we find that chlorine doses over a short period will help. So far as I know, there is no one certain method. It is up to the operator.

Mr. Enslow: When you flood a filter, what is the period of time? It is too bad we cannot turn it upside-down. My point is this, what do you consider the minimum time?

Mr. Holtje: The minimum time is that specified by Headlee in his New Jersey Experimental Station work-out in 1919. He sets twenty-four hours. As soon as you can drown the larvae and get above the filter bed surface it will be all right.

Editor's Note: (Headlee's conclusion was 24 hours after complete submergence.)

Mr. Cohen: I have used an eighteen hour flooding period with good success taking about four to five hours to fill the bed.

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GENEALOGY OF MODERN SEWAGE TREATMENT *

A PRODUCT OF SANITARY, CHEMICAL AND METALLURGICAL ENGINEERING

By John V. N. Dorr

President, The Dorr Company, Inc., Engineers

Chairman Bedell: About fifty or sixty years ago a young lad and his brother delighted in wandering about northern New Jersey gathering specimens of minerals from abandoned workings of copper, iron and zinc mines. A little later the same young lad obtained a position in the laboratories of Thomas A. Edison, where with no respect for a forty-hour week he frequently worked twenty hours a day.

With this background it was not strange that when this young man graduated in chemistry from Rutgers College in 1894 his first job was as chemist and assayist in a gold mill at Deadwood, South Dakota.

Little did anyone envision the brilliant future of that young college graduate who is now regarded as one of the leading chemical, metallurgical and industrial engineers of this country, as well as a prolific inventor of machines and processes that have had far-reaching effects on American industrial and social progress.

His own many inventions supplemented by those of his engineering staff, a total of over 1400 patents, have been applied successfully in many separate and distinct processing industries, making feasible the conversion of intermittent processes to continuous ones; the large-scale exploitation of low-grade ore deposits; and finally, the placing of municipal sewage and water treatment on a sound engineering basis, to the benefit of the public health of this and other countries.

Chance gave him the opportunity to apply his genius to the field of sewage treatment. It appears that in 1913 the American Public Health Association held its annual meeting in Colorado Springs. One of the scheduled inspection trips was to a gold mill which was equipped with the then comparatively new Dorr Thickener.

On the return trip Langdon Pearse expressed the fervent wish to the inventor that some similar application might be made to sewage treatment. Within a short time a small experimental unit was shipped to Chicago and set up in the stockyards. Three years later T. Chalkley Hatton was instrumental in securing the installation of similar units at the Milwaukee activated sludge plant.

It was not until 1920, however, that this conservative company installed its first commercial unit in the sewage treatment field at Bartow, Florida. This was the beginning of the application of Dorr equipment and processes that now continuously treat approximately 3,000,000,000 gallons per day of domestic sewage and water, affecting the lives of

* Guest Speaker, Federation Luncheon, Third Annual Convention and Wartime Conference, Cleveland, Ohio, October 23, 1942.

probably some 30,000,000 people through reducing the hazard of water-born contagion and the pollution of streams.

Our guest speaker's life has been one of engineering alertness, leading to industrial success as well as to full recognition of his many technical achievements. A recipient of many academic and scientific honors and medals, he was chosen in 1941 by the five great chemical societies of America to receive the highest honor they could confer for what he has done for the chemical industries and the mining profession—namely, the Perkin Medal.

It is my great pleasure and privilege to introduce to you our guest speaker, Dr. John Van Nostrand Dorr, engineer, scientist, inventor, public benefactor, and president of The Dorr Company. Dr. Dorr!

Dr. John V. N. Dorr: Mr. Chairman, Gentlemen and Guests of the Association:

The influence of chance has been referred to by your president; I think all of us could write an autobiography that would dwell on the influence of chance in our lives. Incidentally, I think you know that the definition of autobiography is the story of your life as you wish you had lived it. Remember, I would not attempt to give you that of mine, but will refer to the element of chance.

Forty years ago as a youngster operating a small gold property in the Black Hills I was entering Chicago going east and happened to be in the Pullman smoking room where I found another man with a beard. You know how like things attract, and we started to talk. He was from Salt Lake and it proved afterwards, that if I had not met him at that time I would not have been here today, because six months later, when I visited Salt Lake planning to build a mill in which I had put everything I could beg, borrow or steal, he introduced me to the inventor of a new process that proved for the conditions under which I was going to work, the one thing that prevented our mill from being an absolute failure.

Your chairman has mentioned the chance of my meeting the sanitary engineers coming up from Colorado Springs. I have always looked back at it with a great deal of pleasure for it widened my horizon and brought me some staunch friends in a new field.

Well, our first approach to sanitary engineering lay in this chance meeting. We had another contact in the industrial line, that also strangely enough came from cyaniding. In Olean, New York, there was a lawyer who had invested in a gold mine. He went out to look after the mine and took a job in the mill, and it happened to be a mill where a friend of mine was using some of the first Dorr Thickeners made. On his return to Olean where there were a number of tanneries and a great deal of trouble from tannery waste, he thought of his cyanide experience. He came to see us and I think the first thing we did in industrial trade waste was in connection with purification of tannery waste.

The art of sewage treatment has a peculiar appeal to a metallurgist because of one characteristic of every mine. In time—sooner or later—

it gets played out, but the sanitary engineer has a source of supply that never gets played out.

I started to talk about genealogy and now I would like to speak first of the genealogy of mechanization, and to consider it most intelligently I would like you to go back with me to a period 15 years before the date 1920 already mentioned.

There were two general methods for the wet treatment of ores then. *First,* the cyanide process for treating gold and silver ores which comprised (*a*) crushing and grinding the ore to 30 mesh or finer; (*b*) dissolution of the precious metals by a solution of sodium cyanide (*c*) separation of the gold bearing solution from the residues or tailings and recovery of the metal by precipitation.

Second, the "wet method" called roughly "ore dressing" for recovery of the copper zinc or lead minerals from their ores consisted of (*a*) grinding to the fineness that freed the mineral usually making several sized products for different treatment, removing excess water used in grinding and applying gravity concentration by jigs, bubbles, or tables with which many of you are familiar.

In both processes two steps were similar, classification or separation of relatively coarse and fine particles by the difference in settling rates; and sedimentation, or removal of excess liquid from the pulp before further treatment. Both steps were done by gravity only and the classification was done in inverted cones.

A stream of water carrying the ground ore flowed into the cone and the excess water and slow-settling slime overflowed while the coarser or quick settling sand was discharged from the spigot at the point. This was a step requiring a delicate balance and attention, or sand went with the slime and vice versa.

In cyaniding the gold-bearing solution was separated from the slime by a series of decantations—a slow and tedious batch process, while the sand was leached in tanks.

In ore dressing, on the other hand, the excess water was removed from the mud by a multiplicity of small 8 ft. diameter settling cones with the spigot discharge led up the side of the cone to give a larger discharge opening due to less static head. The cyanide mill I mentioned in the beginning was thus equipped.

Into this field in 1904 and 1905 cames two mechanisms, both born of experience—I might really say, of necessity.

The Dorr Classifier replacing the classifier cone was an inclined settling box with mechanically operated rakes to discharge the quick-settling or sand portion above the water level with no chance of choking, and with remarkable efficiency. It made closed-circuit grinding with its enormous savings feasible.

The Dorr Thickener, with which you are familiar as the Dorr Clarifier with its many modifications, was a fundamental discovery. It proved that by mechanical means you could stir the bottom zone of a vessel used for continuous sedimentation fast enough to prevent a deposit of solids on the bottom and yet slow enough not to interfere with the production of the clearest continuous overflow.

This allowed the use of large units in cyaniding and other chemical work and made possible continuous counter-current decantation.

In ore dressing the large units proved valuable. The largest single machine we have built—325 ft. in diameter with a 12 in. discharge pipe, has the capacity of 1400 of those small cones with small discharge pipe requiring continual adjustment.

The advantages, tangible and intangible, of controlling the solid-liquid phase, *i.e.*, a mixture of finely divided solids suspended in liquid mechanically, as against trusting to the normal flow of hydraulics, were very great. Many of those you would not know until you had experienced them, but there was a reliability about it that enabled many things to be done much more cheaply than could otherwise have been accomplished.

With this point of view, that of applying mechanisms to this type of work, we approached a great many other fields. Sometimes they seemed entirely foolish for us to get into, away from our line. For instance, in sugar I think about 1919 we went to Cuba and talked about settling mud in the sugar plant, and they said, ''Well, you may be a good metallurgist but what do you know about sugar?'' We didn't know much but we tried some devices which seemed to work. We followed the same way with cement and chemicals. So we came to the sanitary work with that viewpoint, to see if we could be of any use in that field.

To get back to the early history of sanitary work, I think you all know much more about it than I do, because, after all, it is only one of several things to which I have had to give attention. But let us go back to the Roman sewers. I once saw the mouth of the Cloaca Maxima where the water-borne sewage was carried to the sea, the great purifying place. It is a long step in time to the sewage farms, where the water-borne sewage was used for fertilizer, in Berlin and some of the other towns in Europe, and then in 1929 I was in Japan and had a chance to see there the more primitive but possibly over-all more efficient type of collection, the ''honey cart,'' where the product was carried out without dilution and put on the farms where it could be of use. I think probably in one form or the other that had become the custom all through the Orient, especialy the drier parts of it.

The Industrial Revolution in England, with resultant growth of inland cities often located by small rivers—originally the cities were all by the ocean for means of communication—brought out the effect of stream pollution very greatly and made a nuisance. The help of the chemist and the bacteriologist was called upon and the civil engineer at the end of the century became the sanitary engineer we know, as the profession began to emerge with the names of Hazen, Fuller, Hering, and many others with which you are familiar.

The conditions at the time of World War I are of interest. At that time Imhoff tanks were recognized as of value, being a very definite advance over previous methods. Activated sludge for further purification had been developed in England and people over here—Bartow and others—were interested in the process. Plain settling tanks with intermittent removal of sludge and separate digestion were used, I think, in Baltimore, while fixed nozzles for sprinkling filters had been recognized as important.

To me there was an opportunity for applying our metallurgical experience and mechanization to the entirely new problems. I think that we simply had a bit of luck in coming into the game at that time and the stage was set for introducing those ideas.

When we considered going into the sewage field, we were asked on all sides, "Yes, you want to put a machine into sewage, but do you know anything about sewage?" We didn't, except personally, and we were told, of course, that a sewage plant smells (stinks to be accurate) and is always located in a low district where nothing else ever went. "How could you get men to go down into places like that, which everybody tried to duck, and operate machines and keep the machines in order?" It was absolutely impossible to have a plant operated mechanically! There would always be breakdowns; and there was another factor, in connection with trade waste—which the people here who are on boards of health I know will appreciate. When a factory had to do something about taking care of trade wastes, they were insulted in the first place by such a requirement. What were streams for but to run the waste into them? Why should they spend money to take care of it? The board of health said they had to—and they did.

That meant if they put machines into trade wastes, the odds were very much against those machines running, because every time the machine broke down there was no sludge to carry out. You didn't have to put in chemicals and you were that much ahead. So you can see what chance there was for machinery to get into trade waste—but it got there.

Coming to conditions today, you all know better than I what has happened, as compared with what we anticipated. The plants are a pride of the cities. The men that operate them are splendid men, and I am very sure that in no place I know have there been stricter requirements for continuous operation than are given to the producers of equipment by the sewage plant operators. If the mechanism won't run a year without shutting down or sometimes without oiling, there is something wrong with it. So, as often happens, the trouble we anticipated didn't occur and events worked the opposite way. In other words, we didn't think through far enough.

You can all probably cite special plants you know that are especially good, but I think of one in Spring Lake, New Jersey. Spring Lake, as you know, is a watering spot. There is a big hotel, the Monmouth Hotel, then about fifty feet of land, and then the ocean. Between the two you will see a little dog house with a flag pole. Underneath there is a sewage plant, and the flag pole is the ventilator.

Other benefits have come from mechanization that we didn't expect. I think those who have done a great deal of operating know there are two kinds of benefits, the tangible and the intangible. I was much impressed years ago in visiting a large mill. They had thrown out one type of machinery and put in another. The manager said, "We have kept careful records and after a year's trial could not find a cost justification for change but concluded the intangible benefits justified it—and we were right."

I think the scientific approach which resulted in this mechanization has been the catalyzer that started much research and development by consulting municipal engineers and others and by organizations like our own, whose job is to supply the tools and processes which are really the results of over-all study of functions.

Mechanization in those two steps has been the prelude to mechanization in other phases. We know the comminutor takes the place of the screen and gets rid of everything all at once; in some places they used the coarse screens and the self-cleaning fine screens such as those which were put in at Los Angeles some twenty years ago and are still operating there to meet their particular conditions; the detritors, the digesters and the large capacity sprinkling filters; and the incinerators. In other words, the mechanizing of one part has tended to develop the mechanization of other parts and today we have almost a completely mechanical plant in which I know the operators take great pride, and we on our part are glad to have been privileged to contribute.

Now I would like to come back to something personal. Our very kind chairman has spoken of my working at Edison and that is something that is never forgotten by anybody who has worked there. As he said, I had long hours and we didn't have the Wages and Hour Act in force then. The result was I worked for three months for nothing and then I got $5.00 a week and then $7.00 a week and no time for overtime. If I stayed there until midnight, they gave us a free lunch, so they were thinking ahead to the New Deal, I guess. I think it gave the men who worked there a broad over-all vision. There used to be a saying quoted from Edison that everything is possible with God and chemists, and we hoped God was all right but we were sure the chemists could do things.

I think that I got a great deal there of the fundamental approach toward a problem that stood us in good stead in approaching other problems. One way of doing it is to go to a new problem and try to adapt some equipment that works in cyaniding or smelting or anything to the purpose. In many cases that was done. On the other hand we tried to map out a problem, something to be accomplished. We tried to work out all the conditions to be accomplished and then see if in our minds and experience there was anything we could apply to it and very often, as our experience was naturally along certain lines, the final solution of the problem came from those lines. We did that in the Detritor, I know, and we didn't try to adapt a classifier. We tried to adapt a thickener but the final product was a bit of both and was very much better than if we had tried it either way.

Another illustration of that point of view which to me is a matter of very material importance was the All-American Canal Desilting Works. You are a long way from California, but you may be familiar with the Imperial Valley and the Canal that supplied the water from the Colorado River. I visited it in '29 and saw dredges pumping silt out of the canal. Government figures indicated that the total cost to the district of maintaining the canal, of getting rid of the silt, was $1,-400,000 a year, and that certainly looked like something to shoot at. I very humbly suggested we try a Dorr Thickener. I think no one was interested, so we bided our time. The All-American Canal came on the horizon when the one object of governmental life was to spend money, probably necessarily so, and again we took the thing up. We went to see the Reclamation Service who had it in charge. They had old established methods for collecting silt and washing it out at intervals, and of course, our work was entirely a new world to them but we took them over to the Miami Copper Mill not too far away and there they saw 18,000 tons of solids being taken out of two or three times that amount of liquid and discharged, with an installed 5 horsepower, from a 325-foot tank. They thought that was wonderful. They wanted to build a 500-foot tank and then a 700-foot tank. I don't have to say anything to you mechanical engineers as to what that would have meant, but our experience was broader and we knew the reason that that 18,000 tons was discharged with 5 horsepower was that although the feed was 60-mesh and finer sand, there were also some colloids which lubricated the sand and made it almost flow to the center discharge. A more recent measurement on a 15,000-ton feed was 2½ h.p. input.

This phenomenon, for it would indeed be one to move that tonnage an average distance even of 20 to 50 feet, can be explained when I tell you our earliest experience.

If we turned a stream of sand, water and a small amount of colloids into a tank of water at the designed rate, the sand settled immediately and the mud or colloid remained in suspension so that the power required was so great it shut down the machine and we found it necessary to feed very slowly until a portion of the lubricating colloids reached the bottom.

This question of colloids limitation worried us, so again we said, "Here is a problem, let's study it."

We have a laboratory at Westport, Connecticut. I think it may be the Edisonian background, but I have always been impressed with the utility and value as well as the satisfaction of trying to get to the bottom of things, and have done it for twenty-five years now. So we shipped silt there and experimented with it. We said to the boys, "We don't want to try the Dorr Classifier. We don't want to try to use a Dorr Thickener. We want to find the best way to move silt." We suspected it wouldn't have much colloids.

I don't believe any of you have ever had a more complex and more indefinite problem than was put up to us by the Reclamation Service. They had sampled the river for years, and the great variation both in total amount and nature of the silt that was carried at different times. At the time they planned this canal, they were building Boulder Dam and, therefore, they didn't know how much silt would be coming down either from the deep layer of bedded silt moving slowly on the bottom or what would be picked up or brought into the stream between the dam and the intake, and so we didn't know what the nature of the material would be. We didn't know the amount of it, and we didn't know how it would vary, so you can see what a nice problem that was. After much study they finally gave us performance specifications for their Desilting Plant. They wanted to be able to discharge 70,000 tons per day of silt. It wouldn't be over 100 mesh and there wouldn't be any colloids in it. The stream flow would be one-twentieth of the average flow of Niagara Falls. They gave it in gallons per day, but I think this gives a vivid picture of it.

They shipped us a carload of silt and we worked that over for six months in every way we could think of, and the net result, which incidentally included some real invention on the spot under the pressure of the Mother of Invention—necessity, was a desilting plant of 28 acres with seventy-two 125-foot mechanisms in it. You can see we didn't go to the 700-foot or the 1000-foot. The horsepower provided is somewhere around 300. That was installed to handle a maximum of five times the amount of solids that is discharged, with colloids present, for 2.5 horsepower, so you can see we learned something.

Coming back to what might be discussed first, the question of human relations, Pope said, "The proper study of mankind is man," and I think we all agree that although physical things are interesting, the study of human relationships is perhaps the most important thing before the world today. If we wipe out all our technical developments for the last 100 years and put in exchange for that, the solution of the problem of human relationship, people living together happily, the world will be happy, and we wouldn't be doing what we are doing all over the world today.

When we approached the sanitary engineering field we were presented with the necessity, in addition to what I have said about mechanization, of getting into politics. Now there is nothing the average engineer knows less about than politics. He is too busy. He has other things that interest him. They said, "If you want to go into deals with municipalities you have to be in politics one way or the other," and that didn't look good to me. We hesitated quite a little. Again we have the contrast. We approached the thing from an engineering standpoint, and through all our experience of twenty-five years I should say that politics has entered only in an infinitesimal amount. We have found the finest crowd of men to work with of any industry, forward-looking consulting engineers and municipal engineers, and as a whole that worry has been wiped out.

In studying the field of sanitary engineering we have found that it is different from any other line. It seems to me there are three factors that must be considered. The first is the operating engineer. His job is to operate the plants. He has to know what happens on the "graveyard" shift, and incidentally going way back to my own operating days of the Black Hills, I think one source of success we have had was that our motto was from the beginning—"Build for the 'graveyard' shift," because those who have operated know the "graveyard" shift is the time when the men get sleepy and mechanisms go wrong and they are not repaired. If anything is going to break it will break on the "graveyard" shift.

I know one occasion when in a leaching plant the thickener shaft had been twisted off and they said we didn't make good stuff. We looked into it, and found that the man on the "graveyard" shift had cut the overload alarm wire because the bell interfered with his taking a nap.

The second factor is the consulting engineer. His job is really important. He saves the city, except when there are units being planned for a very large city, from having to carry a staff that is entirely competent to do the plant designing. The consulting engineer brings in a broad general experience and his specialty is to know how to build; only to know how to build he has to know how a thing has to be operated. He also has another function which is quite different from that in any other field. That is to stand between the administration and political attacks on its works.

In politics, there are two classes—the Outs and the Ins—and it is the job of the Outs to reverse the position; with freedom to make all accusation of waste, corruption, etc., in public works with or without any pretext. The consulting engineer stands foursquare to prove the job has been well done.

The third factor I think can be called the equipment and, occasionally, the process engineer. He is an engineer from his own experience in all industries, and from knowledge brought to him by either of the other types. He develops and markets the tools to be shaped into a harmonious whole by the other two. It seems to me that history has shown that this function is also an element of value.

I leave it to you to determine the relative values. Obviously, I wouldn't attempt it, especially here, but I think the three groups working together in a harmonious whole can unitedly (and that is the way it should be anyway) take credit for having done a very fine job in the last 30 years. It is a complete new industry built up and rendering the greatest possible service to the human race.

In closing, I would like to express great appreciation of the opportunity given me to talk to you today. I have known a great many of you before and I have made a great many friends here today.

We don't know what to look for ahead. There is one thought I might give to you people who are in the operating end, and that is, whether you realize it or not, you fellows are all chemical engineers. You are operating chemical processes, and a great many of them, and I speak obviously of some I know more intimately. If it turns out that war pressure is such that we must return to a simpler life and send our equipment in another form overseas I advise you to go to the chemical plants. They are looking for fellows who know how to operate equipment such as you are operating, and I don't think you will have any trouble getting located.

We have to concentrate, however, on winning the war. We have to face the fact that when it is over the composite brains of all of us will be able to utilize the developments that have been made in science, and if we add hope for developments in the science of human relationship, we may give the world something very much better than it has had heretofore.

President Bedell: Thank you, Dr. Dorr. I know we have all been greatly pleased in having you here. You said it was your pleasure to be here, but we certainly have enjoyed having you.

I think I should add another jewel to the necklace I put about his neck as I introduced him. I referred to him as a scientist and various other attributes. I forget to mention he was a philosopher. I think also I would like to call to your attention one very short statement he made that seemed to me the most significant part of his speech. It is typical of his life and accomplishments. It was the statement regarding his approach to the sugar industry problem. He said he knew nothing about sugar making, nevertheless he tried something and it worked. I think that is a very simple statement of a true scientific approach to any problem, and it is characteristic of Dr. Dorr's life. Again we thank you, Dr. Dorr, for coming here today.

SEWAGE TREATMENT PROBLEMS IN CLEVELAND, OHIO *

By J. W. Ellms

Commissioner, Division of Sewage Disposal, Department of Public Utilities, Cleveland, Ohio

The problems which have been encountered in the administration of the Division of Sewage Disposal, and in the operation and maintenance of its three treatment plants, fall naturally into four groups. These problems are Legislative, Financial, Technical, and Personnel in character. They are also more or less necessarily interrelated. In consequence, the following paper consists of a recital of the facts, rather than an attempt to discuss the problems involved. It is hoped that a frank discussion of them by others in this professional engineering field will be helpful to all of us.

Legislative and Financial Problems

Naturally, the legislation which created the organization under which we operate, is directly related to the financial phase and, in consequence, they will be treated together. The growth of sanitary science, as it relates to the collection and treatment of sewage, has an historical aspect which must be considered, if a proper point of view is to be obtained. In the following table, an effort has been made to present the development of a sewerage system and the sewage treatment plants in Cleveland.

Data on the Development of the Sewerage System and Sewage Disposal Plants of Cleveland, Ohio

Year	
1898–1900	Began construction of interceptors. There were no treatment and disposal plants.
1912	Orders of State Department of Health to City of Cleveland to abate nuisances caused by sewage pollution of Cuyahoga River and shores of Lake Erie.
1915–1917	Early experiments on activated sludge at site of Easterly Sewage Treatment Works, which had an important bearing on the design of this plant.
1916–1918	Construction of bar gratings and grit chambers at Easterly Plant.
1922	First disposal plant completed. Cost of operation and maintenance borne by Division of Water.
1928	Second disposal plant completed. Cost of operation and maintenance borne by Division of Water.
1934	Supreme Court of Ohio rendered a decision declaring illegal the operation and maintenance of sewage treatment and disposal plants from water works revenues. Judgment for $637,861.60 was rendered against the General Fund in favor of Division of Water.

* Presented at the Third Annual Convention of the Federation of Sewage Works Associations, Cleveland, Ohio, Oct. 22, 1942.

1935 On July 15, 1935, City Council created a Division of Sewage Disposal and placed it in the Department of Public Utilities, but the Division, however, was actually supported by taxes derived from the General Fund, *i.e.,* from taxes on real estate.

1938 The third and largest sewage treatment plant was started in operation in this year. Council passed an ordinance on July 17, 1938, making a sewerage service charge, based on 40 per cent of the water bill.

1939 Council passed an ordinance on October 17, 1939, reducing the rate to 25 per cent of the water bill, and which charge remained in effect until January 17, 1940.

1940 Report of Board of Advisory Engineers on the financing of the Division of Sewage Disposal. Board recommended that the "rental method," based upon the water converted to sewage, be continued, and that the rate be made 22¢ per 1,000 cubic feet of water as measured. Rate to cover only the administration, operation and maintenance of the Division of Sewage Disposal. Fixed charges on the bonded indebtedness borne by revenue derived from general tax funds.

1940 Funds in 1940 were derived from the balance due on the ordinances of 1938 and 1939, and from a special tax levy on real estate, plus funds from the payments made by the suburban municipalities and the County Sanitary Sewer Districts.

1941 On March 1, 1941, an ordinance was passed providing for an 18¢ per M.C.F. rate, based upon the water delivered to the sewers. This ordinance expired on December 31, 1941.

1942 A new stop-gap ordinance became effective January 1, 1942, and expired June 30, 1942. This ordinance was for a rate of 18¢ per M.C.F.

" A new ordinance, continuing the 18¢ rate, became effective July 1, 1942, and will be in force until December 31, 1942, when either a new rate ordinance will be required, or an appropriation made from the General Fund.

Twenty years ago, certain of the suburban municipalities surrounding Cleveland requested sewer outlet privileges for discharging their sewage into Cleveland's sewerage system. These rights were granted in some cases for a merely nominal annual sum of money, and in other cases for easements for laying interceptors through the suburban municipality, or for a permit to build a sewage disposal plant in the municipality. Under a state law, the County of Cuyahoga established sanitary districts which included incorporated villages, as well as unincorporated portions of the county. The County Commissioners made agreements with the City, whereby the sewage produced was discharged into the City's sewerage system. In still other cases, reciprocal arrangements were made between the City and incorporated cities and villages for treating a portion of their sewage in the City's plants, in exchange for treating some of the City's sewage in the suburbs' plants.

Certain agreements were based on the ratio of the population served to the total population of the metropolitan district receiving sewerage services. This ratio was used for proportioning the cost to the village, city, or sanitary district served for operating and maintaining the City's disposal plants in any given year.

With the growth of the suburbs, there was a steady increase in the volume of sewage which the City was obliged to handle. With increased facilities provided for treating the sewage, the cost of treating and disposing of the sewage by Cleveland also became greater. As a result of the refusal of some of the municipalities to continue their agreements with the City, and in other cases because of their failure to pay on the existing contracts, large sums of money due the City became delinquent. As the City was unable to shut off the flow of sewage from the suburban district, it was obliged to continue to treat this sewage. This complicated situation has had much to do with the attitude of Cleveland's City Council toward providing adequate rates for sewerage service in the city. The Cleveland City Council felt they were imposed upon, and rightfuly so. Negotiations have been in progress for several years and some settlements have been effected. Others are still pending.

This brief history of the development of Cleveland's sewerage system and disposal plants will, doubtless, cause many questions to arise in your minds as to why there were so many changes made in the rates for sewerage services, especially during the past six or seven years. Briefly, they were the result of opposition by a relatively small proportion of the public to being obliged to pay for sewage treatment for which they had never before been required to pay. It, naturally, found expression in the City Council, and in groups which considered themselves unjustly taxed. In consequence, the question of the method by which sewage treatment should be financed was submitted to the electorate at several city elections. The question in different forms was submitted three times to a vote, and three times the electorate, by a majority, decided in favor of a rental method, as against providing for sewage treatment from general tax funds.

There were good reasons for this decision by the electorate. The real estate tax rate had been rising, both as a result of a diminishing value of the tax base, from a reduction in the millage from 15 to 10 mills per dollar allowed by a state law, and from increased expenditures for the usual and ordinary expenses of the government. The securing of funds for sewage treatment by a direct rental charge was, therefore, the only practicable alternative. This method was permitted by a state law, and was adopted.

Although forced by a court decision in 1934 to cease the use of water works revenues for the support of the Sewage Disposal Division, opponents of the rental method adopted still declined to accept the decision of the electorate and declared the treatment of sewage and its disposal to be a governmental function, which must be supported by taxes, and could not be operated by a rental or service charge. The question which the courts will finally have to settle, therefore, is whether the charging of a rental makes such a service a utility, which could finance its support by a rate, or whether it is a governmental function, which must be supported from general tax funds. A recent opinion of the Attorney General of the State of Ohio, which stated that the rental charge was neither a tax nor an assessment, leaves its status still undetermined. To the speaker, the law appears to be an orphan, whose legal parentage will have to be finally fixed by the State Legislature and the courts. There are other angles in the local situation which it is unnecessary to explain here, but which from their practical effect, together with what has been explained, have resulted in providing insufficient funds during some years to do all of those things which are required to operate and maintain the treatment plants in efficient condition.

The City's investment in interceptors and sewage treatment plants is approximately $25,000,000, seventy per cent of which is in the treatment plants. The administration, operation and maintenance budget is about one million dollars annually. The fixed charges on the bonded debt add virtually another million dollars to the yearly cost of this service.

Technical Problems

Cleveland's sewage treatment plants have, in general, met the requirements for efficient and satisfactory treatment. This paper, however, is limited to the particular problems cited.

Probably no sewage treatment plant was ever designed by the most conscientious and far-seeing engineers which did not develop features that would have been treated differently, if foresight could have been as effective as hindsight. The Cleveland plants were designed and constructed by skilled engineers, with an unusual amount of experience. Lack of funds in some instances prevented doing what it was recognized should be done at the time the plants were designed. Adapting old plants to increased volumes of sewage to be treated, and the introduction of new processes, always complicate the designer's problems. The operators of any plant often feel they could have done a much better job than the designers, without taking into consideration their advantageous position of hindsight, as against the designer's foresight.

No designer could have possibly foreseen the conditions created by the present war. Industrial activity has reached unimaginable heights. Trade wastes have poisoned and so changed the character of domestic sewage that they have become a major problem. Acids, iron pickle liquors, oils, grease and soaps play havoc with bio-chemical processes. Deposition of these by-products of industry in aerating tanks clog air diffuser plates and tubes, and even cause pooling on trickling filters. Grease and organic sludges clog pipe lines and increase pressure so that they must be cleaned too frequently. Nevertheless, it has been the general policy of the City to permit trade wastes to enter the sewers, provided they did not produce too much interference with the operation of existing treatment processes.

Preventing difficulties by forbidding their introduction into the sewer system at the point of origin seems, in some cases, about the only way to combat their evil effects on the usual plant processes. However, the speaker can readily foresee the result if plant operators approached manufacturers at the present time and demanded that they cease discharging objectionable trade wastes into the sewers, no matter what the laws have to say on such subjects.

Both ordinary and extraordinary maintenance play no small part in operating highly-mechanized modern sewage treatment plants. Development in equipment, as the result of experience, may indicate the need for modification of their design. Under severe conditions, so frequently encountered in handling grit, grease and sludges, it is found that the usual metals and alloys which have been used in sludge pumps, vacuum pumps, gears, etc., do not wear well. Bucket elevator chains, pump casings, centrifugal impellers, and rubber conveyor belting will not stand up under continuous use. Clogged pipe lines, due to deposits of various kinds, reduce their carrying capacities and increase power costs. Electrical equipment of all types must have constant repair work done on it in order to keep it functioning properly. Vacuum filter cloths blind too quickly, supporting screens for these cloths become clogged and wear out, and vacuum pump valves require frequent removal, cleaning, or replacement.

Under the present war conditions, the difficulties of obtaining supplies of all kinds, requiring priorities and preference ratings, complicate still further the operation and maintenance of modern sewage treatment plants. Substitutes are not always available for the replacement of parts that are desired and may not, and probably will not, be as satisfactory as the original material that was used.

Personnel Problems

Under a merit system, the principles of which are embedded in the City Charter, and which have been quite rigidly enforced by an able Civil Service Commission, the selection of employes and their retention are subject to rules and regulations having the effect of enacted laws. "Like pay for like services" is a euphonius slogan, but one from a practical standpoint with which it is difficult to conform. The administrator frequently discovers that the nature of the services required is more likely to be unlike, rather than like, although the titles may be the same. Competitive examinations for similar positions may serve to sift out the least desirable applicants, but do not necessarily evaluate their qualifications for doing the work required. It is more difficult to remove an inefficient employe, once he has been appointed from an eligible list, than it is to select him in the first place, and it should be just the reverse. The vagaries of human conduct arising from plain lack of ability, and from many ulterior motives on the part of employes, may require disciplinary action by an administrator at times, and may cause him plenty of trouble.

Starting in 1938, at which time the present force was organized, there were 225 to 230 employes. Today there is practically the same number employed. Comparatively few classifications have been changed, and they resulted from the experience gained in operating the new equipment and processes used. The more intelligent employes were advanced when they were found to be better adapted to certain duties. Promotional lines of advancement for certain groups have been approved by the Civil Service Commission.

In general, it may be said that all types of employes (*i.e.*, the unskilled, skilled, and technical), have been co-operative during this difficult organization period of an almost new division. The turnover of employes has been most pronounced among the technical force, as would be expected in these days when the demand for such men is so urgent. The lure of greater compensation is hard to resist, and the speaker has consistently refrained from urging technical men to remain in the employ of the City, telling them that it was their responsibility to decide as to whether they would be better or worse off in the years ahead of them by remaining or by leaving the City's employ.

Conclusion

In this rather "candid camera" photograph of the problems with which we have been confronted, it is not intended to convey the idea that the shadows obscured the bright lights of the picture as a whole. The efforts to adequately treat and dispose of the sewage and trade wastes of the metropolitan district, containing over one million people, have, on the whole, been successful. Furthermore, it is hoped and believed that the problems which now confront us will be eventually solved.

Discussion

By John J. Wirts

Supt., Easterly Sewage Treatment Works, Cleveland, Ohio

To those who study Mr. Ellms' administrative analysis of the legislative, financial, technical and personnel problems concerning sewage treatment in Cleveland, it is evident that the hurdles have been high and spaced close together. It is an astonishing fact that although, historically, sewage treatment in Cleveland dates from the Testing Station in 1912, a full thirty years ago, at the present time there are only two or three engineers with the Department having ten or more years of experience. With three major plants, comprising a capital investment of $25,000,000 and total yearly charges of nearly $2,000,000, this small technical staff has made a very good record. However, this is not a procedure to be recommended.

The author has given in detail the many and varied legislative actions taken by the Cleveland City Council. At times the confusion has been so great that the entire system has been shut down because of the delay in putting adequate legislation in force. It is not difficult to see why the financial program has been sidetracked because it is entirely controlled by legislative action. Naturally the technical and personnel problems have been acute because of the difficulties incurred in establishing a program of long time planning.

During the last few years the duties of the plant superintendents have been complicated by the necessity of acting as operating managers, and to a rather important extent as design engineers. Projects as important as the Easterly, Westerly and Southerly Plants are usually kept up to date by a design staff, similar to the organizations of Gould in New York City and Pearse in Chicago. This is done in two ways, either a consulting engineer is continuously employed outside the municipal government or the department itself develops a group of men capable of designing expansions and improvements as required. The author has indicated many problems arising from Cleveland's ever present industrial wastes that require constant and special attention. Likewise those unforeseen difficulties common to all sewage treatment practice should be under constant study. Nowhere is it ever assumed by competent authorities that a plant once built or system extended is complete for all time. It is only by continuous improvement and modification that progress is made.

Cleveland has an interesting tradition in the field of sanitation. It has pioneered many improvements that have stood the test of time. A partial list would include the early Sewage Testing Station (1912–1916) where a one million gallon activated sludge plant was constructed and operated; the development of glass covered drying beds; vacuum filtration of digested sludge for the first time in a full plant size unit; the successful wide application of aluminum to both structures and process equipment at the Easterly Plant; the construction of the largest separate sludge digestion units at the Southerly and WesterlyPlants; and the installation and successful operation, at the Easterly Plant, of the largest comminutors ever manufactured.

The author's statement that excessive wear on mechanical equipment has been particularly troublesome confirms many published reports on this same subject. The problem is universal and requires extraordinary attention.

Under the heading of wear or erosion of mechanical equipment, Cleveland has developed the use of certain non-ferrous alloys. Outstanding success has been achieved with the sintered carbides of tungsten. Tungsten carbide is one form of powdered metallurgy with excellent abrasion resisting characteristics. It is fabricated from finely divided powders of tungsten, carbon and cobalt. The mixture of these powders is formed under pressure, sintered or cemented in a specially designed furnace in an atmosphere of hydrogen. After cooling, the resulting part or insert can be ground to the desired dimensions.

The specific applications of tungsten carbide now in service are comminutor teeth, shear bars and combs at the Easterly Plant. Tests conducted under actual operating conditions demonstrate conclusively that the cutters, shear bars and combs can be greatly improved with tungsten carbide inserts. Wider application will be made my improving the design of pump wearing rings and pump shear bars.

It has been the general practice in combating abrasion to use steel alloyed with a number of metals, such as nickel or manganese. More recently hard surfacing with non-ferrous metals has been used for this same purpose. Neither method—that is, ferrous alloys or non-ferrous surfacing—should be confused with the powdered metallurgy of tungsten, titanium and cobalt. The latter are always applied as brazed inserts and backed by a base metal. The inserts are usually small and require a considerable skill in brazing and grinding.

Cleveland has experienced serious difficulty with an increased industrial load, resulting from the war effort. In order to combat the clogging of diffusion apparatus, due to iron and grease, a cleaning process has been developed. The procedure for cleaning diffusers consists of a chromic acid treatment that loosens and dissolves a major portion of the obstructing solids. The plates are then transferred to a scrubbing machine where they are scrubbed thoroughly by the application of both water and air under pressure. By this process ninety per cent of the original porosity is recovered, at a cost of 45 cents per plate. In the development of the cleaning procedure, it was found that good recovery of the porosity could be obtained only by an internal scrubbing action of the diffuser after the proper acid treatment. It was demonstrated that the usual acid treatment, as practiced in many cities, did not substantially improve the porosity of the plates.

Sewage Research

PRE-TREATMENT OF ACID CHEMICAL WASTES *

By Willem Rudolfs

Chief, Dept. Water and Sewage Research, N. J. Agricultural Experiment Station, New Brunswick, N. J.

The disposal of acid wastes from chemical manufacturing, particularly when the wastes produced change rapidly in volume and character over short periods, involves several problems. The disposal of such waste has become more difficult with the rapid expansion of a number of industries engaged in war production. The wastes concerned contain mainly acids, alkalies and frequently solvents and poisons. The character, strength and volume of the wastes vary not only in different industrial establishments, but also within one particular industry.

The wastes may affect sewers through corrosion, sewage treatment plant operation (including settling and digestion), biological growth responsible for self-purification of the receiving waters, interfere with fish life, or create odor nuisances and discoloration of painted surfaces. In a number of instances the most immediate problem is prevention of sewer corrosion and amelioration of the harmful effects of the wastes on biological sewage treatment processes.

This paper presents an illustration of the difficulties created by chemical wastes discharges, and describes a method of pre-treatment to prevent interference with the operation of an existing sewage treatment plant.

Sewage Treatment Plant

The Rahway Valley Joint Meeting Sewage Treatment Plant treats the sewage and industrial wastes from nine municipalities and has been in operation for about six years. The plant consists essentially of screens, grit chambers, clarifiers, heated digestors and sludge drying beds. The sewage is received by gravity and pumped into the settling tanks. The average daily sewage flow for 1941 amounted to 9.51 m.g.d. with a trade waste discharge of 2.67 m.g.d. or about 18 per cent. The volume of waste, estimated to be about 16 per cent in 1940 had increased early in 1942, on account of industrial activities, to 30 per cent of the total flow. The number of industries discharging liquid wastes in the area did not increase materially from 1940 to 1942, but the number of employees engaged in these industries nearly doubled in this period.

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The increase in volume of wastes and numbers of employees clearly indicates the increase in industrial activities caused by the war.

Effects of Wastes

The pH values of the sewage received at the plant varied widely from hour to hour, fluctuating from pH 2.5 to 9.6. The quantities of suspended solids received increased and the gas production decreased greatly. Eventually, the entire digestion system was put out of commission, leaving the tanks full of an acid, extremely disagreeably smelling sludge, which could not be dried. By careful manipulation and the addition of large quantities of lime the digesters were nursed back into operation. However, the daily gas production of about 80,000 cu. ft. again gradually declined to about 33,000 cu. ft. in spite of increased quantities of suspended solids.

Preliminary surveys made over a period of several weeks showed that of the 33 industries served by the sewage treatment plant through the various member municipalities, one of the largest industries discharged from 1 to 1.25 m.g.d. of wastes to the sewers. The wastes consisted primarily of mixed acids with occasional batches of spent alkalies and some other waste products, as well as some sanitary sewage. This relatively large volume of wastes was shown to cause corrosion of the collecting sewer, was a factor in increased suspended solids to be handled in the clarifiers, digesters and sludge drying beds, and appeared to be the main reason for the decreased biological activities in the digestion tanks.

Volume and Character of Wastes

The volume of industrial wastes discharged into the collecting sewer reaching the sewage treatment plant varied from a minimum of 0.64 m.g.d. to a maximum of 1.72 m.g.d., with averages of total flows varying from 0.90 to 1.38 m.g.d., depending upon the day of the week. An example of the fluctuation in flow over a 24-hour period is shown in Fig. 1. The daily flow rate may be roughly divided into three parts, from 9 A.M. to 5 P.M., from 5 P.M. to 2 A.M., and from 2 A.M. to 9 A.M., corresponding to the three working shifts. During the day shift the rate of flow remains at a substantially high level, with intermediate and low levels for the evening and night shifts. The existence of these levels indicated that pre-treatment operation could be based upon the flow, provided the character of the wastes was more or less uniform. However, the fluctuations in the character of the wastes, particularly the acidity and alkalinity, were material. The changes were rapid and frequent, as indicated by the curve showing the pH values of the wastes at 5 to 15-minute intervals over the corresponding 24-hour flow period. The curves show that no relation existed between the rate of flow and the acidity or alkalinity of the wastes.

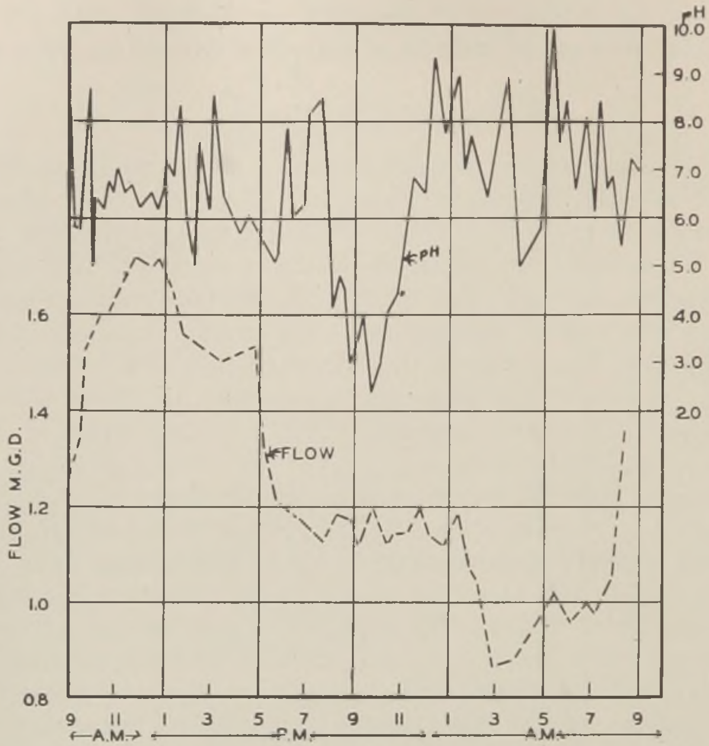

FIG. 1.—Fluctuations in flow and pH values of waste over a 24-hour period.

Mixing of Waste in Sewer

In view of the rapid fluctuations in acidity and alkalinity of the wastes, the possibility of utilizing the excess alkalinity discharged at certain times in equalization basins was studied. These studies raised the question of how much mixing would take place in about one mile of intercepting sewer. The flow was automatically recorded, alkalinity and acidity titrations made and the pH of the liquid determined at two manholes about 3,000 feet apart. The time of travel through this distance in the sewer varied from 43 to 50 minutes, depending upon the rate of flow. A comparison of the pH values obtained during the day period in the wastes collected at the two manholes is illustrated in Fig. 2. Inspection of the curves shows that very little mixing took place, but that the waste moved in slugs. In some instances the very acid or strongly alkaline waste discharges lasted for only a few minutes, but were promptly recorded 3,000 feet below. The results indicated the necessity of providing for equalization and sufficient mixing to make pre-treatment feasible without extreme care in control.

Neutralization Agent

Considerable experimentation with soda ash, caustic soda and various types of hydrated lime, showed that the most practical and economical material for neutralization was high calcium lime.

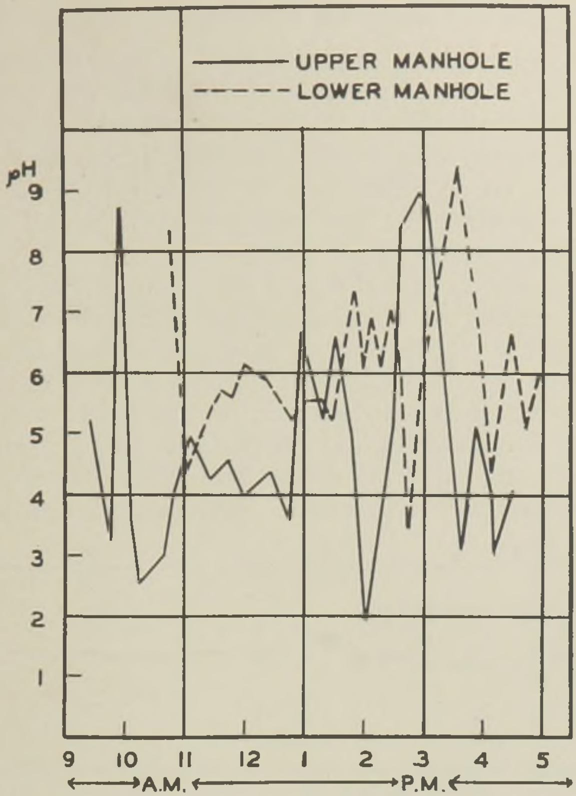

FIG. 2.—pH values of wastes taken 3,000 ft. apart, showing movement of wastes in "slugs."

Pre-treatment Plant

The pre-treatment plant designed consists essentially of bar screens, wet well, dry well with three automatic pumps and motors placed on the operating floor, flash mixers, equalization basins and mixing tanks, each provided with three vertical-paddle type agitators. The equalization and mixing tanks have a capacity sufficient for about one hour detention for an average flow of one million gallons daily. The tanks are provided with return lines for circulation of the mixing tanks effluent to convey the same back to the wet well, in the event that peak concentrations of acid are not thoroughly neutralized in the first passage. Hydrated lime is fed as a slurry for neutralization. Automatic, three-way pH control apparatus is provided, together with valves and other necessary appurtenances.

Each treatment unit can be used independently or by-passed. The equalization and mixing chambers are covered with heavy planks and the wet well is vented to remove any possible fumes. A building, housing the pumps, switch boards and flow measuring devices is placed over the dry well. A control laboratory is located in an existing building, which also provides storage for lime. The building is placed along a railroad siding adjacent to the pre-treatment plant.

Operation and Control

The pre-treatment plant operates on a 24-hour basis, seven days a week. Records are kept of pH values of the raw waste, after equalization and after neutralization. A slurry is made of dry hydrated lime in two tanks equipped with stirring mechanisms and the quantities of concentrated lime slurry added are varied in accordance with the pH values of the raw wastes. The lime slurry is added through three valved outlets from each storage tank.

Results obtained the second day of operation of the plant, indicating the changes in acidity of the waste after equalization and treatment, showed how rapidly control was possible. The flow, acidity and alkalinity of the raw waste entering the plant fluctuated greatly and at short intervals over a 12-hour period; the pH values varying from 3.2 to 10.5. After equalization, the fluctuations in pH values were materially reduced, varying from 4.9 to 9.0. This indicates the value of even a short period of equalization. Additions of lime slurry further

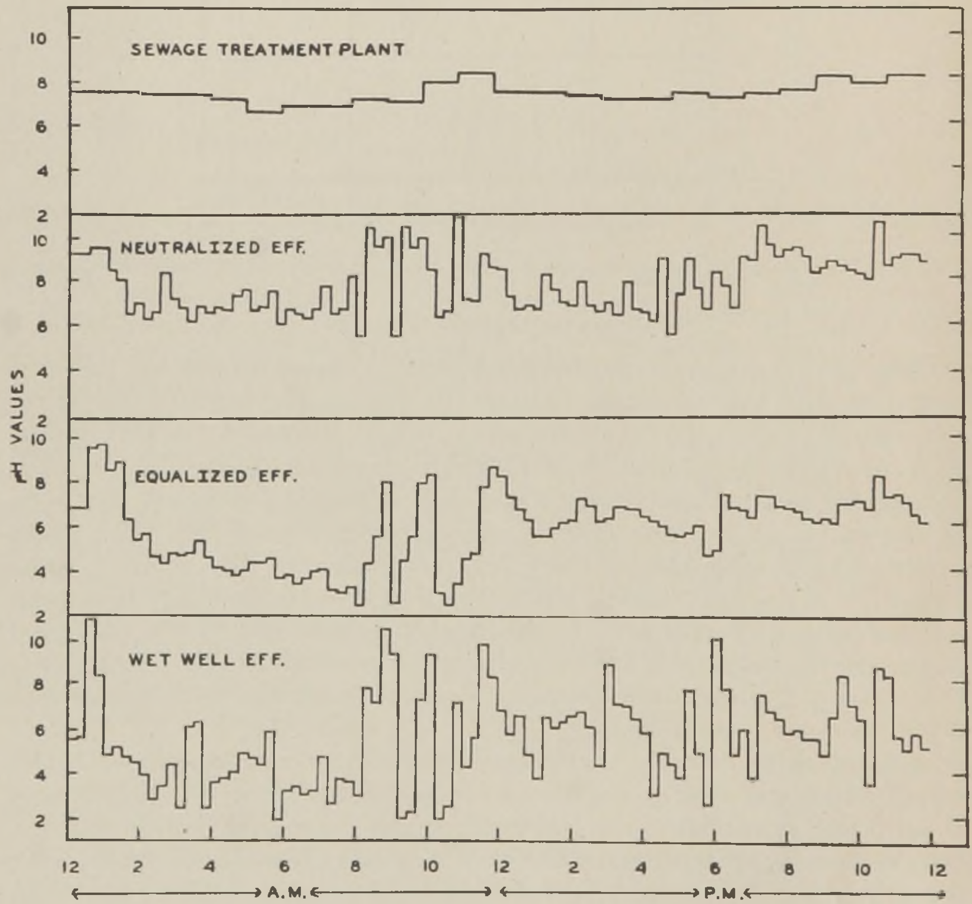

Fig. 3.—Effect on pH values of wastes after a short period of equalization and after lime treatment, together with pH values at sewage plant.

reduced the fluctuations and caused a rise in pH values from an average of 4.8 in the equalized waste to an average of 8.2 in the treated material.

An example of the rapid changes, the effect of equalization and lime treatment, together with the pH values observed at the sewage treatment plant, is shown in Fig. 3. It is clear that the level of the pH values are gradually raised as the treatment progresses, so that the effect of the waste is lost, so far as acidity is concerned, when the waste mixed with sewage reaches the sewage treatment plant.

Results obtained over a period of a week have been summarized and some of the significant figures are given in Table I. The average pH

TABLE I.—*Average pH Values over 24-hour Periods*

Date	Day	Raw	Equalized	Treated	At Sewage Plant
Sept. 17	Thurs.	4.9	5.1	7.9	7.3
18	Fri.	4.7	4.7	7.7	7.1
19	Sat.	4.7	5.2	7.6	7.0
20	Sun.	4.5	5.1	8.5	7.2
21	Mon.	5.2	5.5	8.2	7.3
22	Tues.	5.8	6.0	8.0	7.3
23	Wed.	6.1	6.4	8.0	7.1
24	Thurs.	4.6	5.5	7.1	7.2
25	Fri.	5.7	6.1	8.7	7.4

Note: Each figure in columns 3, 4, and 5 is the average of 96 determinations taken at 15 minute intervals; figures in column are averages of 24 hourly determinations.

values of the equalized waste show, as a rule, a decided increase over the raw waste, due to the utilization of some alkaline materials discharged. The treated material show average pH values well above the neutral point. The average pH values at the sewage treatment plant are lower than those of the treated wastes discharged. The lower values at the treatment plant were obtained on the total flow of mixed sewage and wastes.

The quantities of lime required for neutralization vary from a minimum of 800 to a maximum of 3,500 lb. per day, with an average of 1,690 lb., or about 1,440 lb. per mil. gals.

SUMMARY

Acid industrial wastes discharged by a large industry resulted in considerable difficulty at a sewage treatment plant. A plant to pretreat the wastes was built for the purpose of partial equalization and complete neutralization of the wastes. The acid wastes amounted to roughly 15 per cent of the total sewage flow. Measurements showed that very little mixing took place in the sewer over a distance of 3,000 feet, the acid wastes moving in slugs. Operation of the pre-treatment plant indicated that retention of the waste for as short as one hour caused material equalization. Effective neutralization is accomplished

by means of concentrated hydrated lime slurries. The quantities of lime required averaged about 1,440 lb. per million gallons.

Discussion

By Elson T. Killam

Consulting Engineer, New York, N. Y.

The paper by Dr. Rudolfs is an interesting and informative record of the solution of a troublesome problem through the various stages from the time of the original difficulties at the main disposal plant through successive stages of investigation, design, construction, and operation.

Similar problems are, and will be, present in other systems. Therefore the records of this project should be of considerable interest for reference in a field in which available data are rather limited. Continued operation of this plant will provide information of particular interest on the relative effectiveness of detention and mixing, versus increased chemical use for neutralization; together with data on cost of operation, optimum detention periods, and similar pertinent matters.

It is believed that the direct, prompt and effective solution of this problem was made possible primarily because of thorough investigation, the collection and analysis of many samples, and other field tests undertaken prior to design and construction. It is to be hoped that when the current period, affording little time for investigation, has passed, that the importance, economy and necessity for complete preliminary investigation will not be overlooked, but will be resumed with even greater emphasis.

The results of the investigation upon the effect of travel in the branch sewer upon smoothing out the peaks of concentrated wastes are extremely informative. One is often tempted to rely upon travel in the sewer for mixing and buffering, and the negligible benefits accruing from such travel, as revealed by these tests, are of interest.

Similar results were observed in a municipal sewer system during an investigation some years ago, when it was found that the weekly discharge of three relatively small vats at an industrial plant several miles from the disposal plant, even though mixed with a flow of some 10 million gallons of normal sewage, was so pronounced that the time of dumping of the vats could be estimated very accurately by observations of the pH in the sewage entering the disposal plant.

Examination of the curves indicates, as might be expected, that as detentions are reduced the variations in effluent quality vary throughout a wider range. It will be noted that in the hours from 9 to 5 P.M., during the period of highest flow and consequent minimum detentions, a much wider range of pH value occurred in both the equalization effluent and neutralized effluent. These variations are, in part, due to the fact that the industrial plant is growing rapidly and discharged maximum rates with respect to design. Furthermore, the records of operation were taken immediately after putting the plant into service, and operating experience will undoubtedly produce smoother effluent curves. The design involves no particular hydraulic or structural problems. The principal objective of the design was to provide maximum flexibility in operation.

Two units were provided in order to provide for high and low flows. Tank inlets and outlets were arranged to provide maximum efficiency in splitting the flow equally between two units when same were used in parallel. A supplemental provision for equalization was made by installing a pipe from the effluent of the mixing tanks, returning to the wet well. By this means it was believed that in the event of an extreme peak of acid, followed by higher alkalinity in the raw sewage, recirculation could be adopted to reduce chemical use. Each mixing chamber has three stirring mechanisms, each mechanism being provided with an independent drive unit to increase flexibility of operation. The purpose of the plant was purely for neutralization and not for sludge removal, and accordingly, in the design, every effort was made to minimize and avoid deposition of sludge. The plant was arranged in such manner that additional mixing tanks could be installed with minor piping changes. Particular attention was directed in the layout of the piping and the hydraulic design to allow for peak flows. This provision is especially important under present-day circumstances, when industrial plants are subject to radical expansion in extremely short periods. The necessity for such provision has been already emphasized, by a substantial increase in peak flows which has developed between the time of investigation and completion of construction of the facilities herein discussed.

ANAEROBIC DIGESTION *

II. NITROGEN CHANGES AND LOSSES DURING ANAEROBIC DIGESTION

By J. R. Snell

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The purpose of this article is to present the results of the author's experiments on the nitrogen losses and changes during anaerobic digestion, and to review the literature on the same subject, explaining some of the many inconsistencies which appear. It attempts to answer the question: "Are nitrogenous gases evolved during anaerobic digestion and if so, under what conditions?"

The theory proposed by Waksman (1) seems to answer the question very definitely. For the limited condition in which no oxygen is present, the theory states briefly that nitrogen cannot be evolved as a gas unless it is present in a nitrate or a nitrite. When in this form, however, a large percentage of the nitrogen may break down into N_2, N_2O, and NO gases and the remainder may be reduced to ammonia. None of these nitrogenous gases can be evolved unless nitrates or nitrites are present and then only in a total amount equivalent to the weight of nitrites or nitrates present.

The various articles appearing in the literature seem to disagree as to whether these nitrogenous gases are evolved, some supporting the Waksman theory and others opposing it. The latter find the loss of nitrogen as a gas from the anaerobic digestion of sewage sludge, which contains for all practical purposes no nitrates or nitrites.

The presentation of the author's experimental results and the conclusions drawn from them will be followed by a review of articles reporting the finding of nitrogenous gases evolved during anaerobic digestion. Probable errors will be pointed out and explanations given for their contradictory results. Following this a review will be given of the articles reporting that no nitrogen gas is evolved, and at the end will be given a general summary of results.

Description of Experiments

A series of four experiments was especially designed to prove or disprove the Waksman theory as stated above. Each experiment was conducted in a four-liter Pyrex bottle (see Part I for description of apparatus) and each bottle contained 500 grams of digested sewage sludge for seeding purposes, and was diluted to 3,000 grams in the final mix. The following nitrogenous substances (expressed as nitrogen) were added: in Experiment 65, 3,060 p.p.m. of proteose peptone as a supply of organic nitrogen; in Experiment 66, 1,000 p.p.m. of proteose

* This is the second of a series of papers based on two years of research at the Harvard Graduate School of Engineering. For the first paper, see *This Journal*, 14, 1304 (Nov., 1942).

peptone and 2,000 p.p.m. of $NaNO_3$; in Experiments 67 and 68, no proteose peptone, but 3,000 p.p.m. of $NaNO_3$ to each. In Experiment 67, 1,330 p.p.m. of sucrose was added after 408 hours and an equal amount was added at the end of 792 hours to supply the energy for the denitrifying bacteria. In Experiment 68, 1,670 p.p.m. of sucrose had been added at the beginning and then after 94 hours 500 p.p.m. of proteose peptone was introduced. As was stated above, each of these experiments had a total weight of digesting material of 3,000 grams.

The solids and nitrogen content of the digested sludge, proteose peptone, and sodium nitrate are given in Table I.

TABLE I.—*Solids and Nitrogen Content of Proteose Peptone, Digested Sludge, and Sodium Nitrate*

	Digested Sludge	Proteose Peptone	Sodium Nitrate
% Total Solids	4.03	95.66	99.93
% Volatile Solids	2.08	—	—
Nitrate Nitrogen*	0.2	0.7	164,700
Nitrite Nitrogen*	0.05	0.00	0.1
Ammonia Nitrogen*	350.0	<1.0	—
Total Nitrogen*	1,540.0	126,500	164,700

* P.p.m. as nitrogen on wet basis.

The gases evolved were measured and analyzed for CO_2, O_2, N_2O, NO, N_2, CH_4, and H_2 by the methods described in the first article of this series. Total and ammonia nitrogen content were determined for the seeding sludge, proteose peptone, and the digested mixture by distillation into standard acid, followed by titration. Nitrates, nitrites and ammonia nitrogen were determined colorimetrically. All of these tests were carried out as described in *Standard Methods of Water Analysis* (2). Several attempts to determine the nitrates and nitrites more accurately than by the standard colorimetric methods met with little success.

Results and Conclusions

The breakdown of the organic and nitrate nitrogen during digestion is shown for these experiments in Figs. 1 through 4, and the nitrogen present at the beginning and end of each experiment is given in Table II. This table also indicates the production of carbon dioxide and methane expressed as liters per kilogram of proteose peptone plus sucrose. With the exception of the experimental mixture containing proteose peptone and no sodium nitrate (Experiment 65), the amount of carbon dioxide produced was small and the methane produced almost negligible.

In Fig. 1 (Experiment 65) it is shown that seeded proteose peptone breaks down into carbon dioxide and methane. Over 90 per cent of the organic nitrogen is converted to ammonia nitrogen. No nitrates, nitrites, or nitrogenous gases are formed. The total nitrogen content recorded in Table II shows that there is a gain of less than 1 per cent during the experiment. This is well within the possible experimental error. The gas results have been corrected for the air present in the bottle at the beginning; that is, the oxygen absorbed and remaining from this air. It was shown in this experiment that *no* nitrogen gas was contained in the evolved gas.

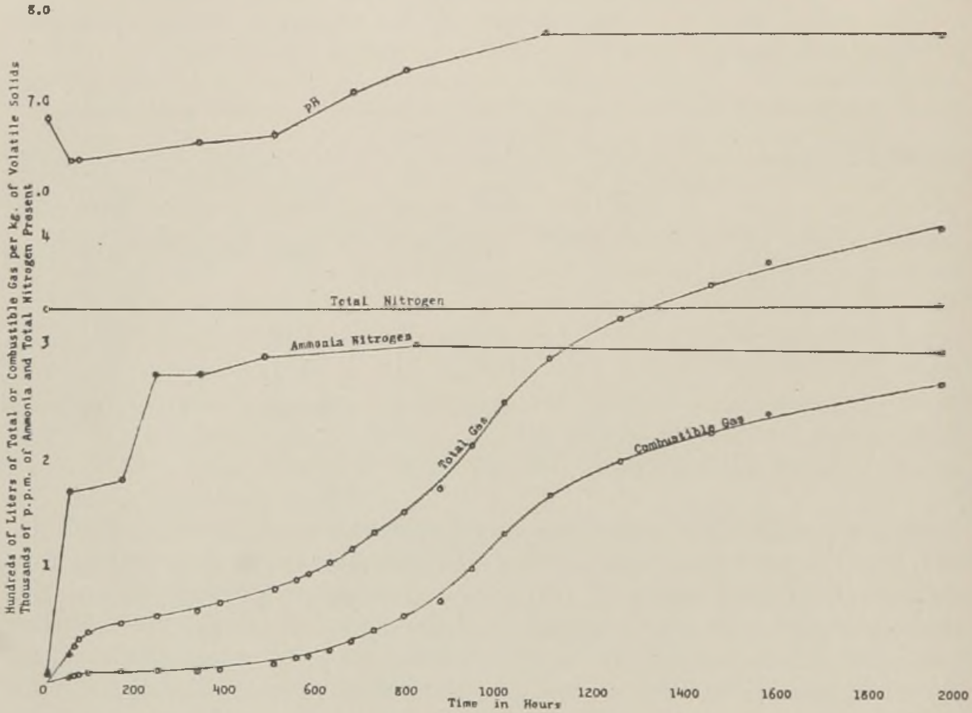


FIG. 1.—Nitrogen balance during the digestion of 3000 P.P.M. of proteose peptone. Experiment No. 65.

Figure 2 (Experiment 66) shows the decomposition of 1,000 p.p.m. of proteose peptone and 2,000 p.p.m. of sodium nitrate. The ordinates between the ploted lines represent the concentrations of the various forms of nitrogen, as indicated. It is seen that most of the nitrogen breaks down into N_2O and N_2 gases, but that a small amount of ammonia nitrogen is also formed. About 75 per cent of the proteose peptone nitrogen was decomposed into ammonia nitrogen instead of over 90 per cent as in Experiment 65, when nitrate nitrogen was absent. Only about 15 per cent as much carbon dioxide and about 2 per cent as much methane was produced as in Experiment 65. The nitrogen balance in Table II shows that considerable nitrogen was unaccounted for in this experiment. This was due to a loss incident to rapid evolution of gas during one night. It was known that some gas was lost but the amount was uncertain. Over 2,000 ml. was measured as evolved during that night. An additional 875 ml. would have accounted for all of the miss-

TABLE II.—*Nitrogen Balance for Experiments 65–68**

	No. 65	No. 66	No. 67	No. 68
At Start:				
Proteose Peptone	3,060	1,000	0	500
Sodium Nitrate	0	2,000	3,000	3,000
Digested Sludge	260	260	260	260
Total	3,320	3,260	3,260	3,760
At End:				
N_2O Gas	0	1,060†	495	1,325
N_2 Gas	0	430†	140	1,010
NO_2 Nitrogen	0	0	280±30	3
NO_3 Nitrogen	0	0	2,500±250	500±50
NH_4 Nitrogen	2,940	960	40	400
Organic Nitrogen	410	445	180	465
Total Nitrogen	3,350	2,895	3,635±280	3,703±50
CO_2 Produced‡	137.5	21.0	52.0	41.5
CH_4 Produced‡	266.0	5.7	1.4	5.4

* All nitrogen values are given as p.p.m. of nitrogen for the whole weight of 3,000 grams.

† Because of rapid evolution and escape of gas overnight these two values are low. When they are corrected so that the total nitrogen at the end balances with that at the start they become 1,390 p.p.m. N_2O gas and 465 p.p.m. N_2 gas.

‡ Liters per kilogram of volatile solids of proteose peptone and sucrose.

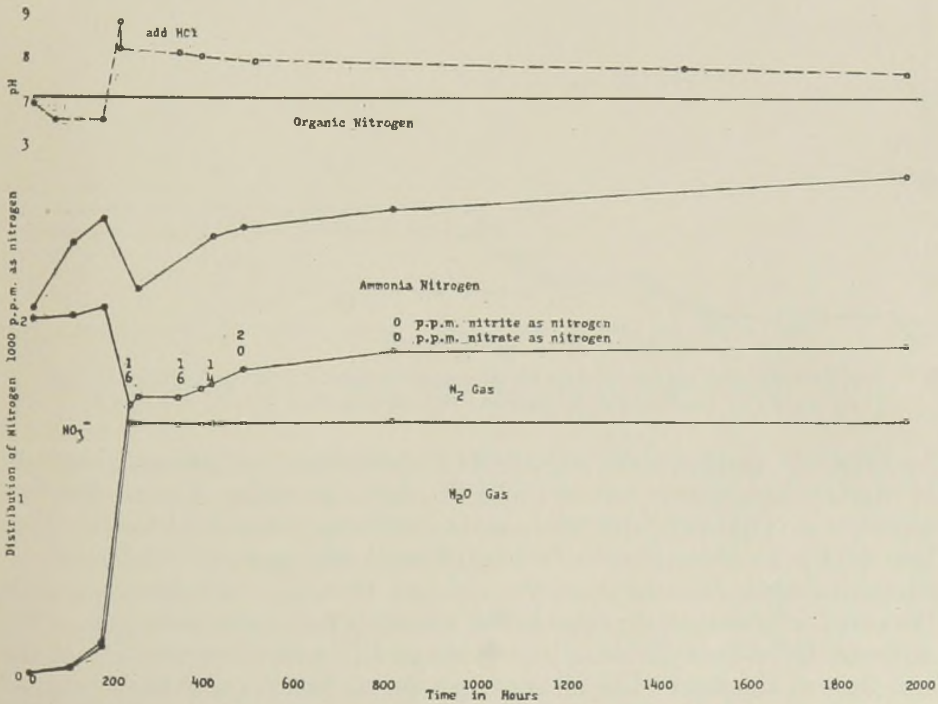


FIG. 2.—Nitrogen balance during the digestion of 2000 P.P.M. of sodium nitrate and 1000 P.P.M. of proteose peptone. Experiment No. 66.

ing nitrogen. The results plotted in Fig. 2 are corrected for this loss of gas.

The apparent error in the changes of organic nitrogen (Fig. 2) is due to the method of calculating the quantities of N_2O and N_2 gases produced. Actually all this gas is produced before the end of 220 hours when all but 6 p.p.m. of the nitrate has been decomposed. The only gases produced after that are CO_2 and CH_4. Both N_2O and N_2 gas contained in the space above the digesting mixture, however, were not measured and recorded until later. Experiment 66 shows that nitrogen present as nitrate may be lost during anaerobic digestion as N_2O or N_2 gas. NO gas was not found in any of the samples analyzed.

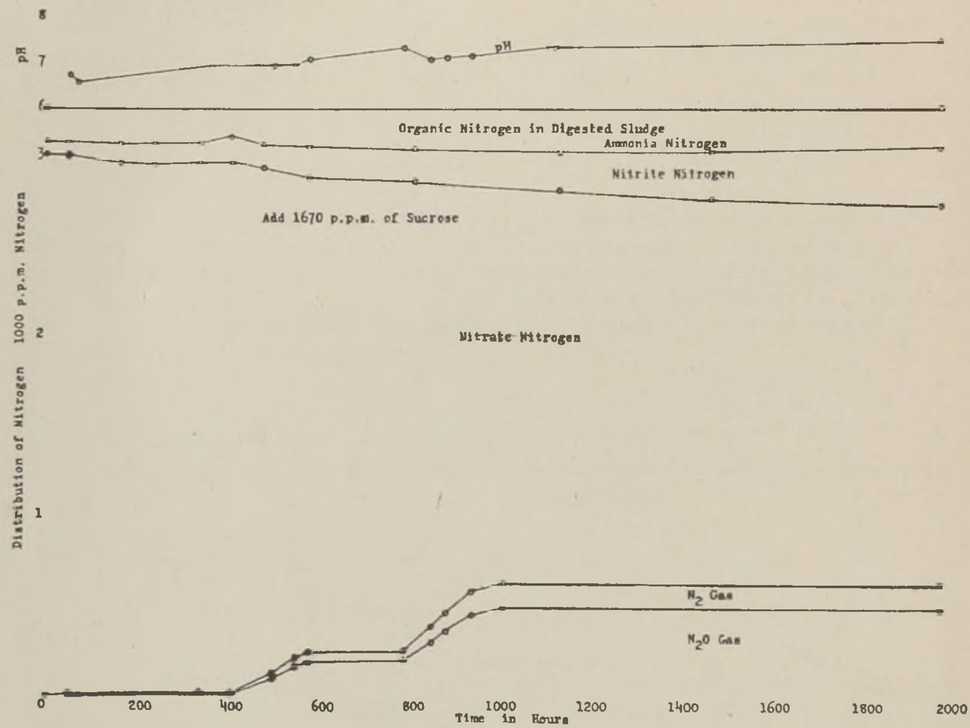


FIG. 3.—Nitrogen balance during the digestion of 3000 P.P.M. sodium nitrate and 3300 P.P.M. sucrose. Experiment No. 67.

Figure 3 (Experiment 67) shows the digestion of sodium nitrate to be almost negligible when seeded with digested sludge alone. Sucrose added after 410 hours and again after 790 hours aided in the denitrification of the sodium nitrate, but insufficient nitrogenous food was evidently present, for the bacteria did not complete the denitrification. However, nitrous oxide (N_2O) and nitrogen gas were given off. The nitrogen balance in Table II shows more nitrogen accounted for at the end than at the beginning of the experiment, but most of this error occurred in the nitrate determination, which is accurate only within about 10 per cent.

Figure 4 (Experiment 68) shows the digestion of sodium nitrate and sucrose when seeded with digested sludge. The break-down of the sucrose necessitated an adjustment of the pH with sodium hydroxide. Little nitrous oxide or nitrogen gas was evolved, but considerable nitrite nitrogen (300 p.p.m.) was formed. After 94 hours 500 p.p.m. of proteose peptone was added. It supplied the necessary food for the bacteria, and digestion proceeded rapidly. Adjustment of the pH with HCl was necessary because of the decomposition of the sodium nitrate. At the end of the experiment denitrification had not reached completion, but a trend toward that end was exhibited. It should be noted that the

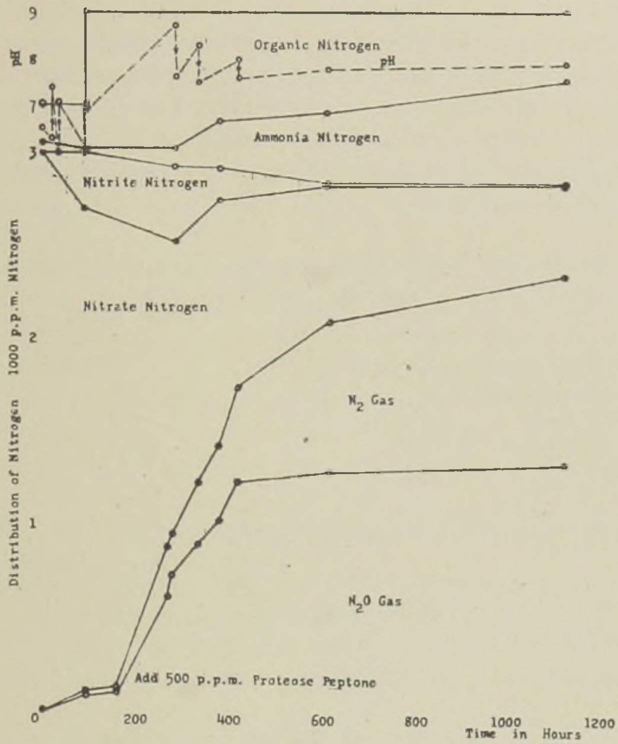


FIG. 4.—Nitrogen balance during the digestion of 3000 P.P.M. of sodium nitrate, 3330 P.P.M. sucrose and 500 P.P.M. of proteose peptone. Experiment No. 68.

rate of denitrification was lower in this experiment than in Experiment 66, where the proteose peptone was added at the beginning and twice as much of it was used. It would seem that at least 500 p.p.m. of organic nitrogen is needed to supply nutrition for the bacteria to carry on complete denitrification of 3,000 p.p.m. of sodium nitrate. To generalize from these few experiments, one would say that to obtain complete denitrification of nitrates the ratio of available organic nitrogen to nitrate nitrogen should be greater than one to six. The nitrogen balance in Table II shows that most of the nitrogen is accounted for in Experiment 68. The error again lies in the nitrate determination.

In other experiments, primarily designed to study the digestion of human excreta, nitrogen observations were made which further confirm the above theory. Attention is first called to an early experiment (No. 24) in which seeded feces were digested with 4,280 p.p.m. of ammonium nitrate. Analysis of the evolved gas showed 4 per cent CO_2, 1 per cent CH_4, and 1.5 per cent O_2. No analysis was made for N_2O or NO, but the expansion during combustion proved their presence. (See Article I.) The remaining 93.5 per cent may, therefore, reasonably be assumed to be a mixture of N_2O and N_2 gases. Making this assumption, 3,480 p.p.m. of the original 4,280 p.p.m. of ammonium nitrate was evolved as nitrogenous gases.

Determinations of total nitrogen were run before and after digestion on several of the feces and excreta digestion experiments. Direct nesslerization with the Kjeldahl method was employed for total nitrogen determinations so that the results summarized in Table III are accurate only to within 3 to 5 per cent. These results add further proof of the theory that nitrogen is not lost during anaerobic digestion unless it is present as nitrate or nitrite.

TABLE III.—*Nitrogen Balance in Experiments on Feces and Excreta Digestion*

Experiment	Total Nitrogen in p.p.m.	
	Beginning	End
No. 17—Unseeded Feces	1,970	1,940
No. 41—Seeded Feces	1,440	1,450
No. 40—Seeded Feces + 1/3 Urine	2,615	2,780

SUMMARY OF CONCLUSIONS

1. Organic nitrogen is not lost as a gas during anaerobic digestion. About 75 to 90 per cent of it is broken down into ammonia nitrogen.

2. Nitrate nitrogen breaks down into nitrous oxide (N_2O), nitrogen gas (N_2), and ammonia nitrogen when sufficient food is present for the bacteria.

3. About 90 to 95 per cent of the nitrate nitrogen is denitrified to N_2O or N_2 and the remainder is reduced to ammonia nitrogen when the digestion is complete.

4. The ratio of the quantity of N_2 gas to that of N_2O gas produced was found to vary from 1:2.8 to 1:1.3.

5. The experiments indicate that, to obtain complete denitrification of the nitrates, a ratio of available organic nitrogen to nitrate nitrogen greater than 1:6 should be established. This ratio is thought necessary to supply food for the bacteria.

LOSS OF NITROGEN DURING DIGESTION

Many authorities claim that organic nitrogen is lost during anaerobic digestion. They usually state that it is reduced and nitrogen gas is formed. Other authorities claim that it is impossible for nitrogen gas to form in anaerobic digestion and that no nitrogen is lost. An attempt will be made here to explain (*a*) how much of the nitrogen calculated to be lost may be accounted for, and (*b*) the necessary conditions for the formation of nitrogen gas during digestion.

Losses of Nitrogen Accounted for in Supernatant and Changes in Per Cent Solids of Sludge

Rudolfs (3), in an article on "Sewage Sludge as a Fertilizer," states: "Sewage sludge loses part of its nitrogen content in the course of digestion, probably most of it as nitrogen gas. . . . An average of a number of (plant) analyses shows 3.62 per cent total nitrogen in fresh solids and 2.70 per cent in the ripe (digested) sludge.

"Domestic wastes settled out in a sewage treatment plant contain from 20 to 25 per cent ash. These solids kept for a considerable number of days in digestion tanks decompose under anaerobic conditions producing about 70 to 75 per cent CH_4, 18 to 25 per cent CO_2, and 3 to 10 per cent N_2."

There are three major nitrogen changes to be considered during digestion: (1) The reduction in total solids due to loss of volatile solids. This would tend to increase the total nitrogen when expressed as per cent of dry total solids. (2) Loss of nitrogen in the sludge supernatant which is drawn off from time to time. A large part of the total nitrogen is changed from an insoluble to a soluble form during digestion and is without question lost with the supernatant. (3) Loss of nitrogen through denitrification into nitrogen gas.

From detailed data reported for Grand Rapids, Michigan (4), the following calculations are made:

	Average Per Cent Total Solids	Thousands of Pounds (15 Months)	
		Dry	Wet
Incoming Sludge	4.9	10,225	208,500
Sludge Withdrawn	12.9	5,738	44,400
Sludge Supernatant	0.44	595	135,000
Gas	—	3,827	3,827
Total of End Products		10,160	183,227

It is incorrect to expect the wet weights to check very closely, for an error of a few per cent in the per cent solids of the supernatant would cause a considerable discrepancy in the answer. However, this serves a purpose by indicating that over 75 per cent of the original volume of sludge (wet) is discharged as supernatant.

For the plant at Elyria, Ohio (4), the similar data are as follows:

	Average Per Cent Total Solids	Thousands of Pounds (15 Months)	
		Dry	Wet
Incoming Sludge	4.3	1,808	42,000
Sludge Withdrawn	5.4	438	8,130
Sludge Supernatant	1.3	386	33,700
Gas	—	369	369
Total of End Products		1,193	42,200

These wet calculations check very closely. Here the supernatant is 80 per cent of the total incoming sludge by volume.

The solids check, in the case of the Grand Rapids plant, but the liquids do not. In the Elyria plant the opposite is true. It would seem that the data of the first plant were made up from measurements of solids, and in the second from measurements of liquid volumes.

In batch (nothing added or removed) sludge digestion, if no nitrogen were lost as a gas, there would be an apparent increase in per cent total nitrogen present during digestion, because the per cent is based on the total solids present, and the total solids are reduced by about 25 per cent. If the per cent nitrogen were calculated on the basis of fixed solids the percentage would be less in error. A still better sytem would be to refer the per cent nitrogen of the digested sludge to the original solids content.

Rudolf's averages of 3.62 per cent total nitrogen for fresh sludge and 2.70 per cent for sludge digested at sewage treatment plants may then be corrected so as to apply to the original solids content. The value of $2.70 \times 0.75 = 2.02$ per cent nitrogen for the digested sludge is correct when referred to the original solids content.

This nitrogen loss is accounted for by nitrogen in the supernatant or in the gas of both. According to Rawn, Banta and Pomeroy (5), the fresh sludge has only 1.4 per cent of its nitrogen in a soluble form. After 32 days of digestion 43.8 per cent of the nitrogen is in solution, and after 55 days 59.5 per cent is in solution. Since about 80 per cent of the volume of wet sludge is wasted as supernatant, 80 per cent of the dissolved nitrogen present would be lost. This is $0.8 \times (3.62 \times 0.438) = 1.27$ per cent lost, or $3.62 - 1.27 = 2.35$ per cent remaining at the end of 32 days. By the end of 55 days the loss would have increased to $0.8 \times (3.62 \times 59.5) = 1.72$ per cent or the amount remaining would be $3.62 - 1.72 = 1.90$ per cent. The average figure for the per cent nitrogen remaining as given by Rudolfs (and corrected to the basis of the raw sludge solids) is 2.02 per cent, which lies between these two computed values. It is therefore possible that drawing off the supernatant accounts for all the nitrogen loss in regular plant digestion and no loss occurs through gas evolution.

Accounting for Calculated Nitrogen Losses as Nitrogen Gas

The average analysis of gases collected from some 30 sewage treatment plants, given in the Report of the Committee on Sludge Digestion (4), shows that the per cent nitrogen varies from 0.1 per cent in one plant to 13.4 per cent in another. The grand average for all 30 plants is 4.47 per cent nitrogen. (This average leaves out the third value because it is a repetition of the second. It also omits the value of 17.5 per cent for the Los Angeles Experimental Station, since that is recorded as including air.)

The Committee states, "The average composition (of sludge gas), based on the data given in the table, is approximately 59 per cent methane, 22 per cent carbon dioxide, 6 per cent nitrogen and 3 per cent hydrogen." Metcalf and Eddy (6) state that, "As a rule, the gases contain 60 to 80 per cent methane, 15 to 30 per cent carbon dioxide, and 5 to 15 per cent nitrogen and miscellaneous gases."

There are four main sources of error that would indicate the presence of nitrogen gas when none is actually present. The first could be due to a leak in the gas collection apparatus which would allow nitrogen from the air to enter the collection system. The second error would be very small and would be caused by the washing out of dissolved nitrogen in the fresh sludge by gases of decomposition. The amount of this error is estimated to be about 0.05 per cent ($\alpha = 0.01434$ at 25° for N_2, 3 per cent volatile solids). The other two errors occur in the gas analysis itself. Incomplete combustion in the burning of methane and hydrogen will indicate fictitious quantities of nitrogen. High nitrogen percentages can often be traced to this mistake. An insufficiently heated slow-combustion wire, too rapid passage of air into the gas, or an insufficient number of passages of the mixture over the hot wire will all cause incomplete combustion. Also there is in most analyzers an unavoidable manifold error which would show 0.9 to 1.4 per cent N_2 present in pure methane. (See Part I of this series.)

The determination of nitrogen by burning the methane and hydrogen with air cannot be assumed to be more accurate than within one or two per cent. The precision of this measurement can be increased to within 0.2 to 0.5 per cent by using a larger sample of gas (about 40 cc.) and burning it in pure *oxygen* (about 90 c.c.).

Nitrogen Balance Experiments on Sludge Digestion

Nitrogen balance experiments on full-scale multiple-stage sewage-sludge digestion by Rawn, Banta and Pomeroy (5) show that after corrections are made for loss of gas from the sludge there is a loss of 7 p.p.m. in 2,080 p.p.m., or 0.34 per cent of the nitrogen as determined from the wet sludges. This is within the probable error of the average determinations on the sludges.

Buswell (7), in digesting casein containing 7.40 grams of nitrogen seeded with sludge containing 1.97 grams of nitrogen (or a total nitrogen content of 9.37 grams), recovered 9.59 grams of nitrogen. He concludes from this that it is "impossible to account for the small amount of nitrogen found in the gas from any source other than the air."

Later work by Larson, Boruff and Buswell (8) on digestion of raw sewage sludge shows a 3.7 per cent gain in the nitrogen content of one tank, and a loss of 2.3 per cent in the other. The gain may be accounted for by errors in gas analysis due to incomplete combustion, for when this extra nitrogen gas recorded is changed to CH_4, it balances the carbon loss. The investigators state, "These balances are well within the limits of sampling and analytical errors."

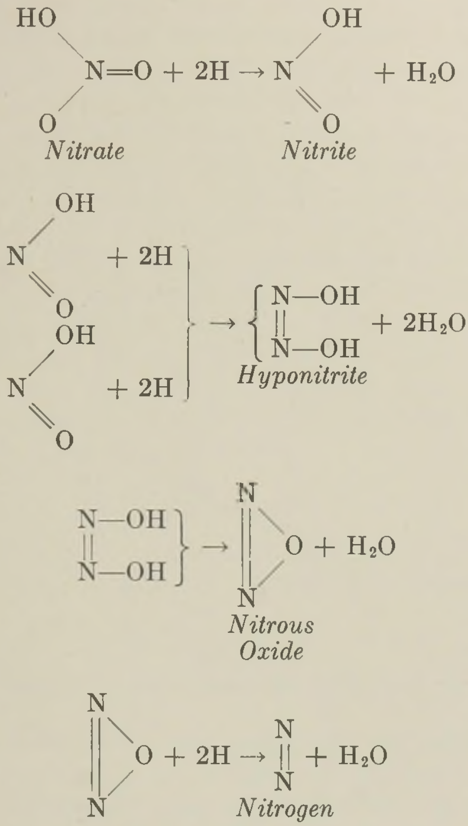
Takano (9), in Japan, ran chemical tests for total nitrogen content of human excreta. After the excreta had passed through a special five-chamber privy there was no evidence of nitrogen loss.

Digestion of Nitrate Nitrogen into Ammonia Nitrogen and Nitrogen Gas

Another aspect of the problem, perhaps of more theoretical than practical interest, involves the following question: Is it theoretically and experimentally possible to produce nitrogen gas by anaerobic digestion, and if so, what conditions are necessary for its production? Bacteriologists have long known that many organisms have the power to reduce nitrates to N_2, N_2O, or NO gases, or to nitrites and ammonia nitrogen. Probably the best source of information is Waksman's book, *Principles of Soil Microbiology* (1). This work states: "The disappearance of nitrates in the soil as a result of activities of micro-organisms may be due to three groups of phenomena. (1) Direct utilization of nitrates by micro-organisms as a source of nitrogen, in the presence of sufficient energy material. (2) Reduction of nitrogen to nitrite and ammonia in the process of the nitrate assimilation. (3) Utilization of nitrates as a source of oxygen (nitrates as hydrogen acceptors). In the last-named process oxygen is used by the organisms for the oxidation of carbon compounds or inorganic substances such as sulfur. The energy thus derived is used for the reduction of the nitrate to nitrite, free nitrogen gas, oxides of nitrogen, or the ammonia stage. . . . The term 'denitrification' (or complete denitrification) should designate the complete reduction of nitrates to atmospheric nitrogen and oxides of nitrogen, while the other process involving the disappearance of nitrates may be referred to as 'nitrate reduction' and 'nitrate assimilation.' "

In the first two phenomena defined, no nitrogen is lost overall, and further discussion of them, while of considerable interest, will be omitted.

From work done by Blam (10), Waksman suggests that the following formulas are now accepted as best describing the reactions taking place in the conversion of nitrates to nitrogen gas and to N_2O gas:



The progress of the above reactions is shown graphically in Fig. 5, taken from an experiment by Korsakowa (11) (Waksman, p. 483).

To complete the picture Waksman discusses the formation of nitrogen gas through the decomposition of organic compounds. He says that nitrogen gas may be generated by the rapid oxidation of ammonia which is formed from those compounds, as follows:

$$4NH_3 + 2O_2 \rightarrow 6H_2O + 2N_2, \text{ or}$$

$$2NH_3 + 3H_2O_2 \rightarrow 6H_2O + N_2.$$

Waksman further states, "These two processes may play an important part in causing a loss of nitrogen in the decomposition of manure. Nitrogen gas may also be formed by the interaction of nitrites with amino compounds; both of these may be formed in the decomposition of organic matter rich in nitrogen accompanied by the incomplete liberation of ammonia, as follows:

$$-CH_2NH_2 + HNO_2 \rightarrow -2CH_2OH + H_2O + N_2.$$

The free nitrogen may of course be a result of the chemical interaction of the oxides of nitrogen and ammonia, *i.e.*

$$NH_4NO_2 \rightarrow N_2 + 2H_2O."$$

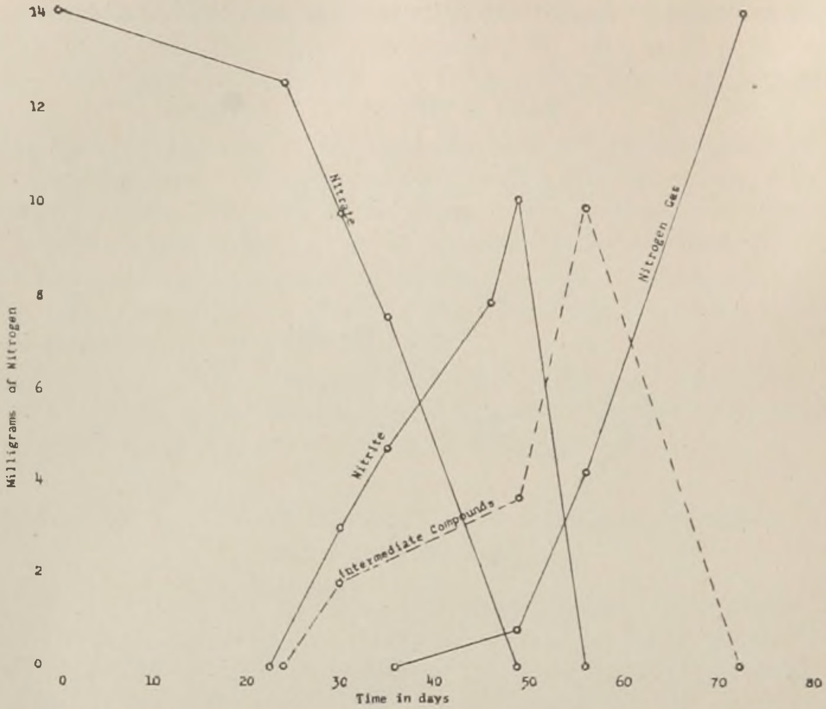


FIG. 5.—Reduction of nitrates by microbes (after Korsakowa, Reference 102).

From this discussion it is evident that nitrogen gas can be liberated during anaerobic digestion, but only when nitrates or nitrites are present. The absence of free oxygen prevents organic nitrogenous material from evolving any nitrogen gas. Since nitrates and nitrites constitute only a small percentage of the total nitrogen present in activated sludge and are entirely negligible in sludge produced by plain sedimentation of sewage, the loss of nitrogen gas during anaerobic digestion may be considered unimportant. In cases where the sewage contains industrial wastes rich in nitrates, losses during digestion do become more important.

IMPORTANCE OF DENITRIFICATION AND NITRATE REDUCTION IN THE SOIL

Waksman (1) states that denitrification and nitrate reduction occur in the soil when considerable amounts of organic matter are added together with the nitrate nitrogen. This is especially true when the soil is more than 40 per cent saturated with water. In the case of soils kept under water for some time, as in rice-field soils, the addition of nitrates may even prove injurious due to the formation of toxic nitrites. He continues: "The losses of nitrogen in the manure compost were found to be due largely to the presence of nitrate-forming bacteria. When these bacteria are eliminated or conditions are made unfavorable for their growth the losses are considerably reduced. The presence of the bacteria resulted in an increase in the loss of nitrogen from

6.28 to 23.75 per cent in the case of horse manure. . . . Applications of acid phosphate were found to be useful in the preservation of the manure by neutralizing the ammonia and lowering the pH.'' The use of human excreta on rice fields involves no nitrogen loss because of the complete lack of nitrates. Nitrates present in the soil previous to flooding are probably lost during the flooded period. Lyon (12) states that the use of digested rather than the fresh excreta would probably cause a smaller loss of nitrates because fresh excreta provides better food for the denitrifying bacteria. One way to prevent loss of nitrates would be to prevent their formation during the year. Probably flooding several weeks in advance of the addition of fertilizer would give the nitrates time to be reduced to ammonia and thereby to be conserved. Waksman (1) says that the use of disinfectants for the destruction of denitrifying bacteria in the soil is often recommended. The optimum reaction for denitrification is at pH 7.0 to 8.2; the process is greatly retarded at pH 3.2 to 5.8 and 8.2 to 9.0.

Summary

1. During studies of the anaerobic digestion of human excreta special experiments were devised to study the changes and losses of nitrogen.

2. These experiments included nitrogen balances during the anaerobic digestion of proteose peptone, of mixtures of proteose peptone and $NaNO_3$, and of mixtures of sucrose and $NaNO_3$, with and without proteose peptone added. Each experiment was seeded with digested sludge.

3. Nitrogen balances were also run on experiments designed primarily to study the digestion of human excreta.

4. The results from these experiments are in perfect accordance with Waksman's theory that, for the limited conditions in which no oxygen is present, nitrogen cannot be evolved as a gas unless it is present in the form of a nitrate or a nitrite. When present in this form, however, a large percentage may break down into N_2, N_2O, and NO gases, and the remainder may be reduced to ammonia. None of these gases can be evolved unless nitrates or nitrites are present and then only in a quantity equivalent to the weight of the nitrate or nitrite present.

5. A review is given of the literature which claims that nitrogen is lost during anaerobic digestion and explanations of probable errors are pointed out which adequately account for the contrary results.

6. A review is also given of the literature showing no loss of nitrogen as a gas during digestion.

7. A few practical applications are pointed out.

Acknowledgment

The author gratefuly acknowledges his indebtedness to Professor G. M. Fair of the Harvard Graduate School of Engineering for his consultation in this work.

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Industrial Wastes

CHARACTERISTICS AND TREATMENT OF POTATO DEHYDRATION WASTES *

By Harold Farnsworth Gray and Harvey F. Ludwig †

Vegetable dehydration wastes may be classified, at least at present, as war production wastes. The necessity for transporting overseas, with a critical shortage of shipping facilities, the great quantities of vegetables required by the Army, Navy, and Lend-Lease has resulted in a tremendous expansion of the vegetable dehydration industry. Prior to the war stimulus the normal dehydrated vegetable production in the United States amounted to about 3,000 dry tons annually; this year, 1942, it is estimated that some 50,000 dry tons will be prepared. A majority of the vegetable dehydration plants have been located on the west coast, particularly in California, where numerous fruit dehydrators have been available for ready conversion to vegetable drying. Seven vegetables have been of major importance in the dehydration program, viz., white potatoes, onions, cabbage, carrots, sweet potatoes and yams, beets, and turnips. Of these the white potatoes have been most important, constituting possibly half of the total production.

Liquid wastes resulting from the dehydration of potatoes and other root vegetables such as carrots, turnips, etc., are derived from the processing operations preparatory to drying. Figure 1 illustrates a typical plant flow sheet, in which it is seen that prior to drying the potatoes are peeled (mechanically), trimmed (manually), diced or otherwise cut up into small segments or shapes, washed, and steam blanched. The product is then spread on the drying trays, and these are stacked onto trucks and passed through the tunnel driers. The liquid wastes are associated, as indicated by the double-line boundaries in Fig. 1, with the operations of peeling and of washing after cutting. Abrasive carborundum units, either batch or continuous, are generally employed for peeling, the surface of the potato being simply rubbed off to the desired degree of peeling, and the remaining bits of skin, eyes, etc., being later removed by manual trimming. The rubbing action is carried out under water sprays, and the rubbed-off material is piped from the peelers as a liquid waste. The operation of washing the cut potato shapes is necessary to remove the surface materials which would otherwise cause sticking and matting of these shapes when they are later dehydrated. This washing operation employs water sprays, these frequently being incorporated in the structure of the steam blancher.

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Separate barrel and other type washers may also be used. The washings are collected by floor drains, and are hereinafter described as the spray washing wastes. There are also intermittent plant washing wastes, most plants being hose-cleaned after each shift; but these are of small quantity and significance. The trimming wastes are removed as garbage. Dehydration plants usually operate 24 hours daily, seven days per week, as it is costly to break the drying cycle.

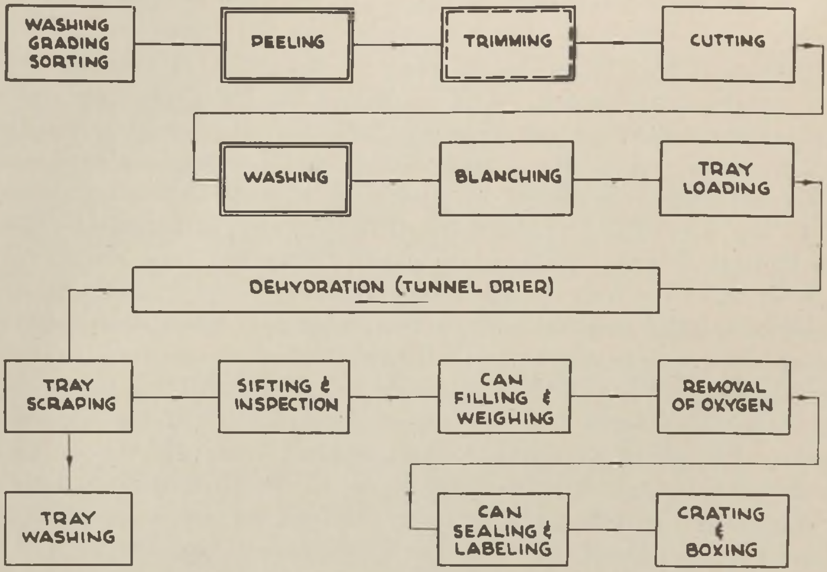

FIG. 1.—Typical flow sheet for root vegetable dehydration plant.

Characteristics of Abrasive Peeler Wastes

The percentage of the initial weight of potato rubbed off in the abrasive peeling operation varies over wide limits. Under very favorable conditions, with properly sorted potatoes of good size and quality, these losses may be as low as 12 or 15 per cent. Generally they will be greater, particularly if the potatoes are not sorted, are excessively irregular, have rough surfaces, or have become softened by improper storage. Losses of 30 per cent and more are not uncommon. The losses will also depend, of course, upon the degree of peeling desired, or, in other words, upon the amount of skin to be left for removal by hand trimming. Usually the potatoes are mechanically peeled to a high degree, only some eyes and irregularities remaining.

General characteristics of abrasive peeler wastes are given in Table I. These wastes amount to approximately 600 gal. per ton of potatoes handled; for an ordinary sized plant of about one ton per hour capacity this will equal 14,400 gal. per day. Since the organic loading carried by these wastes will be proportional to the percentage loss in the peelers, this loading has been expressed as the quantity of B.O.D., suspended solids, or other constituent, per ton of potatoes handled per percentage of loss in the peelers. Considering the 5-day B.O.D., for example, the peeler wastes will contain approximately 1.0 lb. B.O.D. per ton per percentage; and in the usual plant (peeler losses 20 per cent) of ordinary size (one ton per hour) this will amount to 480 lb. B.O.D. daily, equivalent to a population of roughly 4500 (at 0.11 lb. per capita per day).

TABLE I.—*Characteristics of Potato Dehydration Wastes*

	Abrasive Peeler Wastes	Spray Washing Wastes
Quantity of Flow	—	—
Gal. per ton (of potatoes dehydrated)	600	2,500
B.O.D. (5-day, 20° C.) (bicarbonate dil. water)	—	—
Parts per million (approx.)	4,000	1,000
Lbs. per ton per per cent loss (in peeling)	1.0	—
Lbs. per ton	20	20
Lbs. per lb. dry potato solids	0.20	—
Per cent removed by screening (60 mesh)	20±	0
Per cent removed by 10 min. settling	30±	Little
Suspended Solids (with Whatman 40 paper)	—	—
Parts per million (approx.)	18,000	1,500
Lbs. per ton per per cent loss	4.5	—
Lbs. per ton	90	30
Lbs. per lb. dry potato solids	0.90	—
Per cent removed by screening (60 mesh)	30±	0
Settleable Solids (2 hrs. detention)	—	—
Ml. per liter (approx.)	185	12
Cu. ft. per ton per per cent	0.7	—
Cu. ft. per ton	15	4
Cu. ft. per lb. dry potato solids	0.15	—
Per cent removed by screening (60 mesh)	80±	0
Per cent removed by 10 min. settling	90±	Little
pH (approx.)	6.5	6.9

Notes.—The p.p.m. and lbs. per ton values for the peeling wastes correspond to an assumed peeling loss of 20 per cent.

Solids concentration of potatoes 25 per cent.

In determining the B.O.D. of the peeling wastes the sample was macerated for 10 min. in a Waring Blendor, diluted 1 : 9 with water, and then mixed 1 : 3 by volume with domestic sewage. The B.O.D. of the peeling wastes was computed from the values for the mixture and for the domestic sewage. The B.O.D. of the spray washing wastes was similarly determined from a 1 : 3 mixture with sewage.

The settleable solids for these wastes are high, equal to 0.7 cu. ft. per ton per percentage, or about 335 cu. ft. daily for the 24-ton plant mentioned above. Ninety per cent of the settleable solids are removed during the first 10 minutes settling, this representing the coarse pieces of potato. During the next 20 minutes a layer of fine starch particles settles out, these particles later permeating to the bottom of the mass of sludge. Very little further removals can be feasibly effected by plain sedimentation. Further removals can be effected by chemical flocculation, but very high dosages are required.

On standing the abrasive peeler wastes quickly undergo decomposition with the production of a nauseating odor typical of fermenting starch. The pH drops during the first 24–48 hours, reaching a value of

5.0–5.5, after which further change in the pH evidently depends upon the particular types of organisms present.

Characteristics of Spray Washing Wastes

General characteristics of these wastes are given in Table I. They amount to about 2500 gal. per ton of potatoes handled, roughly four times the volume utilized for abrasive peeling. The total organic matter carried by these wastes is about equally divided between: (1) a soluble fraction, and (2) a suspended fraction consisting of fine starch particles, most of which will be removed in a 30-minute laboratory settling period. The organic loading for these wastes will vary considerably at different plants, depending upon the amounts of surface area exposed by the different methods of cutting (slicing, dicing, shredding, etc.). Table I represents the usual case where the potatoes are extruded or stripped into small elongated bars. Although the volume of these wastes is large compared with the peeler wastes, their concentration of organic matter is very much less. For the ordinary sized plant of one ton per hour capacity the total daily volume of these wastes will be about 60,000 gal., containing about 480 lb. of B.O.D., equivalent roughly to a population of 4500, about 720 lb. of suspended solids, and about 96 cu. ft. of settleable solids.

Composition of the Potato

The organic matter making up the whole potato may be classified (1) in three parts: the skin, the cortex, and the pith or flesh. The cortex ring has a thickness of about one-tenth the potato breadth, and practicaly all of this is removed by abrasive peeling. Both the cortex and pith contain on the average about 20 per cent solids, comprising about 16 percentage units of starch, 2 of protein matter, 1 of ash, and ½ each of fiber and sugars. Approximately 15 per cent of the organic (non-ash) solids are soluble in water. The solids content of different potato types varies considerably, over a range of about 15 to 30 per cent. Utah-Idaho varieties have the highest solids concentrations, Rocky Mountain types the least, and eastern potatoes are intermediate. Other factors which may considerably influence the solids composition of the potato are seasonal variations, methods of culture, and storage. The solids content of different root vegetables are also different; carrots and rutabagas, for example, have average concentrations of only about 10 per cent.

The "per ton per percentage" values given for the abrasive peeler wastes in Table I correspond to potatoes of high solids content (25 per cent), these of course being preferred for dehydration purposes. Since these values will vary with different solids contents, it seems desirable, for purposes of comparing different types of potatoes or even different root vegetables, to express the B.O.D., suspended solids, or other constituent per unit weight of dry vegetable solids contained in the wastes. These data have been included in Table I.

Waste Disposal at Modesto

At the Modesto, Calif., plant of the Pacific Coast Dehydrated Products Co., Oakland, Calif., the spray washing and the screened peeler wastes are combined and disposed of by irrigation. Figure 2 illustrates this plant, which at the time of sampling was operating at about 28 tons daily capacity. The abrasive peeler wastes are piped to a vi-

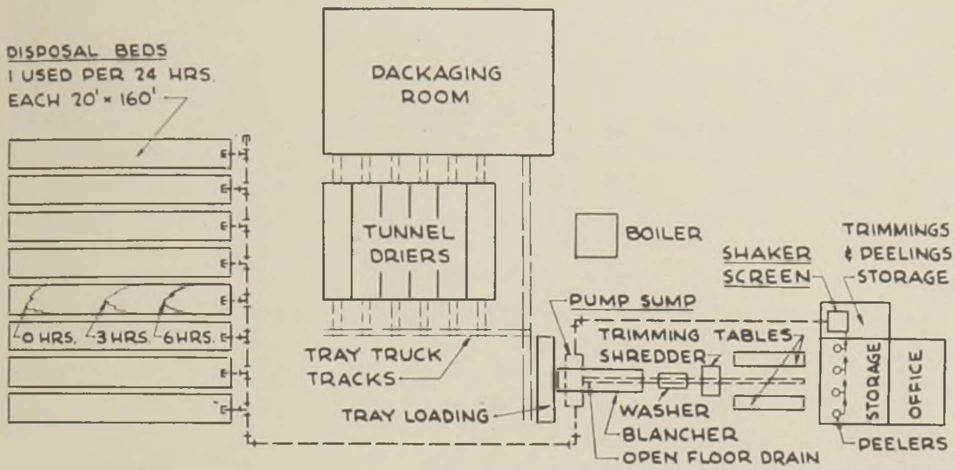

Fig. 2.—Modesto potato dehydrating plant, Pacific Coast Dehydrated Products Co., Oakland, Calif.

brating 60-mesh shaker-screen which removes the coarser particles (representing 80 per cent of the settleable solids, 30 per cent of the suspended solids, and 20 per cent of the B.O.D.). The screen effluent flows by gravity to a pump sump. The various spray washing wastes are collected into this same sump by means of a floor channel running beneath the line of equipment. The combined wastes are pumped continuously to one of the disposal beds, the flow velocity being adequate (one foot per second) to prevent settling of starch in the pipe. Seven disposal beds, each about 20 ft. by 170 ft., are used in rotation. A new bed is placed in service each 24 hours, beginning at seven o'clock in the morning at the change in shifts. In Fig. 3 are shown the total 24-hr. quantities of flow, 5-day B.O.D., suspended solids, and settleable solids at various stages through the plant.

The period of time required for the beds to dry varies with weather conditions, but during the month of September, characterized by ample sunshine and mild winds, all the surface water percolated into the ground by about six hours after the flow had been shut off. This represents a total percolation time of 30 hours, and an effective percolation rate of approximately two inches per hour. This rate is high, as would be expected by the sandy nature of the soil (Fig. 4). The soil has been identified as Delano fine sandy loam, and has a porosity of 50 per cent. An experimental laboratory test showed the percolation rate of clear water through a 12 in. column of this material under an initial head of 12 in. at 20° C. to be 3.0 in. per hour.

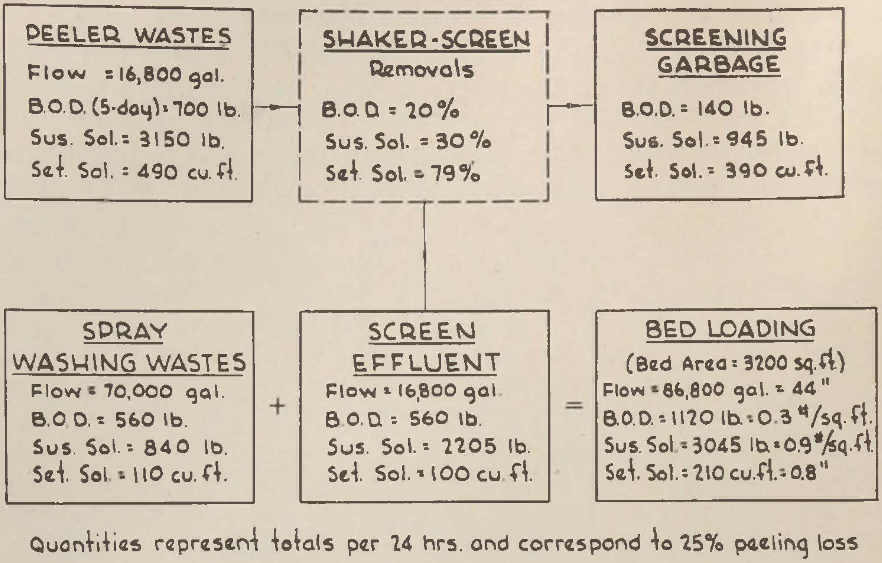

FIG. 3.—Waste disposal at Modesto—28 ton daily capacity.

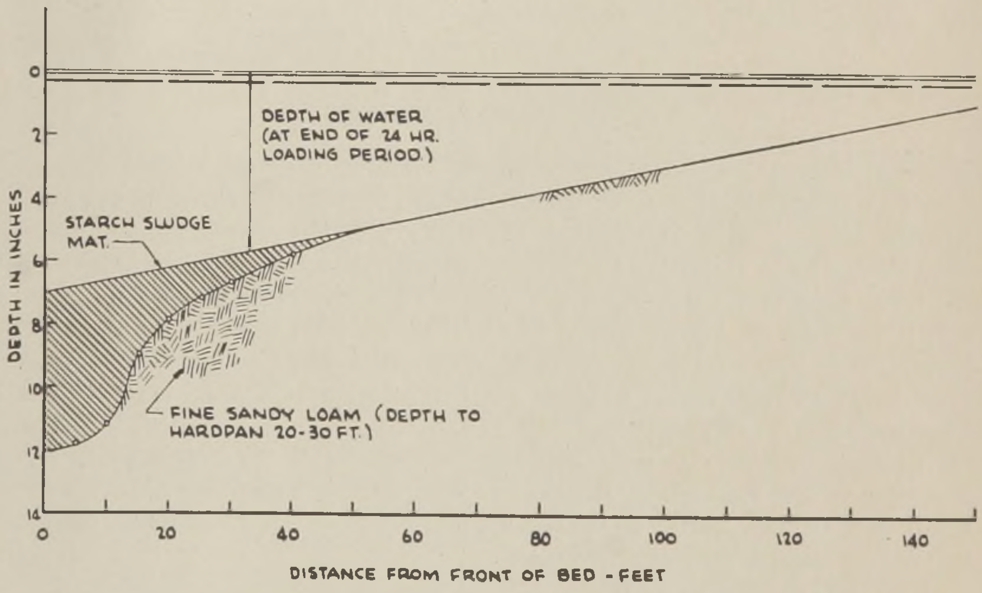

FIG. 4.—Profile of disposal bed along longitudinal centerline.

The exposed starchy sludge mat dries very readily, even in the deepest areas. About 30 hours after disappearance of surface water the sludge has reached a moisture content of approximately 30 per cent at which point it is sufficiently dry for shoveling. The sludge is shoveled from the beds into piles and then onto trucks for removal as garbage. The beds are disced soon thereafter. No clogging of the soil could be observed on discing, and although the beds had been operated only a few weeks at the time of these studies it is believed that their capacity to absorb these wastes will not be substantially decreased by clogging.

The disposal beds are practically free from all but slight odors, and very little if any odor can be detected more than 50–100 ft. from the beds. Odors develop only when the sludge is maintained fairly moist for long periods of time. The most odor occurs when the sludge is shoveled from the beds, but this disappears very quickly.

Recommended Disposal Methods

In very few dehydration plants would the installation of advanced treatment (such as chemical flocculation or biological oxidation) be justified. If such a high degree of treatment is essential, due to conditions of final disposal of the effluent, it may be cheaper to shut down and move the plant to a more favorable site. In most cases the best solution appears to comprise primary sedimentation plus disposal of the effluent by irrigation. Where excellent percolating beds are available, as at Modesto, no pretreatment is really essential, as the initial sections of the beds themselves can serve as primary settling units. Generally it will be best to provide a primary settling tank (such as a Dortman tank) with a design detention period of not less than 30 minutes, and with provision for removal of sludge accumulations at least daily. This will effect removal of most of the settleable solids, including the fine starch particles which might readily clog an ordinary soil. These fine starch particles might also cause trouble, if not removed, by setting out in conduits or sewers and forming a hard bottom mat. The percolating properties of the soil may be measured by a simple hydraulic test, and the necessary area estimated accordingly. Inasmuch as the wastes percolating into the soil are predominantly acid, it is improbable that the permeability of the soil will be lessened by base-exchange reactions. Other effects which might possibly result from addition of this supply of hydrogen ions to the ground water can only be conjectured.

Other Methods of Peeling

The peeler waste characteristics described above are based on the use of the abrasive type peeler, this type now being in common use. It is quite possible that this method of peeling will become obsolete and be supplemented by improved methods, such as flame peeling and lye peeling, which can remove the skins with much smaller losses. Whatever the method of peeling, the organic loadings of the liquid peeling wastes can be estimated from Table I by multiplying the values expressed per unit percentage peeling loss by the percentage loss actually obtained (with a correction for differences in solids content). With either of the new methods mentioned it will probably be possible to reduce peeling losses to values of ten per cent and less.

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Stream Pollution

SEWAGE, ALGAE AND FISH *

By Floyd J. Brinley †

U. S. Public Health Service, Cincinnati, Ohio

Much has been written concerning the effects of stream pollutants on fish life. It is the general belief that fish cannot live in a stream polluted by domestic sewage or industrial wastes. The conservationists would like to have all waste materials prevented from entering our streams, thereby returning them, at least partially, to their virgin state. This, of course, would be ideal, but our population has increased to more than one hundred million people, conditions have changed and the clock cannot be turned backwards. Few people, however, seem to realize that domestic sewage, after proper treatment, increases the stream's biological productivity as represented by the plankton and fish population. It is the purpose of this paper to show that treated domestic sewage acts as a fertilizer for a stream in much the same manner as barnyard manure does for field plants.

While making a biological survey of the Ohio River Watershed the author was able to collect a large amount of data on the relation of domestic sewage to aquatic life. The present paper is based upon the data presented in detail in a supplement of a forthcoming report of the Ohio River Pollution Survey (1).

Relation of Sewage to Algae

The entrance of untreated domestic sewage produces a well defined series of physical, chemical and biological changes in a flowing stream (2). In heavily polluted streams, the region immediately below the source of pollution is characterized by a high bacterial population. The water frequently has a cloudy appearance, high biochemical oxygen demand and a strong disagreeable odor, all indicating general depletion of dissolved oxygen. Masses of gaseous sludge, rising from the bottom of the more sluggish streams, are often noticed floating near the surface of the water. The plankton population in this region is composed largely of bacteria-eating ciliated protozoa, such as *Paramecium* and *Colpidium*. Large numbers of stalked ciliates (*Vorticella* and *Carchesium*) are frequently found attached to bottom objects. Colorless flagellates may be abundant, with an occasional chlorophyll-bearing species. The total volume of plankton is usually less than 2000 parts per million, but may reach several times that figure if conditions are optimum for

* Published by permission of the Surgeon-General. From the Division of Public Health Methods.

† Now at U. S. Public Health Service, Austin, Texas.

the development of large numbers of protozoa. Long streamers of sewage fungus are frequently attached to submerged objects. The fishes that normally penetrate this region are carp and buffalo and they are found near the sewer outlet, feeding upon the raw sewage, where the bacterial action has not yet depleted the dissolved oxygen. These fish survive the prevailing low oxygen concentration by coming to the surface to "gulp" air.

Farther down stream, after sufficient time has elapsed for the masses of bacteria to decompose the sewage, the water tends to become clear and the dissolved oxygen level is sufficiently high to support forage and rough fish. The plankton population is slightly higher than upstream but is still composed largely of ciliated protozoa and colorless flagellates. Chlorophyll-bearing species are beginning to make their appearance in noticeable numbers. Blue-green and filamentous green algae are commonly found along the margins and bottom of the stream. Accumulated oxygen may bring large masses of the bottom algae to the surface of the water and give to the stream an unsightly appearance. (These floating islands of algae should not be confused with the gaseous sludge masses previously mentioned.) The combined photosynthetic action of all the green plants is an important factor in raising the oxygen level, especially on bright sunny days.

The adjacent region farther downstream clearly shows the beneficial effect of the decomposed sewage which entered upstream. The bacterial action in the upper reaches of the stream has oxidized the complex organic compounds present in the sewage to nitrates and phosphates. The availability of these end products as plant foods results in the development of large numbers of chlorophyll-bearing algae, which furnish food for the zooplankton and this food supply results in an increase in the population of mixed fishes (Fig. 1). The photosynthetic action of the green algae in this region increases the dissolved oxygen, often to supersaturation during the day, which, however, decreases at night but seldom to the asphyxial level for fishes.

Still farther downstream the plankton population drops sharply, probably owing largely to the utilization of the available food materials by the heavy growth of plankton in the upstream region. There is a tendency for a reduction in the forage and rough fishes, but the game fishes tend to increase.

The above statements give a brief description of the conditions present in a small stream that receives untreated domestic sewage. However, if the waste receives complete or secondary treatment, so that the bacterial action oxidizes the sewage to available plant foods before the effluent enters the stream, the early obnoxious stage will not occur and the stream will be benefited by the fertilizing effect of the sewage for many miles of its length. Beneficial effects of primary treatment are shown by the reduction in sludge deposits and a shortening of the zone of degradation.

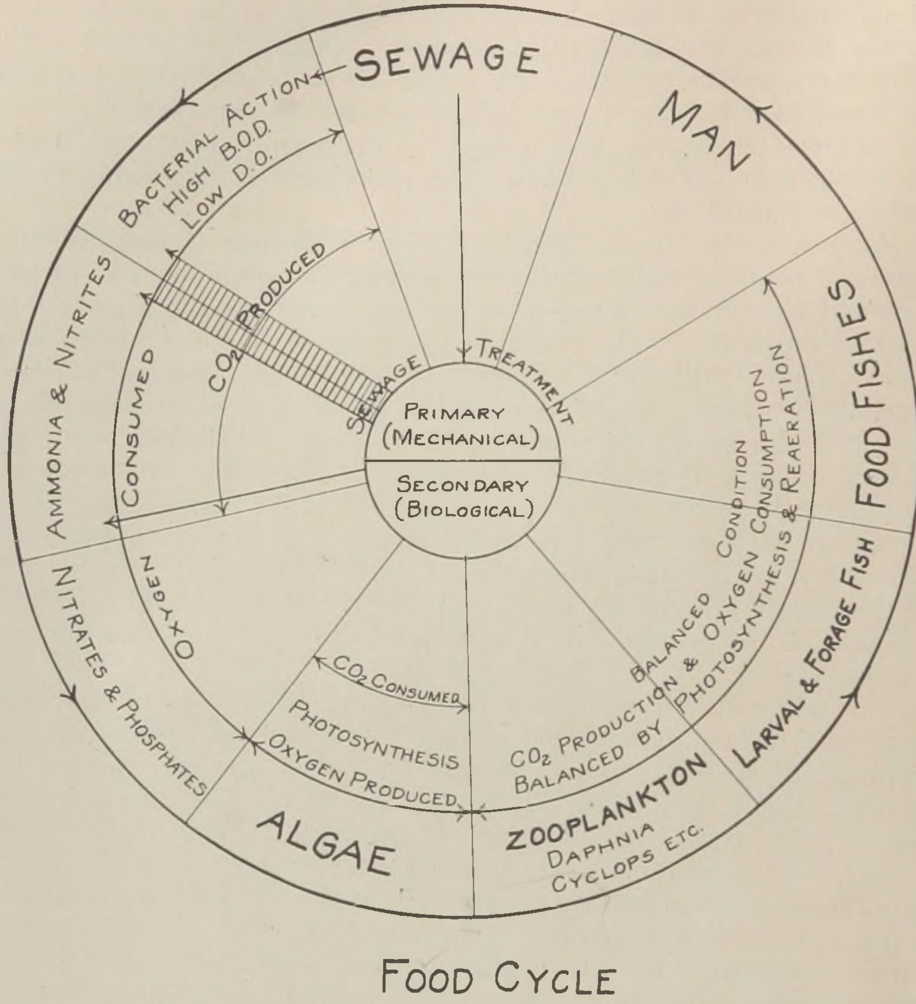

FIG. 1.—Food Cycle in a Polluted Stream. Sewage or other putrescible organic matter after entrance into a flowing stream is changed by bacterial action into ammonia and nitrites and finally into nitrates and phosphates. These latter compounds are assimilated by the algae and result in an increase in growth of these plants. The algae are consumed as food by the larger plankton, zooplankton, which in turn are eaten by fishes. Cross hatched area shows the condition of the effluent as it leaves the treatment plant. The effluent from a primary plant contains some ammonia and nitrites, but is still subject to bacterial action after disposition into the receiving stream. The degradation zone, of high bacterial action, high B.O.D. and low D.O., in the stream can be eliminated by passing the sewage through a complete or secondary treatment plant. Complete treatment converts much of the organic matter into nitrates and phosphates which become immediately available for plant growth resulting in an increased fish population.

Relation of Sewage to Fish Life

The effect of sewage on fish life varies with the season and also with the time of day. In summer the fish are active, their metabolic rate is high and more oxygen is required for their respiration than during the winter, when their activity is greatly reduced. On the other hand, during the warm summer periods the bacterial decomposition in a heavily polluted region of a stream is at its maximum, resulting in an increased biological oxygen demand and a lower dissolved oxygen concentration. The solubility of oxygen, moreover, is less in warm water than in cold water, so that less oxygen is absorbed from the atmosphere and held in solution. The increased oxygen requirement of the fish and the reduced oxygen concentration of the water renders hot weather particularly unfavorable for fish life in a polluted stream. Fish, therefore, usually die of suffocation during warm periods in regions grossly polluted by putrescible organic matter. It must not be assumed that summer is the only time that fish suffer from low oxygen concentration, because thousands of fish may die under ice by suffocation owing to the depletion of oxygen by decaying organic matter. This condition may last for only a day or two but that is sufficient time to destroy the fish population in a stream.

The toxicity of the hydrogen sulfide and other compounds produced by anaerobic bacterial action in the bottom sludge deposits may be an important factor in the death of fishes in streams receiving untreated sewage. Ellis (3) reports that 10 p.p.m. of H_2S in hard water killed goldfish in 96 hours or less. Local freshets resulting from heavy rains during low water periods tend to mix the sludge with the supernatant water and to carry the putrid mass downstream. The resulting reduction in the dissolved oxygen and the end products of anaerobic bacterial action destroy the fish for miles below.

It is also well known that heavy organic pollution causes an increase in disease, parasitism and abnormalities among fishes.

The deposition of sludge on the bottom of streams renders that portion of the stream unfit for nesting sites and will smother any eggs that may have been laid prior to the entrance of the waste. Polluted regions may act as barriers to the upstream migration of fish for the purpose of spawning.

Relation of Algae to Fish Life

Algae serve directly or indirectly as food for all fishes. The green algae are the medium by which the complex organic compounds in sewage, following bacterial decomposition, are transferred to fish. The organic compounds, as previously stated, are converted by bacterial action into available plant foods. These materials are absorbed from the water by the aquatic plants and by the process of photosynthesis, and other cellular activities are converted into the living plant cell. The organic materials comprising the green algae are transferred to the fish through the medium of the zooplankton which are found associated with the algae. Small fish feed directly upon the algae and zooplankton and the adults of many species, such as the shad, live almost entirely upon the microscopic life in the water. The larger zooplankton such as Daphnia, Cyclops, etc., are important articles of diet for larval and small species of fish; in turn, these are eaten by larger fishes which may become the food of man (Fig. 1).

As stated in the first section of this paper, domestic sewage, after it has been decomposed by bacterial action, either in the stream or previously by artificial secondary treatment, increases the growth of aquatic plants by virtue of the fertilizing value of the end products. These plants furnish food for the zooplankton which in turn furnishes food for fish and thus the fish population is increased in regions where stream fertilization by sewage occurs.

Another important factor in the relation of algae to fish life is the reoxygenation of the stream by the photosynthesis of algae. The combined photosynthetic action of all the algae may increase the dissolved oxygen to supersaturation during sunny days. Purdy (4) has shown that *Oocystis* increases appreciably the amount of oxygen in a closed sample of water. The fact must not be overlooked, however, that the plants themselves, in addition to all forms of aquatic life, consume oxygen during the process of respiration, so the rapid rise of oxygen during the day may be followed by a disastrous fall in the early morning hours if the stream is heavily polluted by decaying organic matter.

Photosynthesis also removes from the water carbon dioxide which is produced as a waste product by the living cell and the decomposition of organic matter. Wells (5) has shown that fishes are very sensitive to small changes in the carbon dioxide content of the water and tend to avoid detrimental concentrations of this gas by moving away to more favorable locations when possible, and that fresh water species of fish tend to select regions where the CO_2 concentration lies between 1 and 6 cc. per liter.

Turbidity may occur in hard-water ponds by the removal of the CO_2 by plants with the subsequent precipitation of the carbonates that are held in solution by the carbonic acid in the water. The removal of CO_2 tends to keep the water from becoming acid, but fish will tolerate without apparent harm a pH as low as 4.5 (6).

Summary

Data obtained from a pollution survey of the Ohio River Basin clearly show that the decomposition products of domestic sewage and other putrescible organic matter increase the growth of plankton, which growth is reflected in an increase in the fish population.

Untreated or raw sewage, when in sufficient concentration, produces a toxic area below the sewer outlet. The region extends downstream for a variable distance, until the sewage is decomposed by bacteria. From this point, the stream is benefited by the fertilizing action of the decomposition products.

When the sewage has received proper secondary treatment, the toxic or degradation zone does not exist and the entire stream will be benefited biologically by the available plant foods introduced.

References

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THE OPERATOR'S CORNER

Conducted by W. H. WISELY, Executive Secretary*
Federation of Sewage Works Associations
Box 18 · · Urbana, Illinois

PERSONNEL PROBLEMS

Replacement of personnel lost to military forces and war industry is a problem exceeded in importance to the sewage works field only by that of materials procurement. Yet, these same two problems hold an identical relationship in all phases of civilian life to-day and we must be prepared to assume every associated responsibility in the interest of winning the war.

Methods of meeting personnel loss problems? We suggest the following as a beginning:

1. Eliminate all activities not directly necessary to the performance of adequate sewage collection and treatment service. Operation research, grounds and park development, desirable but non-essential plant improvements and similar functions can be readily resumed when the war is won.
2. Be prepared to spend more time in training non-skilled replacements than was necessary in peace time. College, industrial art and many high school students can be used in part or full time services to excellent advantage if carefully selected and adequately trained.
3. Anticipate personnel losses insofar as possible so as to have a maximum of time to seek and train replacements. A close and frank contact with local Selective Service officials will usually bring extended deferments when the need is real.
4. Longer shifts and fewer "days off" will make available personnel go farther. Everyone must be willing to work harder and longer in these times.
5. Increase salaries and wage scales to compete with other local industries. Sewage works administrative officials must be made to realize that the relatively low salary and wage appropriations of past years must be increased if adequate sewerage service is to continue.
6. Go to an unprecedented extent in eliminating safety hazards and loss of time from accidents. Time lost by sickness and accident is completely wasted.
7. Be sure that existing operation staffs are being utilized to fullest advantage. Every employee should be used in duties for which he is best fitted.

* Also Engineer-Manager, Urbana and Champaign Sanitary District.

Realizing that sewerage services would be most greatly affected by loss of technically trained key personnel such as plant superintendents, chemists, engineering employees, etc., the Federation's Board of Control resolved on October 24 that a recommendation be made to Selective Service authorities for the issuance of a suitable directive to local boards, requesting the most careful consideration of cases involving such men. Although very few such instances have caused serious difficulty up to this time, it is anticipated that 1943 will bring many problems of this kind.

As the war progresses, we must be reconciled to meeting day by day readjustments as they become necessary. The writer has not been without concern himself, having lost one of three regular shift operators to the Army, a chemist to an ordnance plant, an experienced and faithful foreman for four months because of an unavoidable accident, having had to train three office assistants in the past year and being located in a community practically devoid of common labor—all while giving the most serious consideration to his own proper place in the war effort.

Personnel problems to-day leave little time for personal problems!

MORE ABOUT SELECTIVE SERVICE

In response to the resolution concerning Selective Service, adopted by the Federation's 1943 Board of Control on October 24, 1942, and transmitted to Chairman Paul V. McNutt (see minutes as published in the November 1942, issue of *This Journal*), the following communication has been received by the Secretary:

Office for Emergency Management
War Manpower Commission
Washington, D. C.

Chairman
Paul V. McNutt
Federal Security Administrator

November 18, 1942

W. H. Wisely, Secretary
Federation of Sewage Works Associations
Box 18
Urbana, Illinois

Dear Mr. Wisely:

Mr. McNutt has asked me to reply to your letter of November 6, together with the resolution of the Federation of Sewage Works Associations.

As you undoubtedly know, "sewage systems" have have been included in the *List of Essential Activities* of the War Manpower Commission. The item was listed under *Health and Welfare Services* in the List of Essential Activities issued in July. The occupational bulletin for *Health and Welfare Services* has not been released to the local boards of the Selective Service System and it is now planned to include the item "sewage systems" under *Governmental Services Other Than Federal.* This occupational bulletin is not yet complete but it is probable that it will be ready for release to the local boards of the Selective Service System by December 1, at which time you would be able to obtain a copy or the information you desire from your local board.

Very sincerely yours,

(Signed) JOHN J. CORSON, *Chief,*
Industrial and Agricultural Employment

A news release of the War Manpower Commission dated December 13, 1942, indicates that the directive referred to by Mr. Corson has been distributed to local Selective Service Boards. The same news release states, "At present, deferment as an essential worker is granted only if it is shown affirmatively that a training period of at least six months is necessary before an untrained worker can attain reasonable proficiency in the job, that the job is essential in the industry, and that the worker is currently irreplaceable."

It would appear that local Boards are now authorized to grant deferments to critical sewage works employees where it can be proven that a real problem will be created by the loss of such personnel.

THE GADGET DEPARTMENT

The devices presented here are the winners in the Gadget Competition sponsored by the Central States Sewage Works Association in the meeting held at Minneapolis on June 18–19, 1942.

FIRST PRIZE

A B.O.D. Calculator

BY PAUL L. BRUNNER

Chief Operating Chemist, Ft. Wayne, Indiana, Sewage Treatment Plant

Construction.—The tables are typewritten with figures spaced at one-quarter inch. It should be noted that the columns indicated by arrows in Fig. 1 have a red background which was produced by use of a red indelible pencil before lacquering. The black "L" shaped space in the lower left corner is bare masonite.

Cut one-quarter inch oil-tempered masonite as shown in Fig. 2, and glue to one-eighth inch material so that slide "B" slips freely. Then glue on tables with rubberized glue and apply at least four coats of clear lacquer or varnish.

Operation.—Slip slide "B" so that black square is opposite the proper available or 5-day blank D.O. on the right column of scale "A"; then, by noting the residual D.O. obtained by titration on scale of slide "B" and going horizontally to the right across table "C," read p.p.m. B.O.D. under the proper per cent of sample column. D.O.'s from 0.0 to 3.4 are read on white background and D.O.'s of 3.5 to 8.9 on red background of table "C."

A: Permissable Residual D.O. for A 40 to 70 Percent Depletion	A: Available or 5 Day Blank	B	B: Residual Dissolved Oxygen ↓	C: B. O. D. Calculator — Percent of Sample: 0.75		1.5		3.0		6.0		15		25		50		75	
2.7-5.4	9.0	0.0	3.5	1192	725	592	359	292	175	142	84	60.0	36.6	25.7	15.7	18.0	11.0	12.0	7.3
2.7-5.3	8.9	0.1	3.6	1179	712	585	352	289	172	140	82	59.3	36.0	25.4	15.4	17.8	10.8	11.9	7.2
2.6-5.3	8.8	0.2	3.7	1165	699	579	345	285	169	139	80	58.6	35.3	25.2	15.2	17.6	10.6	11.7	7.1
2.6-5.2	8.7	0.3	3.8	1152	685	572	339	282	165	137	79	58.0	34.6	24.8	14.8	17.4	10.4	11.6	6.9
2.6-5.2	8.6	0.4	3.9	1139	672	565	332	279	162	135	77	57.3	34.0	24.6	14.6	17.2	10.2	11.5	6.8
2.5-5.1	8.5	0.5	4.0	1125	659	559	325	275	159	134	75	56.6	33.3	24.3	14.3	17.0	10.0	11.3	6.7
2.5-5.0	8.4	0.6	4.1	1112	645	552	319	272	155	132	74	56.0	32.6	24.0	14.0	16.8	9.8	11.2	6.6
[illegible]-5.0	8.3	0.7	4.2	1099	632	545	312	269	152	130	72	55.3	32.0	23.7	13.7	16.6	9.6	11.1	6.4
[illegible]	8.2	0.8	4.3	1085	619	539	305	265	149	129	70	54.6	31.3	23.4	13.4	16.4	9.4	10.9	6.3
[illegible]	8.1	0.9	4.4	1072	605	532	299	262	145	127	69	54.0	30.6	23.2	13.2	16.2	9.2	10.8	6.1
[illegible]	[illegible]	1.0	4.5	1059	592	525	292	259	142	125	67	53.3	30.0	22.8	12.8	16.0	9.0	10.7	[illegible]
[illegible]	7.9	1.1	4.6	1045	579	519	285	255	139	124	65	52.6	29.3	22.6	12.6	15.8	8.8	10.5	5.9
[illegible]	7.8	1.2	4.7	1032	565	512	279	252	135	122	64	52.0	28.6	22.3	12.3	15.6	8.6	10.4	5.7
[illegible]	7.7	1.3	4.8	1019	552	505	272	249	132	120	62	51.3	28.0	22.0	12.0	15.4	8.4	10.3	5.6
[illegible]	7.6	1.4	4.9	1005	539	499	265	245	129	119	60	50.6	27.3	21.7	11.7	15.2	8.2	10.1	5.5
[illegible]	7.5	1.5	5.0	992	525	492	259	242	125	117	59	50.0	26.6	21.4	11.4	15.0	8.0	10.0	5.3
2.2-4.4	7.4	1.6	5.1	979	512	485	252	239	122	115	57	49.3	26.0	21.2	11.2	14.8	7.8	9.9	5.2
2.2-4.[illegible]	7.3	1.7	5.2	965	499	479	245	235	119	114	55	48.6	25.3	20.8	10.8	14.6	7.6	9.7	5.1
2.2-4.3	7.2	1.8	5.3	952	485	472	239	232	115	112	54	48.0	24.6	20.6	10.6	14.4	7.4	9.6	4.9
2.1-4.3	7.1	1.9	5.4	939	472	465	232	229	112	110	52	47.3	24.0	20.3	10.3	14.2	7.2	9.5	4.8
2.1-4.2	7.0	2.0	5.5	925	459	459	225	225	109	109	50	46.6	23.3	20.0	10.0	14.0	7.0	9.3	4.7
		2.1	5.6	912	445	452	219	222	105	107	49	46.0	22.6	19.7	9.7	13.8	6.8	9.2	4.5
		2.2	5.7	899	432	445	212	219	102	105	47	45.3	22.0	19.4	9.4	13.6	6.6	9.1	4.4
		2.3	5.8	885	419	439	205	215	99	104	45	44.6	21.3	19.2	9.2	13.4	6.4	8.9	4.3
		2.4	5.9	872	405	432	199	212	95	102	44	44.0	20.6	18.8	8.8	13.2	6.2	8.8	4.1
		2.5	6.0	859	392	425	192	209	92	100	42	43.3	20.0	18.6	8.6	13.0	6.0	8.7	4.0
		2.6	6.1	845	379	419	185	205	89	99	40	42.6	19.3	18.3	8.3	12.8	5.8	8.5	3.9
		2.7	6.2	832	365	412	179	202	85	97	39	42.0	18.6	18.0	8.0	12.6	5.6	8.4	3.7
		2.8	6.3	819	352	405	172	199	82	95	37	41.3	18.0	17.7	7.7	12.4	5.4	8.3	3.6
		2.9	6.4	805	339	399	165	195	79	94	35	40.6	17.3	17.4	7.4	12.2	5.2	8.1	3.5
		3.0	6.5	792	325	392	159	192	75	92	34	40.0	16.6	17.2	7.2	12.0	5.0	8.0	3.3
		3.1	6.6	779	312	385	152	189	72	90	32	39.3	16.0	16.8	6.8	11.8	4.8	7.9	3.2
		3.2	6.7	765	299	379	145	185	69	89	30	38.6	15.3	16.6	6.6	11.6	4.6	7.7	3.1
		3.3	6.8	752	285	372	139	182	65	87	29	38.0	14.6	16.3	6.3	11.4	4.4	7.6	2.9
		3.4	6.9	739	272	365	132	179	62	85	27	37.3	14.0	16.0	6.0	11.2	4.2	7.5	2.8
			7.0	725	259	359	125	175	59	84	25	36.6	13.3	15.7	5.7	11.0	4.0	7.3	2.7
			7.1	712	245	352	119	172	55	82	24	36.0	12.6	15.4	5.4	10.8	3.8	7.2	2.5
			7.2	699	232	345	112	169	52	80	22	35.3	12.0	15.2	5.2	10.6	3.6	7.1	2.4
			7.3	685	219	339	105	165	49	79	20	34.6	11.3	14.8	4.8	10.4	3.4	6.9	2.3
			7.4	672	205	332	99	162	45	77	19	34.0	10.6	14.6	4.6	10.2	3.2	6.8	2.1
			7.5	659	192	325	92	159	42	75	17	33.3	10.0	14.3	4.3	10.0	3.0	6.7	2.0
			7.6	645	179	319	85	155	39	74	15	32.6	9.3	14.0	4.0	9.8	2.8	6.5	1.9
			7.7	632	165	312	79	152	35	72	14	32.0	8.6	13.7	3.7	9.6	2.6	6.4	1.7
			7.8	619	152	305	72	149	32	70	12	31.3	8.0	13.4	3.4	9.4	2.4	6.3	1.6
			7.9	605	139	299	65	145	29	69	10	30.6	7.3	13.2	3.2	9.2	2.2	6.1	1.5
			8.0	592	125	292	59	142	25	67	9	30.0	6.6	12.8	2.8	9.0	2.0	6.0	1.3
			8.1	579	112	285	52	139	22	65	7	29.3	6.0	12.6	2.6	8.8	1.8	5.9	1.2
			8.2	565	99	279	45	135	19	64	5	28.6	5.3	12.3	2.3	8.6	1.6	5.7	1.1
			8.3	552	85	272	39	132	15	62	4	28.0	4.6	12.0	2.0	8.4	1.4	5.6	0.9
			8.4	539	72	265	32	129	12	60	2	27.3	4.0	11.7	1.7	8.2	1.2	5.5	0.8
			8.5	525	59	259	25	125	9	59	-	26.6	3.3	11.4	1.4	8.0	1.0	5.3	0.7
			8.6	512	45	252	19	122	5	57	-	26.0	2.6	11.2	1.2	7.8	0.8	5.2	0.5
			8.7	499	32	245	12	119	2	55	-	25.3	2.0	10.8	0.8	7.6	0.6	5.1	0.4
			8.8	485	19	239	5	115	-	54	-	24.6	1.3	10.6	0.6	7.4	0.4	4.9	0.3
			8.9	472	5	232	-	112	-	52	-	24.0	0.6	10.3	0.3	7.2	0.2	4.8	0.1

FIG. 1.—B.O.D. calculator developed by Paul L. Brunner, Fort Wayne, Indiana.

Take an example as follows: Raw sewage sample of 1.5 per cent dilution, 5-day blank = 9.0, 5-day D.O. titration = 3.0. Since 3.0 is on the white scale of "B," we would read on white column under 1.5 per cent of sample, which is the third column of table "C," and find a B.O.D. of 392. If final titration of above had been 4.0, we would read in the fourth column of table "C" which is red in background and find our B.O.D. to be 325.

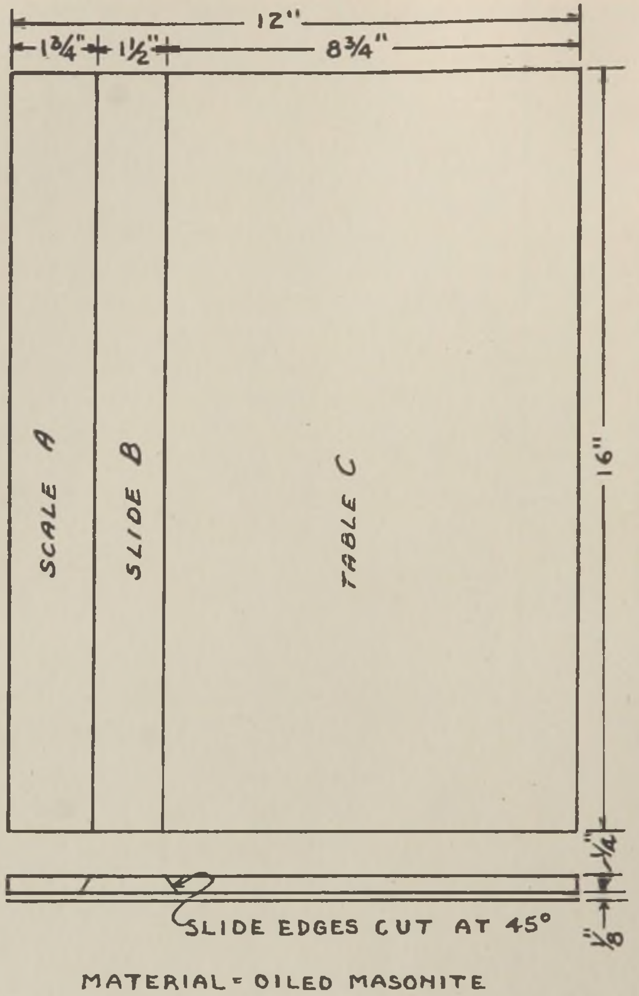

Fig. 2.—Dimensions of B.O.D. calculator. Paul L. Brunner, Fort Wayne, Indiana.

In the operation of this calculator, it is to be noted that the 0.75, 1.5, 3.0, and 6.0 per cent of sample calculations on the left of table "C" are based on samples devoid of oxygen; while the right side of the table "C," namely, the 15, 35, 50, and 75 per cent columns are calculated for samples containing oxygen.

The left column of figures of scale "A" lists the permissible D.O. for a 40 to 70 per cent depletion of the initial oxygen content for most reliable results as requested by Standard Methods. Thus, if 8.0 p.p.m. D.O. were available, the final D.O. titration should be between 2.4 to 4.8.

A 12-in. by 16-in. photostat of the original of Fig. 1 will be sent to anyone upon request for a nominal charge to cover cost of photostating.

The use of this calculator at the Ft. Wayne Plant has saved considerable time and trouble making calculations and is recommended to those who need to save time and still maintain 100 per cent accuracy.

SECOND PRIZE

A Sludge-Level Measuring and Sampling Device

By MATT KIRN

Manager, Waukegan (Illinois) Sewage Treatment Plant

This device was designed to take the place of pumping or other means of measuring sludge levels. It has proved very satisfactory in our plant not only in checking sludge levels, but also in getting sludge samples in many cases.

Place the bottle in the cylinder and close the bottom; then push the rod on which the stopper is secured down into the position shown in the drawing. The gadget is now lowered gently into the tank. When the

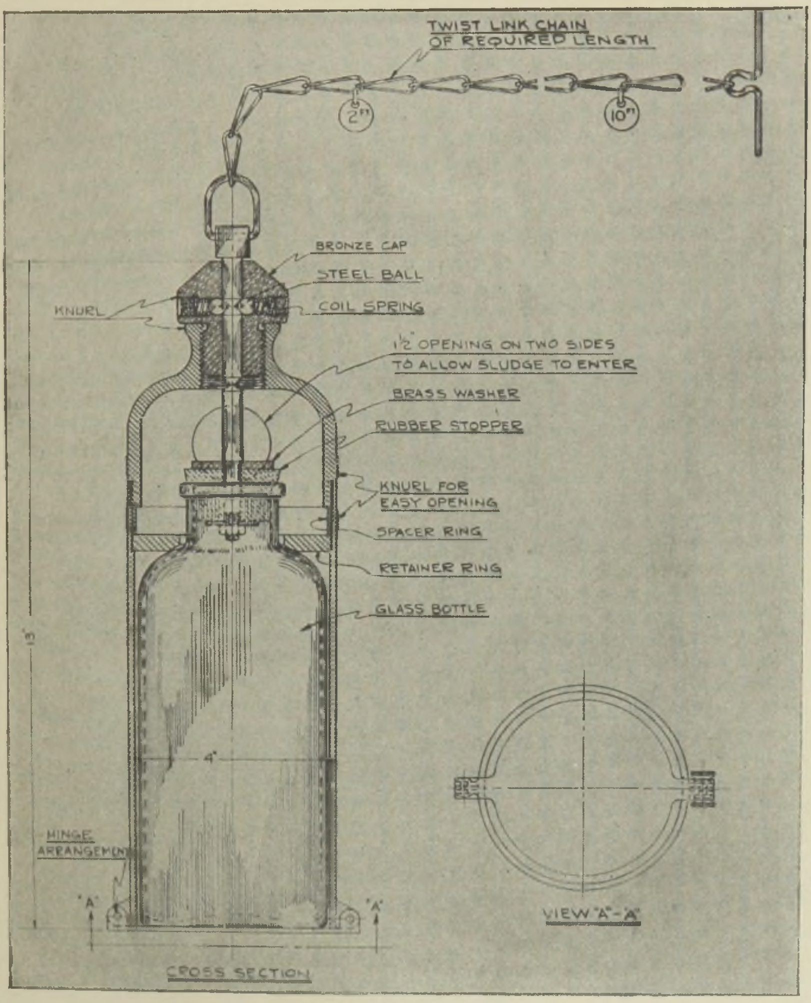

FIG. 3.—Sludge level measuring and sampling device. Matt Kirn, Waukegan, Illinois.

depth of the sludge level at last checking is reached give the chain a short jerk. This will pull the stopper out of the bottle permitting the sludge to enter. Wait in that position until air bubbles come to the surface. Pull out the gadget and if sludge is found, rinse the bottle and repeat the same operation raising the gadget to 6 to 12 in. higher each time until you reach water. This will give you the sludge level.

The chain on the gadget is graduated in feet. The first graduation from the top of the bottle is 10 ft., then graduations are at 15, 20, 25, 30 and 35 feet. In between each graduation are ⅜-in. spring washers placed one foot apart. The spring washers are not shown in the drawing.

We find that it is very handy to have a chain long enough to reach the bottom of our tanks enabling us to check the pH of the sludge in the different levels.

Third Prize

A Sludge Pump Piston Cleaner

By Minneapolis-St. Paul Sanitary District

This cleaner was developed to clean the exposed surface of pistons on displacement sludge pumps, which was formerly done with a putty knife, as sludge will collect and cake at the top of the piston and then fall into the packing gland grooves, causing wear on the packing.

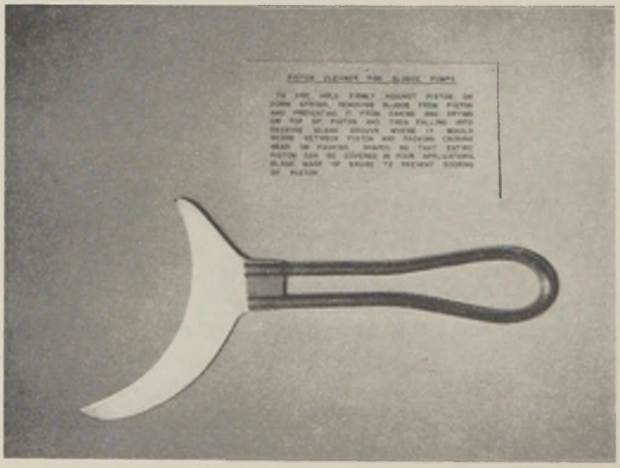

Fig. 4.—Sludge pump piston cleaner. Minneapolis-St. Paul Sanitary District.

The blade is made of brass to prevent scratching or scoring of the surface of the pistons and shaped to permit the portion of the piston near the support for the shaft to be reached easily.

The cleaner is placed firmly against the surface of the piston while the pump is in operation and when the piston is on the down stroke, thereby scraping off all of the accumulated sludge cleanly. The blade of the cleaner is long enough so that each piston can be cleaned in four applications of the cleaner.

REHABILITATION OF TRICKLING FILTER BEDS

By F. E. Johnson

Superintendent, Elgin, Illinois, Sanitary District

Rehabilitation of the trickling filter beds at the Sanitary District of Elgin sewage treatment plant as accomplished during July, 1941–March, 1942, was necessitated by disintegration of the filter media. Though quick temperature changes of freezing and thawing during the winter months were noticed to have serious effect and were responsible for the disintegration of the stone, there is no doubt that the filter media as used in the original construction was of an inferior quality for filter purposes. Recent comparison with the stone in the filters at Decatur, Urbana and Aurora indicate that the Elgin stone stood up poorly. Stone obtained at the same quarry and used at other plants in this vicinity has likewise failed.

The filter beds are composed of two units, each 258 ft. long, 129 ft. wide and 8 ft. deep. Thus the area of the filters is 1.5 acres and they contain 19,720 cu. yd. of aggregate. The filter underdrains are pre-cast reinforced concrete brick, laid on end across concrete channels in the filter floor. The distribution system comprises twin dosing tanks with fixed spray nozzles. Laterals are of cast-iron pipe with Universal joints and were placed 13 in. below the surface of the beds. This later proved good design as it facilitated the removal of the pipe and made access to the beds convenient for the screening of stone.

Specifications for the original filter stone required that the stone be "hard limestone rock, free from seams and porous spots." The bottom layer of stone (6 in. depth) was 2½ to 4¾ in. stone, and the remainder of the stone was specified to be retained on a screen having circular holes 1 in. in diameter and to pass through a screen having circular holes 2 in. in diameter.

The stone was furnished by a quarry located near Elmhurst, Illinois, and would be classed as dolomitic limestone. Analysis of the stone indicated that it contained considerable silica, 47 per cent of calcium carbonate and 40 per cent of magnesia. No freezing and thawing or sodium sulfate tests were made on the stone at the time it was placed.

The filter beds were placed in operation in 1927 and the first indications of shaling of the surface stone was noticed as early as 1930. Many of the individual pieces of stone that failed, "exploded" into many small fragments although a majority of the stone split into slices or slab-like pieces. Disintegration progressed during each winter season and by 1940 the stone on practically the entire surface area of the filters had badly shaled and spalled (Fig. 1).

This condition caused considerable pooling of the beds from December through April, 1940 and 1941. Much time was spent in attempting to keep the beds open by spading during these months but due to the amount of fine shaled and spalled material, aeration of beds was blocked off creating anaerobic areas throughout the beds and the spading proved of little avail. This condition also reflects the generally low B.O.D. removal efficiency of the filters during the past several years and especially the low results as obtained during the year prior to the start of rehabilitation work.

FIG. 1.—Condition of filter stone before removal and regrading.

Steps to formulate a plan as to the best method and extent of repair that would be necessary were taken in February, 1941. A test pit was dug in the west unit extending from the top of the filter to the underdrains and loosely sheeted so as to expose as much stone as possible. Samples of stone were selected at various depths and subjected to the standard sodium sulfate test. Average results of three tests indicated that the stone was unsound, in general, failing after six cycles of the twenty required by the test procedure. Inspection of the stone throughout the entire depth indicated that extensive repairs would be required. Due to small pieces of stone and shale following down as the pit was being dug by hand, it was difficult to determine in advance exactly how deeply into the bed the stone had disintegrated or been fouled by disintegrated stone from upper layers. Specifications were therefore set up so that the amount of work required to accomplish complete rehabilitation could be determined during the progress of work when a cross section of the beds could be observed.

Work on the beds was started on July 1, 1941. As the stone was being moved it was definitely established that the disintegration had taken place in the top 12 to 14 in. of the filters. It was also ascertained that the beds were fouled and clogged throughout their entire depth. This was due to compaction and cementation of small particles of shale and spalled material which had washed down from the top portion of the beds. The stone at the lower depths was observed to be in good condition.

In view of this situation it was deemed necessary to screen all of the existing stone. Even though the present stone was not up to the requirements of the sodium sulfate test, its ability to stand up in the lower depths of the beds where more uniform temperatures prevail was considered as a logical reason to warrant its continued use.

Screen tests on samples of stone indicated that screening to 1½ in. minimum size, removed all objectionable material and produced a media which for size would be very satisfactory for use in the lower portion of the beds. It was estimated that a saving in cost of $36,200 would result by the re-use of screened stone.

Sufficient stone was first removed and stock-piled to allow for the initial setup of a shovel crane, portable shaker type screen and conveyor equipment. Screening the remainder of the old stone was then performed within the filters (Fig. 2).

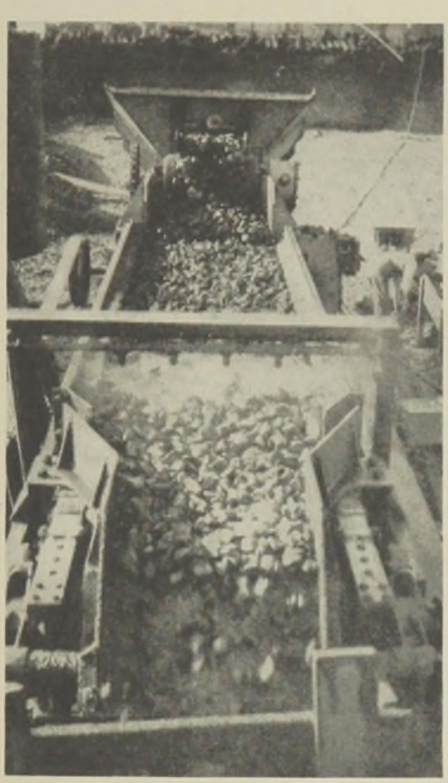

Fig. 2.—Portable shaker screen and washer used for reclaiming original stone.

Replacement of salvaged rock occurred simultaneously with its removal and screening, and progress was from one end of the bed to the other. Sixty per cent or 4½ ft. of the 7½ ft. of old stone originally graded from 1 to 2 inches in size was salvaged. Screenings from the stone were utilized to build up a low area of ground adjacent to the present sludge beds thus providing a base for future sludge beds.

In excavating with the shovel crane, approximately 1 ft. of stone was left above the underdrain system so as not to damage the concrete blocks. Included in this layer was the bottom 6 in. of large stone which was screened out by hand shoveling the stone onto a horizontal bar screen with 3 in. square openings. Stone retained on the screen was hand picked from the screen and replaced upon the underdrains. The concrete blocks were removed along with the bottom layer of stone and replaced after thoroughly cleaning the channels in the filter floor. As all this necessitated hand work, it proved to be the most difficult and time consuming work encountered during the entire project (Fig. 3).

FIG. 3.—Hand screening of bottom layer of original stone.

Loss of concrete blocks through breakage during progress of the work or culled out because of cracks acquired since first being placed, amounted to 5,676 bricks or 2 per cent of the total number of blocks in the underdrain system.

New limestone, tested to twenty cycles of the sodium sulfate test with the resultant average loss of 2.5 per cent in weight on two tested samples, was placed on top of the salvaged stone to a depth of 20 in. This stone was obtained from a quarry at Racine, Wisconsin, and was graded from 2 to 3 in. in size (Fig. 4).

The filters were then brought to grade by putting 14 in. of Ableman, Wisconsin, quartzite on the top or surface of the beds. This quartzite ranged in size from 2¼ to 3¼ in. and results of sodium sulfate tests showed 0.2 per cent loss in weight after samples were subjected to the twenty cycles. It was felt that the use of quartzite on the surface layer of the filters where the stone is subjected to severe conditions, because of its greater durability, would compensate its added cost.

New stone was rescreened and washed at the plant site immediately outside the filter wall. Stone was then conveyed over the filter wall into dump cars of the conventional tilting sludge car type. A two-ton gasoline locomotive and industrial tracks were used in distributing the stone on the filters. Loading of new stone from freight cars was facilitated by installing a loading pit under the tracks at a nearby railroad siding. Trucks were thus easily and quickly loaded from hopper bottom freight cars by means of a stationary under-car hopper provided with a shut-off gate. Rescreening of stone at the plant site removed 75 cu. yd. of limestone and 37 cu. yd. of granite screenings, respectively. It was evident that breakage was due to loading and unloading and indicates the desirability of rescreening stone at the site prior to placing.

FIG. 4.—Restored filter prior to placing of granite surface layer.

The project was scheduled for completion October 1, 1941, but was considerably delayed due to the unanticipated amount of handwork that was involved in preparing the bottom portion of the filter. Further delay was due to the output capacity of the quarry furnishing granite being limited to four cars per week. The west bed was completed December 23rd and the east bed in the fore part of March, 1942.

Unit price costs of rehabilitation work were as follows; For the removal and replacement of the distribution system—$1,850.00. Removing, rescreening and replacing of the old filter stone—$1.20 per cu. yd. New limestone in place was $3.65 per cu. yd. and granite $5.35 per cu. yd. Quarry price of the limestone and granite was $1.00 and $2.50 per cu. yd., respectively. The total cost of the project totaled $55,841.00.

BARK FROM THE DAILY LOG *

October 1—Began the annual fall chore of pumping scum from the gas vents of the Imhoff tanks to the sludge drying beds. When completed, 105,000 pounds of dry solids ranging from 56 to 62 per cent volatile had been re-

* From 1941 records of Urbana-Champaign (Illinois) Sanitary District.

moved in this fashion. This material constitutes mainly snail shells, rags, matchsticks, hair and light solids which are not reduced by the gas vent water sprays (see **This Journal, 13,** 793 (1941)) and positive removal at least once a year is essential to proper functioning of the tanks.

October 4—Forty-four nozzles mysteriously disappeared from the trickling filters during the second shift yesterday, necessitating a bit of amateur gum-shoeing. Inquiries in the right places located all but eleven of them in a temporary cache, pending sale as junk by certain youthful culprits. The remainder were recovered later.

October 11—Anticipating a possible industrial waste problem, the local Chamber of Commerce Secretary brought out some samples of industrial wastes produced by a cannery which is considering the location of a plant in the community. The samples were probably not collected correctly and certainly were not properly conditioned but we were able to determine that they represented a very potent raw material for a sewage plant.

The opportunity to investigate the problem before the cannery came into our midst was greatly appreciated!

October 16—Checked through the first-aid kit to make certain that all necessary items were available, and replenished those found inadequate. A good idea to do this about twice a year.

October 20—Took down the discharge check valve on Pump No. 1 to ascertain cause of unsatisfactory operation. Found new hinge and hinge-pin required. Interesting to note that this valve lasted only a year longer than the one on Pump No. 2, both having been installed in 1924!

October 24—Now engaged in one of the most difficult of maintenance jobs—that of patching concrete.

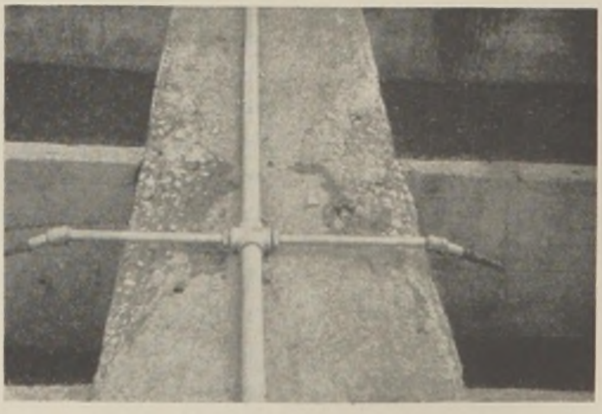

FIG. 1.—Badly weathered concrete walkway—a safety hazard.

Figure 1 illustrates a weathered condition on the Imhoff tank walkways, one of 29 such places that constitute dangerous safety hazards. First, all of the faulty concrete was removed (fragments being caught in a tarpaulin hammock suspended beneath the work) until a hard, sharp bonding edge was available with a liberal amount of exposed reinforcing steel. After the forms were placed, the bonding edge was painted with an ironite waterproofing compound sold under the name "Ferritex" by The Truscon Laboratories. A patch thus prepared for placement of the concrete is shown in Fig. 2.

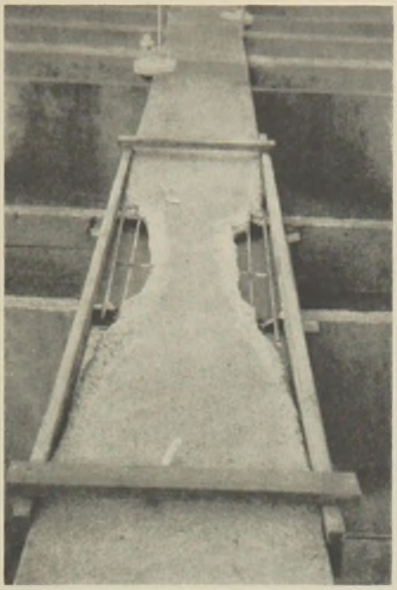

Fig. 2.—A patch ready for placement of concrete.

Fig. 3.—Patches after stripping of forms. Walkways pointed with cement and fine sand mixture to complete the job.

To minimize ultimate shrinkage and assure positive bonding of the patch, another Truscon product known as "Iso-Vol" was used in the rich, dense concrete mix. It was readily noted in mixing that an unusually small quantity of water was required to give a smooth and workable mixture. The concrete was carefully tamped into the forms and float-finished at the surface. A view of one walkway showing several finished patches is given in Fig. 3.

Many operators will be confronted with similar maintenance problems as their plants become older. If our attempt proves unsuccessful, it isn't because we didn't try hard!

October 29—Drained the final sedimentation tank for inspection and adjustment of the clarifier. Found the gilsonite asphalt paint applied to the under-water metal 15 months ago to be in excellent condition. Coverage was good as proven by the absence of rust streaks and the paint itself was still soft.

November 3—While cleaning one of the sludge beds filled with scum last month, an extra laborer found a $5.00 bill that had undergone primary treatment. Called upon every persuasive power but the police to keep him on the job the rest of the day.

November 4—Persuasion only temporary. Had to round up another sludge scooper this A.M.

November 10—In the midst of painting the filter distribution piping in the pipe gallery. Because of the chronic dampness here, a gilsonite-aluminum paint is being used.

November 18—A real opportunist, the second shift operator took advantage of the Aurora Borealis to rake down some sludge beds in preparation for reuse. Got quite a "kick" out of performing this day-time job at 11 P.M.

November 20—A month ago, we made reassignments of shifts among three of the regular shift operators in an effort to utilize the individual capabilities of the men to better advantage. Results since the change are gratifying—which may prove that an occasional bit of juggling is advantageous.

November 22—Attention, electric motor manufacturers! How about a rodent-repellent insulation for motor windings? Noting "something new to be added" to the usual aroma pervading the screen house, one of the operators found an electrocuted rat in the splash-proof motor of the screenings grinder.

Another saboteur had received his just deserts!

November 23—Due to the variance in Thanksgiving dates between Iowa and Illinois, we find ourselves eating our Thanksgiving dinner in a plane en route to Ames, Iowa, where the Iowa Waste Disposal Association is having its annual meeting. Always a real pleasure to renew friendships in this hospitable and energetic group.

November 29—Grounds Superintendent of University out to arrange for sludge supply to be used on the Memorial Stadium football field.

(**Note:** October 10, 1942. We do not claim that the riboflavin in the sludge rejuvenated the Fighting Illini as well as the sod, but certainly that score of Illinois 20–Minnesota 13 was not entirely due to the efforts of the new coach alone!)

EXTRACTS FROM 1940 REPORT OF DIVISION OF SEWAGE DISPOSAL, CLEVELAND, OHIO

By J. W. Ellms

Commissioner

Easterly Sewage Treatment Plant

By John J. Wirts

Superintendent

The Easterly Sewage Treatment Plant during 1940 treated an average daily flow of 89.1 million gallons of domestic sewage and industrial wastes. Of the total flow treated, 7.8 per cent was given preparatory and primary treatment only, and 92.9 per cent was given complete treatment. Split treatment of the settled sewage was practiced from January 1 to March 31 and from December 20 to December 31.

Comminutors.—The four 54-in. comminutors operated a total of 8,789 machine hours during the year, which is equivalent to the operation, if it were possible, of one machine continuously for 365 days. The estimated flow passing through these machines, based on 60 m.g.d. per machine was 80 per cent of the raw sewage flow.

Nos. 3 and 4 comminutors were equipped with newly designed bottom cylinders. These new sections contain shear bars at the cutting edges thereby reducing the wear and markedly increasing the efficiency of these machines.

Trouble was experienced with the Universal gear units on the 54-in. comminutors. One driving gear is a fibre gear which shears when highly loaded, thereby necessitating replacement.

In November the cylinder of comminutor No. 4 dropped about $\frac{1}{16}$ in. Upon investigation it was found that the thrust bearings supporting the cylinder were under-designed for the load to which they are subject.

Bar Grating and Grit Chambers.—The bar gratings and grit chambers operated a total of 5,186 hrs. and treated about 20 per cent of the raw sewage flow. A total of 28,027 cu. ft. of screenings were removed from all sources, all of which were disposed of by burying on the grit dump.

A total of 2,369 cu. yd. of grit from the grit chambers was removed to the dump, which evaluates to 0.43 cu. yd. per m. g. This is five times greater than the average of 0.08 cu. yd. per m. g. reported for the years 1924 to 1934, and is due primarily to a greater proportion of storm flow passed through the grit chambers during 1940. Quantities for 1940 compare favorably with 1939 and substantiate the contention that the grit chambers as operated handle much greater concentrations of grit.

Pre-Chlorination.—There was no chlorine applied to the raw sewage entering the plant during 1940. However, the pre-chlorination equipment was maintained and held in readiness should the necessity arise for pre-chlorination of the raw sewage.

Grease Flocculation.—The grease flocculation tank plates were cleaned during August, September, and October. At this time there was removed a total of 12 cu. yd. of grit from No. 3 tank which was the only tank containing deposited grit. The amount of grit removed this year in comparison with past years is much smaller and is the result of careful operation to eliminate, so far as practical, any grit from reaching the grease flocculation tanks and eventually the primary tanks.

The Roots-Connersville blowers supplying air to the tanks operated with little maintenance. The oil pump on the 500 c.f.m. blower was replaced during the early part of the year. Solenoids of new design were installed on all the Roots-Connersville blower cone valves.

The action of the grease flocculation tanks assisted in the removal of 32 p.p.m. of grease from the primary tanks. Another function of the grease flocculation tanks is the beneficial effect produced by the air blowing through the sewage; this operation freshens the sewage and blows out entrained gases and odors that are then removed from the grease flocculation room by the ventilating system.

Pre-Settling Tanks.—With an average detention time of 1.4 hours the primary or pre-settling tanks effected a removal of 103 p.p.m., or 43.3 per cent of the suspended solids in the raw sewage treated.

Excess activated sludge was discharged into the pre-settling tanks in order to concentrate the activated sludge prior to pumping to the Southerly Plant. The introduction of these additional solids accounts for the lower removal of 43.3 per cent for 1940 as against 56.2 per cent for 1939. Difficulties were experienced controlling this process since higher flows and differences in the settling qualities of the activated sludge led to re-cycling of activated sludge into the aeration system. The pre-settling tanks were not designed for the thickening of activated solids.

The concentration tanks at the Southerly site were constructed for that function and, therefore, the primary tanks are doing two assignments, one, that of removal of settleable solids and two, concentration of activated sludge. If it is necessary to continue this practice at the Easterly Plant suitable tanks should be constructed.

The grease skimming devices were re-designed and replaced by the Link-Belt Company. The increased efficiency of the new skimmers reduced the time necessary to skim the tanks from about 10 hr. per day down to less than 2 hr. per day. By re-setting the float control mechanism to allow pumping at a lower hydraulic head in the sump, the prob-

TABLE I.—*Summary of Operation Data—Easterly Plant, Cleveland, Ohio*

Item	1940 Average	
Sewage flow treated	89.1	m.g.d.
Flow given complete treatment	82.2	m.g.d.
Grit removal	0.125	cu. yd. per m.g.
Screenings removal	0.86	cu. ft. per m.g.
Analytical data:		
5-Day B.O.D.—raw sewage	130	p.p.m.
Settled sewage	77	p.p.m.
Reduction	40.8	%
Final effluent	11.1	p.p.m.
Reduction	91.5	%
Suspended solids—raw sewage	238	p.p.m.
Settled sewage	135	p.p.m.
Reduction	56.8	%
Final effluent	12.5	p.p.m.
Reduction	94.7	%
Grease content—raw sewage	80.3	p.p.m.
Settled sewage	41.9	p.p.m.
Reduction	47.8	%
Final effluent	11.5	p.p.m.
Reduction	85.7	%
Grease content of sludge	9.8	%
Activated sludge data:		
Mixed liquor solids	2,810	p.p.m.
Sludge index	60	ml. per gm.
Return sludge total solids	14,420	p.p.m.
Fixed solids	5,560	p.p.m.
Volatile solids	61.4	%
Suspended solids	13,760	p.p.m.
Sludge index	71	ml. per gm.
Bacterial data:		
37° Agar counts—raw sewage	1,960	1,000 per ml.
Unchlorinated effluent	19.3	1,000 per ml.
Reduction	99.0	%
Chlorinated effluent	0.033	1,000 per ml.
Reduction	99.99	%
20° Agar counts—raw sewage	2,700	1,000 per ml.
Unchlorinated effluent	37.2	1,000 per ml.
Reduction	98.6	%
Chlorinated effluent	0.017	1,000 per ml.
Reduction	99.99	%
Indicated number presumptive *B. Coli*—raw	293	1,000 per ml.
Unchlorinated effluent	1.2	1,000 per ml.
Reduction	99.6	%
Chlorinated effluent	0.005	1,000 per ml.
Reduction	99.99	%
Operation Cost (per m.g. treated)*	$16.26	

* Adjusted to treatment processes as employed in Easterly, Southerly and Westerly plants.

lem of transporting the grease skimmings from the troughs to the sump has been eliminated.

Southerly Sludge Pumps and Force Main.—The amount of primary sludge, grease, and excess activated sludge pumped to the Southerly

Plant for final disposal is estimated at 252.5 million gallons per year. The concentration of dry solids in the fluid pumped to the Southerly Plant is estimated at 2.97 per cent. Based upon the suspended solids removed by the treatment processes, the amount of solids delivered on a dry basis was 31,205 tons. All of the sludge extracted from the sewage is digested, filtered, and incinerated at the Southerly Plant. The relatively small amount of grit and screenings removed from the sewage is dumped at the site of the Easterly Plant.

The pumps and sludge line were in operation over 98 per cent of the time; only part of the off-time operation was due to maintenance work on the pumps. Recognizing the fact that any long shut-downs would reduce the effective work of the plant, every effort was made to keep the pumps operating and at as great an efficiency as possible.

A great deal of trouble was experienced pumping all the sludge collected at the plant. After considerable work in attempts to clean the line by various means, including the operation of two pumps at one time, examination of the inside of sections of the line, and after determining the hydraulic gradient, it became evident by late summer that the sludge force main was rapidly becoming clogged with grease and grit, and that steps had to be taken in order to prevent a shutdown of the Easterly Plant. In October, two different types of line-cleaning devices were tested on sections of the line and excavation was started at the plant for a manhole to be used for future insertion of the line-cleaning mechanisms into the line. At the Southerly Plant end of the sludge line, concrete abutments were poured to make solid foundations for the section of line that was to be exposed for removal of the line-cleaning mechanisms.

In order to carry out the above work and also the routine venting of gas and sludge in the line, 199 man hours of work per month were required. A contract was prepared for the purpose of having the line cleaned during 1941.

Aeration Tanks.—The average detention time of the settled sewage was 5.9 hours in the aeration tanks. Only 75 per cent of the 16 aeration tanks were kept in service, in order to obtain more effective and economical use of the air applied and to allow for plate cleaning work on the idle tanks.

Complete treatment was given to 92.9 per cent of the metered raw sewage. The return sludge, averaging 1.44 per cent total solids, was 25.9 per cent of the settled sewage flow. The mixed liquor solids averaged 2,810 parts per million with an average sludge index of 60.

Final Settling Tanks.—The final settling tanks operated at a settling rate of 755 gallons per square foot per day.

On April 3, a new case-hardened worm and a new worm gear were installed in the drive of No. 3 tank. Outside of a touching up on several of the worm gears, very little maintenance was required, largely as a result of the use of extreme pressure lubricant in these units. New electrical pull-boxes were installed on all final settling tanks.

Blower Building.—Preventive check-up maintenance work was carried out on all blowers. Minor adjustments were made and one bearing that was slightly scored was retouched to prevent further trouble. A separate non-competitive contract was obtained for the turbine oil required for the blowers. Results have been very good and the equipment was protected.

Lines were installed by the plumbers to allow for back-washing the cooling water side of the oil and air coolers. The oil in the oil air filters was changed during the year because the supply varied in quality. On one occasion, oil was supplied by one manufacturer which did not meet the specifications. The manufacturer removed this oil and replaced it gratis with seven drums of another oil. The paper filters were changed when the pressure loss approached one inch of water.

Leaks in the main air duct in the basement of the blower building were plugged with lead wool. Lights were also installed in this basement.

Post-Chlorination.—The average dosage of chlorine applied to the effluent was 3.6 p.p.m.; 253,000 pounds of chlorine were used. The removals of *B. coli* of 99.99 per cent were considered very satisfactory.

The installation of a new discharge manifold for the post-chlorination machines was finished in June. The new discharge manifold enters the effluent conduit at three points instead of one. Chlorine residual tests in each of the twin conduits indicated a uniform distribution of chlorine.

Grounds and Buildings.—In April, replacements were made for some shrubs put in under contract No. 112. Direct relief labor valued at $4,000 was used to good advantage on the grounds.

A prize was awarded to this plant by the "Cleveland Press" for the best industrial grounds in the entire metropolitan area.

Special Studies.—Preliminary studies on place cleaning carried out during 1939, have been continued through 1940. The purpose of these studies is to determine the factors involved in economically maintaining the diffuser system with relation to blower discharge pressure. Results so far have shown that there is justification for industrial waste studies and industrial waste control. The cost of industrial waste studies and control would be more than offset by improved operation. Increased industrial activity should be watched in order to prevent as far as practical the difficulties experienced in May of this year. The following paragraph is taken from the May monthly report of the Easterly Plant.

On May 2 large quantities of oil started coming into the Main Interceptor and continued throughout the month, except for short intervals on Sundays. A systematic program of observing intercepting sewers was used to isolate the offender. On Tuesday, June 4, a private manhole was uncovered within the property line of the Park Drop Forge Company. Catch samples collected at this point contained 25 per cent No. 5 fuel oil by volume. Mr. W. A. Humel, Asst. General Manager of the Company, was notified and the leak was stopped within the hour. By analysis and observation it was estimated that 37,500 gallons of fuel oil at four cents per gallon, which evaluates to $1,400 was lost.

Space does not permit further discussion on the industrial waste problems in this report. However, until this problem is thoroughly studied and adequate control effected costs can be expected to increase.

Westerly Sewage Treatment Plant

By Walter E. Gerdel

Superintendent

Sewage Flows, Screenings and Grit.—A total sewage flow of 10,436 m.g. was treated at the plant; this amounted to an average daily flow of 28.5 m.g. A new sewage flow indicating meter was installed in the screen building on January 18, actuated by the old Venturi meter in the disinfection building, and provides for much better control over sewage flows during storm periods. Aluminum markers were installed on the sidewalls of the grit chambers during July to improve control over sewage flows in the individual grit chamber channels.

The measurement of the quantity of screenings was discontinued after April. It was thought that due to the offensive character of the screenings, it would be highly desirable to dispose of this material continuously.

A total of 2.34 cu. ft. of grit per m.g. was removed from the sewage. The use of a dump truck for transportation of the grit was continued the entire year and greatly facilitated this portion of the work. A new clamshell bucket was installed on the grit crane in October. It is expected that in the near future the present grit dumping area will be completely filled in. This is a problem that will have to be solved as soon as possible.

The mechanical equipment used in the preparatory treatment of the sewage (mechanical rake, screenings shredder, detritor and grit crane) operated with about the normal amount of maintenance work being necessary.

Aeration Grease Separation.—The grease separation tanks were operated the entire year, either on a partial or complete operation basis. The aero-chlorination equipment was not operated during the chlorination season because of the difficulties that had been encountered the year before, and it was felt that the same results could be achieved by the use of the solution pre-chlorination equipment. A removal of 41.3 per cent of the "ether soluble" material was accomplished during the months of June, July, and August, when pre-chlorination was practiced. This compares to a removal of 29.6 per cent of the same material during the remainder of the year (excluding the results for September) when no pre-chlorination took place.

The matter of clogged aeration plates still caused trouble, and it was necessary to clean them with a combination treatment of caustic soda and sodium dichromate dissolved in concentrated sulfuric acid. Difficulty in obtaining parts and supplies to repair aeration pans made it necessary to cut out the north side section of the aeration unit the latter part of the year.

Imhoff Tanks.—The sewage treated in the Imhoff tanks was slightly stronger than that handled in 1939. The reductions effected were 38.9 per cent of suspended matter, and 25.4 per cent of B.O.D. The bacteriological reductions during the summer months after post-chlorination were very favorable and show what can be accomplished in this respect by use of chlorine.

There were removed from the surfaces of the Imhoff tanks by means of water sprays and hand skimming, 51,900 cu. ft. of grease skimmings, amounting to 900,000 lb. of dry solids. This removal amounted to 10.3 p.p.m., and constituted about 10 per cent of the total amount of matter removed from the sewage.

The Imhoff tanks were again operated as primary settling tanks, with the digestion of sludge being accomplished as much as possible in the separate sludge digestion tanks. A full season (June, July, August, and part of September) of pre-chlorination showed the full value of this process as far as practically eliminating serious gas vent foaming nuisance of the Imhoff tanks, during this period. The retardation of digestion in the Imhoff tanks also resulted in production of more gas in the separate digesters.

During the early spring months it was necessary to pump down and clean out the flowing through compartments of all the tanks. This procedure was also followed during the remainder of the year whenever conditions justified doing so.

The practice was continued the entire year of using Number 13 Imhoff tank as a digested sludge storage and concentration tank. No odor nuisance was apparent at any time during the year. The digested sludge entering this tank contained 7.07 per cent total solids, and that being removed averaged 77.76 per cent total solids. The more uniform sludge obtained, and added flexibility created, plus the increase in solids content, justifies the continued operation of this storage tank.

Sewage Chlorination.—Pre-chlorination was practiced from June 1, to September 17, while post-chlorination took place from June 1 to September 4. Pre-chlorination dosages averaged 4.19 p.p.m., while post-chlorination dosages averaged 7.02 p.p.m. An attempt was made during the post-chlorination period to maintain a chlorine residual in the sewage effluent. This was possible 75 per cent of the time. The method used for testing of residual chlorine was the starch-iodine determination which apparently is a more sensitive and practical method on settled sewage, than the orthotolidine method which was used previously. Chlorine residual determinations on the sewage effluent were made each hour during the month of June, and every two hours the remainder of the post-chlorination season. An attempt was made to schedule and program post-chlorination dosages, but it was found that because of extremely quick and wide variations in the character of the sewage, it was more economical to run residual chlorine tests frequently, and to depend on the chlorine demand curves to show trends during the day. Pre-chlorination dosages were scheduled according to the strength of the sewage during various parts of the day, and only enough chlorine was used to control odors and gas vent foaming of the Imhoff tanks.

The chlorine equipment (chlorine evaporator, chlorinators) operated quite well with the exception of the recorders, which gave considerable trouble. This trouble was remedied to some extent by minor adjustments, and was more easily recognized and overcome with added experience with the equipment. The pre-chlorination solution diffusion equipment caused some difficulty because of screenings catching on the submerged drop hoses and bringing them to the surface of the sewage, resulting at times in chlorine fumes escaping into the screen building. This difficulty was overcome to a large extent by installing longer drop hoses and weighting the free ends down with collars made out of chrome-nickel iron pipe.

Separate Sludge Digestion.—All of the digesters were operated as primary digestion tanks and practically all of the resulting sludge was pumped to Number 13 Imhoff sludge storage tank for concentration and compositing. The digesters handled the largest amount of raw sludge in the history of the plant, and at the same time produced the largest volume of gas. This was in some measure due to the fact that prechlorination retarded the digestion of sludge in the Imhoff tanks and consequently this gas was captured at the digesters.

The past summer's operation of this unit demonstrated more than ever the need of making changes and improvements to the old digestion unit (Numbers 1 and 2 digesters) so that this unit can carry a greater portion of the raw sludge load. During the peak months of May–August, the old digesters carried 23.5 per cent of the total load, while their tank volume is such that they should be able to carry 33.3 per cent of the total load. The main reason for this lower loading is the inability to handle the larger volumes of gas that would be generated with higher loadings.

Three digester heating coils broke during the year and were repaired. Along with the last two repairs, suitable friction pipe clamps were made up and attached to the piping coil at frequent intervals. These clamps were for the purpose of tying the whole coil together into one unit and obtaining greater strength and rigidity. Outside of the heating coil breaks, the maintenance work necessary in this unit was as usual, very low.

Sludge Vacuum Filtration.—The average chemical dosages necessary to properly condition the sludge were 3.01 per cent ferric chloride, and 12.6 per cent calcium oxide on a dry sludge solids basis. Despite the fact that a thinner sludge was handled during 1940, the total chemical dosing costs per unit weight of sludge dry solids was less than in 1939.

The resulting filter cake averaged 66.3 per cent moisture. An average of 3.74 lb. dry solids per sq. ft. filter area per hour was produced.

A lower yield was deliberately obtained by reducing the filter drum speed. This permitted the operation of two vacuum filters at a time, feeding one incinerator at full load, whereas to produce the same amount of cake with one filter was almost impossible with reasonable chemical dosages. This procedure also produced a steadier feed and less trouble with blinding filters. Cotton filter cloths were used the entire year and averaged 246 hours of operating life.

The technique of filtering sludge was developed to such a state during the year that very little filter cloth blinding was encountered and the filter cake yield was for the most part steady and uniform. Trouble was encountered with the wire screens of the filters closing up with scale deposits. This difficulty has been overcome by the use of hydrochloric acid to dissolve the scale and a rubberized cloth used as an apron between the filter drum and agitator to hold the acid. It has been found necessary to give a filter an acid bath about once every six months. The sludge mixing chambers have demanded a considerable amount of maintenance work because of wear on the sprockets, chains, and shaft bearings. It is planned to remedy this situation to some degree by separating the driving mechanism (2 sprockets, chain, and one bearing) from the sludge by means of built-in steel plates in the mixing chambers. The sludge conveyor belts have given some trouble because of failures at the lacings. These failures were principally due to moisture entering the belt fabric and rotting it. This difficulty is now being overcome somewhat by rubberizing all fabric exposed belt ends and lacing bolt holes when new splices are made.

A new filter cake chute was constructed and put into operation in August. This enables filter cake to be diverted from the incinerators and placed outside of the incineration building. A portable belt conveyor was obtained from the Southerly Sewage Treatment Plant, and is used to convey the filter cake from the chute discharge to a point farther removed from the building. The portable conveyor can also be used to load trucks. About 14 per cent of the total filter cake produced since the chute was installed has been diverted from the incinerators. The chute installation has given the filtration and incineration unit added flexibility that has increased the ease of operation, and also permits the operation of the vacuum filters when repairs are necessary on the incineration equipment.

All of the vacuum pump valves were removed and heavily galvanized. This has resulted in the valves remaining cleaner for longer periods of time. Some additional copper piping and brass fittings were replaced inside the filter drums. This replacement is being done with extra heavy iron pipe whenever it is found necessary to do so.

Filter Cake Incineration.—As a whole, the incineration process proceeded in a highly satisfactory manner the entire year. A marked increase in the volatile content of the filter cake over 1939 enabled incineration to take place for long periods of time without any auxiliary fuel being necessary. On the average, the equivalent of 274 cu. ft. of gas was used per ton of filter cake incinerated during 1940 as compared to 812 cu. ft. during 1939.

Average dry solids loading of the incinerators was about 93 per cent of design capacity. Incinerator temperatures were a little higher than during 1939, and were caused by the higher loading and volatile content of the filter cake.

The air pre-heaters of both incinerators caused some difficulty due to excessive loss of draft through them and insufficient draft on the incinerators. It has been recommended that gas by-passes be installed around both pre-heaters. In addition to securing greater draft on the incinerators, the by-passes would permit better control of the temperature of the air leaving the pre-heaters, which sometimes tend to overheat.

High air temperatures in the incineration building during the summer months again have shown the need of installing, in the near future, some adequate ventilating system.

TABLE II.—*Summary of Operation Data—Westerly Plant, Cleveland, Ohio*

Item	1940 Average	
Sewage flow treated	28.5	m.g.d.
Grit removal	2.34	c.f. per m.g.
Volatile content	23.0	%
Analytical data:		
5-Day B.O.D.—raw sewage	245	p.p.m.
Imhoff effluent	182	p.p.m.
Reduction	25.7	%
Suspended solids—raw sewage	262	p.p.m.
Imhoff effluent	160	p.p.m.
Reduction	38.9	%
Grease—raw sewage (acidified ether sol.)	130	p.p.m.
Imhoff effluent	88	p.p.m.
Reduction	32.4	%
Oxygen consumed—raw sewage	176	p.p.m.
Imhoff effluent	156	p.p.m.
Reduction	11.5	%
Chlorination data:		
Prechlorination—days operated	108	
Average dosage	4.19	p.p.m.
Post chlorination—days operated	95	
Average dosage	7.02	p.p.m.
Average residual	1.48	p.p.m.
Time residual maintained	74.9	%
Bacterial data:		
Total bacteria—raw sewage	1,808	1,000 per ml.
Imhoff effluent	1,250	1,000 per ml.
Reduction	30.9	%
Presumptive *B. Coli*—raw sewage	88	1,000 per ml.
Imhoff effluent	42.9	1,000 per ml.
Reduction	51.3	%

TABLE II.—*Continued*

Item	1940 Average	
Sludge digestion data:		
Volatile content fresh solids	72.2	%
Sludge drawn from Imhoffs to digesters	65.3	%
Quantity sludge to digesters (gal. per m.g. sewage)	1,824	gallons
Solids content	7.03	%
Alkalinity as Ca CO_3	1,059	p.p.m.
pH	6.7	
Digestion temperature	91.0	degrees F.
Gas production:		
Per pound volatile solids added	9.07	c.f.
Per pound volatile solids destroyed	21.49	c.f.
Supernatant liquor (gal. per m.g. sewage)	707	gallons
Solids content	0.66	%
Volatile content	50.5	%
Alkalinity as $CaCO_3$	3,200	p.p.m.
pH	7.3	
Digested sludge quantity (gal. per m.g. sewage)	1,206	gallons
Solids content	7.48	%
Volatile content	49.8	%
Alkalinity as $CaCO_3$	3,280	p.p.m.
pH	7.3	
Sludge dewatering:		
Chemical dosage—ferric chloride	3.01	%
Lime (as CaO)	12.60	%
Filter cake moisture content	66.3	%
Volatile content	42.9	%
Filter rate (lb. per sq. ft. per hr.)	3.74	lb.
Ave. life of filter cloth	246	hours
Filtrate total solids content	4,121	p.p.m.
Suspended solids content	495	p.p.m.
Incineration data:		
Quantity filter cake incinerated	832	tons per mo.
Dry solids incinerated	280	tons per mo.
Incineration rate (per unit)	1.35	tons per hr.
Fuel value of cake (per lb. dry vol. solids)	11,217	B.T.U.
Moisture evaporated	552	tons per mo.
Volatile matter in ash	0.12	%
Auxiliary fuel consumption:		
Oil—per ton cake	0.369	gallons
Per ton dry solids	1.098	gallons
Standby rate	0.146	gal. per hr.
Gas—per ton cake	187	c.f.
Per ton dry solids	556	c.f.
Standby rate	1,209	c.f. per hr.
Incineration temperatures:		
Hearth Number 1	910	deg. F.
Number 2	1,220	deg. F.
Number 3	1,230	deg. F.
Number 4	1,440	deg. F.
Number 6	850	deg. F.
Preheater—air entering	310	deg. F.
Air leaving	780	deg. F.
Cooling air—top of shaft	460	deg. F.
Operation costs (per m.g. treated)*	$12.41	

* Adjusted to treatment processes as employed at Easterly, Southerly and Westerly plants.

Southerly Sewage Treatment Plant

By G. E. Flower

Superintendent

Bar Grates and Grit Chambers.—There is no serious difficulty in the operation of these units. However, a mechanically cleaned fine screen is highly desirable. The carrying over of large particles of floating material seriously hampers the proper operation of the trickling filters. At the present time, removable screens in the effluent end of the Imhoff tanks hold back the large floating material from going over with the sewage. The objection to this method is that the screens soon plug up, necessitating the by-passing of all sewage from the Imhoff tanks to the river long enough for the screens to be cleaned and put back in place. At the present time this is a daily occurrence involving a partial cessation in the operation of the aeration tanks, Dorr settling tanks, trickling filters, and magnetite filters. During 1940, 302 hours were spent on this operation alone. As long as this condition persists the plant cannot function in its best possible manner.

Despite all efforts to keep the grit chamber pockets clean, a substantial quantity of sand and cinders is found in the approach channels and in the conduit and channels leading to the Imhoff tanks. Also, a considerable quantity of grit is found in the bottom of some of the Imhoff tanks. The dry weather flow channel was in use an average of 21.8 days per month or about 73 per cent of the total time.

Imhoff Tanks.—The twelve Imhoff tanks were in continuous service throughout the year. Due to the increased sewage flow, concentration tank overflow liquor and digester supernatant liquors the tanks were overloaded and presented a somewhat unsightly appearance and decreased efficiency of operation. The chief source of trouble is the presence of large amounts of grease which floats on the surface of the sewage.

The sludge pot ejectors for pumping are not very effective for large volumes. Their ineffectiveness is due to a lack of pumping capacity, high maintenance costs and excessive power consumption. At frequent intervals, 24-hour pumping schedules had to be maintained in order to remove the solids deposited in the tanks. A centrifugal pump, to replace the sludge pot ejectors, would be far more economical from the standpoint of pumping time and cost of operation. If the installation of the centrifugal pump as specified had been possible, it would have probably paid for itself during the year and at the same time insured more positive and convenient operation.

Pumping Station.—The installation of telechron clocks in the electrical circuits of the sewage pumps has proved to be satisfactory. The time of pumping has served as a reliable index of the volume of sewage pumped.

Abbreviated Aeration Unit.—This portion of the plant is the most effective single unit in use, despite the fact that along with sewage, a considerable amount of supernatant liquors was treated. The only drawback to this unit is insufficient capacity. For complete purification the capacity of this unit (22 m.g.d.) should be doubled. As it is, less than 48 per cent of the Imhoff tank effluent was treated in the aeration unit and the balance by-passed to the river.

One of the chief difficulties experienced is in the clogging of the diffuser plates and tubes. This is largely due to the presence of periodically occurring high iron wastes. In each case (tubes or plates) the tanks have to be taken out of service, pumped down and then the diffusing material dismantled, washed, treated with acid, washed again and then re-assembled. On this diffuser tube unit provisions were made for lifting tube sections out of the water without interrupting operation of the unit. However, the lifting cables were installed in such a way that their exposure to sewage was unavoidable. Because of this the cables were soon corroded and subsequent cleaning necessitated shutdown of the unit. Since the installation of the original aeration units at the Southerly Plant the Chicago Pump Company has developed a lifting mechanism for their diffuser tube assemblies which does not subject the lifting cables to sewage exposure. Because of the frequency of tube and plate cleaning, caused by industrial wastes from pickling plants, it would be highly desirable to change over all the aeration tanks at the Southerly plant into tube-type diffuser units incorporating the use of the lately developed type of tube lifter. In this way no shutdowns would be necessary and periodic replacements of plugged tubes with clean ones readily accomplished.

Blowers.—The blowers have functioned satisfactorily but because of the undue plugging of plates and tubes the discharge air has frequently been delivered at pressures in excess of the designed maximum of 8.5 lb. per sq. ft. This is a highly undesirable condition and may result eventually in serious damage to the blowers.

The air intake passage to the blower has been in continuous vibration (due to the blower pulsations) and has loosened up some of the tile dividing wall so that excessive vibrations are set up in it and the adjoining walls of the building proper. This wall will eventually have to be removed and facilities provided to lessen the structure vibrations in order to prevent future building damage.

Trickling Filters.—The trickling filters were in operation during the last eight months of the year. The plant has sufficient flexibility to allow the treatment of mixtures of Imhoff tank effluent and Dorr tank effluent. The trickling filters and the pumping station have adequate capacity to treat the entire present plant flow. However, the capacity of the magnetite filters is insufficient for these flows and furthermore, there are no adequate facilities for by-passing the trickling filter effluent. Because of these reasons full trickling filter capacity cannot be realized. Another contributing cause has already been mentioned; the difficulty of keeping material out of the sewage which would tend to clog the spray nozzles on the filters. If these objections were removed, and they can be removed, considerably greater purifications could be effected at practically no additional operation cost except the additional power costs necessary to pump the volumes of sewage now by-passed to the river.

Magnetite Filters.—During the first four months of the year the magnetite filters treated Dorr clarifier effluent (trickling filters not in operation) directly and during the last eight months they treated trickling filter effluent. The wash water from the magnetite filters is metered and pumped back to the Imhoff tanks. The magnetite filters have not operated satisfactorily. The reasons for this unsatisfactory operation are as follows:

1. Costs of electrical maintenance. A good many features of the equipment causing electrical trouble have been eliminated but difficulties are still being experienced.

2. Lack of uniformity in depth of magnetite filtering medium. A tendency for the formation of bare spots and gradual deposition of magnetite material at the ends of the filter are the chief causes. Most of this difficulty has been eliminated by the installation of scraper bars but greater improvement should still be effected by improvements in the design of the scraping equipment.

3. Deposition of solids in the old humus tank bottoms which now serve as the bottoms for the magnetite filters. There are no provisions for the removal of these solids, consequently the B.O.D. of the effluent is higher than that of the influent despite the fact that the filters do bring about a satisfactory solids removal.

4. Effluent channels inadequate for sewage removal. About 20 m.g.d. is the capacity of the magnetite filters at the present time. The filters themselves have adequate capacity to handle the entire plant flow (in excess of 30 m.g.d.), but the hydraulics are such that only 20 m.g.d. can be adequately handled. There are no provisions for by-passing part of the trickling filter effluent and as a result of this, the capacity of the trickling filters is restricted to that of the magnetite filters. To remedy this situation two installations should be made. A sewer that will handle about 40 m.g.d. should be installed to allow full use of the magnetite filters to satisfy present and future needs and a by-pass sewer for 40 m.g.d. to allow by-passing of the magnetite filters in the event that repairs have to be made on the magnetite filters.

Concentration Tanks.—The concentration tanks were designed to concentrate the incoming solids from the Easterly plant and the excess sludge from the Dorr clarifiers of the Southerly plant. The plant piping also has sufficient flexibility to allow pumping of sludge from the Imhoff tanks. The incoming solids to the tanks consist of primary solids, skimmings, excess activated sludge, and grease from the Easterly plant, and excess sludge from the Southerly plant. Practically all of this material is quite septic and any attempt at concentration by pure settling action is quite difficult of accomplishment.

The tanks were designed to treat incoming solids having a 3 per cent solids content and to concentrate this mixture to a 4 per cent solids content. On the basis of 1940 operation this premise was well founded. The average solids content of the influent material was 3.1 per cent and that of the concentrated sludge 3.9 per cent.

The handling of grease at the concentration tanks is a serious problem. The grease floats on the surface of the tanks, and when drawn to the Imhoff tanks of the Southerly plant, necessitates considerable labor for its removal. A suggested procedure is to skim the material at the concentration tanks, where the surface area for skimming is at a minimum, into some sort of improvised sump, and to pump from this sump into the digestion tanks. By this procedure, greater gas yields would be brought about in the digestion tanks, and an unsightly condition would be minimized in the sewage purification units. An alternative plan would be for the Easterly plant to dispose of its own grease and skimmings. It would also be worthwhile to investigate the possibilities of mechanical dewatering machines either of the vacuum or pressure type. The need for this further concentration is due to an insufficiency of detention time in the digesters.

Separate Digestion Tanks.—One of the chief difficulties in the operation of the digestion tanks is a lack of sufficiently concentrated solids influent to the digestion tanks. This lack of solids concentration decreased the effective capacity of the digesters, increases the amount of supernatant to be handled, produces a thin digested sludge, causes a wastage of gas used in heating the tanks, and cuts down on gas production. In fact the whole keynote of proper operation in the solids treatment units of the plant appears to be the demand for increased solids concentrations.

The digestion tanks were designed to give a 36-day digestion period. In 1939 the average digestion period was 17 days and in 1940 it was 26 days. The increase in digestion time in 1940 is due chiefly to improved methods of sludge concentration at the Easterly plant. However, the 26-day period (for 1940) is still 10 days short of the basis for design and does not allow sufficient margin for handling Imhoff tank sludges in digestion tanks. The bulk of Imhoff tank sludge is now lagooned; an undesirable but unavoidable practice.

Sludge Filtration.—The average dose of chemicals, on the basis of weight of dry sludge solids conditions, was 3.9 per cent for ferric chloride, 15.3 per cent for lime and 13.6 per cent for calcium oxide. This is an improvement over 1939 where the corresponding percentages were 4.2 per cent, 16.5 per cent and 14.6 per cent. This improvement in economy of chemical consumption is largely due to improved operation and a greater concentration of solids in the digested sludge; 6.0 per cent solids for 1940 as against 5.7 per cent for 1939. Greater economies in chemical consumption could and should be effected in ensuing years.

This economy in chemical consumption has also reflected itself in increased filter yields. The average rate of production of the filters for the whole year was 4.3 lb. dry solids per sq. ft. of filter area per hour as against a 4.2 figure for 1939. This is about the rate for which the filter installation was designed.

The average life of a filter cloth was about 154 hours for 1940 as against 149 hours for 1939, a slight improvement.

Sludge Incineration.—During the year 55,000 tons of filter cake, representing 83 per cent of all sludge cake produced, were incinerated. To incinerate this sludge cake, 88,823 gallons of fuel oil and 40,827,000 cu. ft. of sewage gas were used. During 1939, there were used 6.11 gallons of fuel oil per ton of filter cake. At this rate, with fuel oil at 3.85 cents per gallon, there was a saving of $9,518.00 by using sewage gas to supplement fuel oil in filter cake incineration. This saving in fuel oil should be increased in following years. Similar savings had been effected by utilizing sewage gas for coal in heating the administration building, and sewage gas for high test gasoline in the chemical laboratory. Of the total auxiliary fuel used, 88 per cent of the total oil used was for incineration and 86 per cent of the total gas used was for incineration; the balance of the fuel was used for stand-by purposes.

The average incineration rate has been 60 tons per incinerator per 24 hours of incineration. The basis of design had been 100 tons of cake per 24 hour day. The difficulty of attaining designed capacity is primarily due to a rapid accumulation of fly ash in the preheater passages. It is difficult to restrict this deposition of fly ash and impossible to clean these passages with the incinerators in operation. On this

TABLE III.—*Summary of Operation Data, Southerly Plant, Cleveland, Ohio*

Item	1940 Average	
Sewage flow treated	31.6	m.g.d.
Screenings removal (per m.g. sewage)	0.04	cu. yds.
Grit removal (per m.g. sewage)	0.046	cu. yds.
Volatile content	41.3	%
Analytical data:		
5-Day B.O.D.—raw sewage	204	p.p.m.
Imhoff effluent	113	p.p.m.
Aeration plant effluent	188*	p.p.m.
Intermediate clarifier effluent	43	p.p.m.
Trickling filter effluent	31	p.p.m.
Magnetite filter effluent	51	p.p.m.
Suspended solids—raw sewage	270	p.p.m.
Imhoff effluent	170	p.p.m.
Aeration plant effluent	508*	p.p.m.
Intermediate clarifier effluent	63	p.p.m.
Trickling filter effluent	39	p.p.m.
Magnetite filter effluent	37	p.p.m.
Bacterial data:		
Bacteria—raw sewage	131	1,000 per ml.
Imhoff effluent	90	1,000 per ml.
Intermediate clarifier effluent	83	1,000 per ml.
Trickling filter effluent	64	1,000 per ml.
Magnetite filter effluent	27	1,000 per ml.
Presumptive *B. Coli*—raw sewage	216	1,000 per ml.
Imhoff effluent	70	1,000 per ml.
Intermediate clarifier effluent	40	1,000 per ml.
Trickling filter effluent	14	1,000 per ml.
Magnetite filter effluent	14	1,000 per ml.

TABLE III.—*Continued*

Item	1940 Average	
Sludge digestion data:		
Imhoff sludge (digested)	32,645	1,000 gallons
Moisture content	93.7	%
Volatile content	44.2	%
Specific gravity	1.02	
Alkalinity	1,672	p.p.m.
Sludge to concentration tanks—solids	3.1	%
Volatile content	62.0	%
Alkalinity	824	p.p.m.
pH	6.6	
Concentration tank supernatant—solids	0.36	%
Volatile content	59.1	%
Alkalinity	586	p.p.m.
pH	6.7	
Sludge to separate digestion—solids	3.9	%
Volatile content	55.1	%
Alkalinity	933	p.p.m.
pH	6.6	
Digester supernatant—solids	0.64	%
Volatile content	50.8	%
Alkalinity	2,291	p.p.m.
pH	7.1	
Digested sludge—solids	6.0	%
Volatile content	45.5	%
Alkalinity	2,601	p.p.m.
pH	7.2	
Gas production—daily	911.3	1,000 c.f.
Sludge dewatering data:		
Chemical dosage—ferric chloride	15.3	%
Lime (as CaO)	13.6	%
Filter cake moisture content	74.1	%
Filter rate (lbs. per sq. ft. per hr.)	4.3	lb.
Ave. life of filter cloth	154	hr.
Filtrate total solids content	4,884	p.p.m.
Suspended solids content	429	p.p.m.
Alkalinity	2,448	p.p.m.
pH	11.5	
Incineration data:		
Quantity filter cake incinerated	4,583	tons per mo.
Dry solids incinerated	1,187	tons per mo.
Incineration rate (per unit)	2.46	tons per hr.
Fuel value of cake (per lb. vol. solids)	10,918	B.T.U.
Evaporated water	3,396	tons per mo.
Operation cost (per m.g. treated)†	$9.39	

* Includes supernatant liquors from concentration and digestion tanks.
† Adjusted to treatment processes as employed at Easterly, Southerly and Westerly plants.

account the incinerators suffer because of lack of adequate draft and hence the capacity of the incinerators is seriously curtailed. Since there is an ample supply of gas the solution would seem to be the removal of some of the preheater ducts, and enlargement of the passages on the remaining ducts. In this way greater draft conditions would prevail. The loss in heat efficiency would be compensated for by the additional consumption of sewage gas which, at the present time, is being wasted.

Of all the filter cake produced (66,420 tons) about 83 per cent was disposed of by incineration. The balance was hauled out of the plant by various groups. The largest single group comprised the city sponsored W.P.A. sludge hauling project. Other large haulers were Calvary and Crown Hill cemeteries as well as many individual haulers. Larger amounts of sludge cake could be hauled away if more rapid sludge unloading facilities were provided as well as greater disposal to individual users by proper dissemination of information about the availability and general applicability of the sludge produced.

TIPS AND QUIPS

Highlights of the War Time Conference at Cleveland.—Vice President Rawn's keynote address . . . Dr. G. E. ("Rusty," "Doc," "Honey-dew") Symon's fine job of writing the Convention Daily. . . . Winning of the Attendance Trophy for the second time in succession by the Central States contingent. Sixty eight members traveled 28,220 miles to win, over New York (46 members, 16,000 miles), Ohio (52 members, 4,160 miles) and Pennsylvania (18 members, 3,780 miles). . . . Expansion of the Quarter Century Operator's Club to eleven members by the enrollment of William C. Hamm of Port Washington, Long Island, N. Y.; T. C. Schaetzle, Akron, Ohio; and George O. Behnke, Oberlin, Ohio . . . the remarkable memory feats demonstrated by the M. C. at the Stag Smoker . . . the timely and informative program . . . the splendid work of the Local Arrangements Committee headed by W. L. (Bill) Havens.

* * *

The Pioneer, issued by the Niagara Alkali Company, relates that candidates for the position of sewer inspector in Milwaukee were recently required to undergo a sewer crawling test through a 327-foot line in the city system. Sort of "trying 'em on for size," it would appear!

* * *

Paint brushes scarce? How about a small wringer for convenient removal of paint from brushes before they are stored in suitable solvents?

* * *

Digester foaming is not uncommon but the cause of such an upset in the Tifton, Georgia plant, as reported by City Engineer D. H. Hurst in the *Georgia Faucet,** is somewhat out of the ordinary. It seems that a leaky sewer admitted acid solutions from a fertilizer plant wastewater lagoon, making it impossible for normal digestion conditions to

* News Bulletin of The Georgia Water and Sewage Association.

be maintained. Replacement of the faulty section of sewer effected the remedy.

* * *

Now that gas rationing is here, the German practice of using sewage gas for automobile fuel, as described in the May, 1939 issue of Illinois' *Digester,* may be of interest. Figure 1 shows the scrubbing and

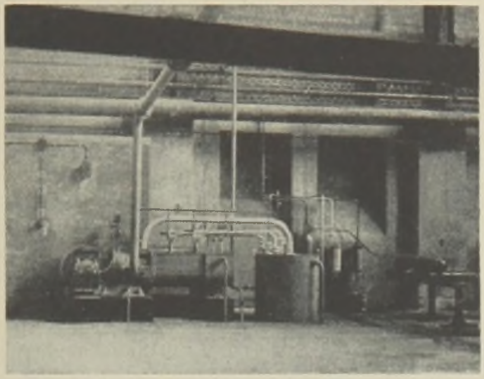

FIG. 1.—Plant for producing automobile fuel from sewage gas at Stuttgart, Germany.

compression plant with the fuel cylinders being loaded at the right. A truck equipped with gas-fuel tanks is shown in Fig. 2. Although de-

FIG. 2.—Truck equipped with sewage gas fuel cylinders.

tails of the carburetion changes required at the motor are not available, it will be noted that an ordinary gas pressure regulator appears to be mounted above the manifold.

* * *

A recent report of a Special Committee on Salaries for Sewage Treatment Plant Operators, indicates that the New England Sewage Works Association is actively engaged in the improvement of the status and welfare of operation personnel. A questionnaire survey of 57 plants in Connecticut, Massachusetts, New Hampshire and Rhode

Island revealed the following practice as regards vacations and sick leaves for operators:

State	Number Plants	Vacation With Pay	Sick Leave Allowed
Connecticut	20	15	13
Massachusetts	30	21	15
New Hampshire	3	1	1
Rhode Island	4	3	4
Total	57	40	33

The Committee concludes, "there is considerable room for improvement when, in 17 out of 57 plants reporting, no vacation is allowed, and in 24 of the plants no provision is made for sick leave."

The questionnaire data also made possible a comparison of chief operator or plant superintendent salaries between Connecticut, where plant operators must be approved by the State Department of Health and Massachusetts, where such approval is not required. The following summary uses the New York State classification of the size and type of plants included:

Class of Plant	Annual Salaries	
	Connecticut	Massachusetts
Grade 1	$3000	$2319
Grade 2	1993	1584
Grade 3	1923	1358

In noting the higher salaries in Connecticut, the Committee states, "this may indicate the value of state approval for sewage treatment plant operators to establish higher salary ratings. On the other hand, it might be taken to indicate that under an approval system a higher grade of operator is required, demanding a higher compensation than under an unapproved status."

In recommending the establishment of a permanent operation salaries committee, the following suggestions were offered:

(1) An investigation should be made of the workings of other committees and associations with similar aims and ideals.

(2) A study should be made of advisable legislation to promote the status of our sewage treatment plant operators, including in particular:

(*a*) Licensing of operators.
(*b*) Tenure of office.

(3) The establishment of suitable classifications and step increases in salary should be promoted. The assistance and coöperation of consulting engineers in establishing appropriate salary rates and step increases in pay for operators of plants designed by them should be invited.

(4) Vacations with pay and reasonable allowances for sick leave should be sought for all plant operators on the permanent staff.

The Special Committee consisted of Frank L. Flood, Chairman; Willis J. Snow and Paul V. Fleming.

WESTERN NEW YORK SECTION ELECTS OFFICERS—DISCUSS PUMPS AND SAFETY

The Annual Meeting of the Western Section of the N. Y. S. S. W. A. was held December 5, 1942, at the Delaware Hotel in Tonawanda, N. Y. In the absence of Chairman Al Martin, the secretary called the meeting to order at 10:30 A.M. and conducted a short business meeting, reporting on the business of the section during the past year.

The meeting was attended by 32 members and 7 guests. Mr. John W. Johnson, Program Chairman, introduced Mr. William Meiter, of the Worthington Pump Co., who, with the aid of blackboard and slides, gave a very interesting discussion of the design and characteristics of centrifugal sewage pumps. By means of diagrams, Mr. Meiter showed why the double suction pump was not well adapted to sewage work and spoke of the need for a special non-clogging impeller and a single suction. "Centrifugal pumps below 3 inch are not practical," said Mr. Meiter.

In considering design, layout, and operation of centrifugal pumps, Mr. Meiter named several items to bear in mind, including:

(1) The relation of the speed of the pump to the diameter of the pump and the size of solids to be passed;
(2) The layout of the pump station to produce a minimum friction loss of head;
(3) The pipe size in relation to the pump suction and discharge;
(4) The characteristics of the pump; that is, the capacity relation to the head and the efficiency of the pump;
(5) The installation of pumps of proper ranges to obtain the most efficient combinations;
(6) The use of eccentric reducers, and proper location of valves on suction and discharge to minimize friction loss.

By means of slides Mr. Meiter showed the relation of several pumps of varying capacities and characteristics of range and combination. Also shown were the mixed flow type of impeller and several typical installations. Other slides presented pictures of gas engine installations and blowers.

Mr. Meiter offered the following suggestions for pump care in this time of priorities:

1. Write the manufacturer for the pump characteristics.
2. Frame and hang the characteristics by the pump.
3. Check the head to determine what is obtained from the pump.
4. Adjust the stuffing boxes to allow five drops of water to emerge each minute.
5. Make sure that stuffing boxes are turned down properly, not unevenly.
6. Install screens, if not already present.
7. Check the alignment of the pump.

Mr. Meiter concluded with answers to these several questions put to him from the floor.

There should be no tolerance in the couplings; the pump and motor should be in perfect alignment. Pumps should not take any pipe strain. Pipe connections and pump suction and discharge should meet perfectly without need for strain. The company making the pump will be glad to check the installation of pumps and make suggestions for improvement where needed. The measurement of the discharge head should not be done from the tap on the top of the pump casing.

Mr. Johnson next introduced Mr. E. L. Benton of the State Insurance Fund. Mr. Benton presented a series of slides on industrial safety, and introduced the series with the statement that since Pearl Harbor a year ago, there had been seven industrial deaths for each military death. The pictures were accompanied by a recorded sound track which called attention to the relation of the war effort to accident prevention and management's cooperation with the men. The commentary pointed out that accidents are unintentional sabotage and that the 4000 lost time accidents per day in this country are equivalent to shutting down, every day, one factory employing 4000 men.

Among the six main causes of accidents which were presented and pictorially emphasized were the following:

1. Removal of guards on mechanical equipment.
2. Failure to use personal protective equipment (goggles, gloves).
3. Unsafe use of tools (damaged chisels, hammers, files, etc.).
4. Horseplay during lunch hours or working hours.
5. Lack of knowledge or skill for machine being used (don't be afraid to ask for help or advice when starting a new job).
6. Undue haste (in walking, moving materials, doing a job).

Mr. Benton warned that all operators should think, work, and play safely, for the most common types of accidents in plants are common to all industrial plants and do not come from specialized work. These most common accidents are caused by falling objects or by persons falling over misplaced objects or unprotected dangerous walkways.

Following the meeting, the executive committee met and performed the annual functions of electing a chairman and choosing the meeting places for the coming year. Dr. Symons was elected Chairman and Channel Sampson Secretary for 1943: It was decided to hold the spring meeting in Cheektowaga. It was also tentatively decided, because of travel restrictions, to hold but two meetings next year. The fall and annual meeting to be combined and held in October, in connection with the Annual Meeting of the Canadian Institute of Sewage and Sanitation at Niagara Falls, Ontario. This joint meeting is tentative on further arrangements with the Institute.

Mr. H. Semon gave a short description of the Tonawanda Plant and distributed printed descriptions of the design and layout. He told of recent high water in the Niagara River when the river level was above the effluent weirs of the settling tanks. During the inspection Semon also described some of the problems of starting the plant and some of the operating problems. Among the latter have been personnel turnover, wind pressure against doors which open into the wind, the excess chemicals used on secondary tank sludge when the volatile matter content is down to 30 per cent.

Despite the relatively small attendance and the fact that several who had reserved did not attend, the meeting was successful in the best traditions of this Western Section of N. Y. S. S. W. A.

George E. Symons, *Sec'y*, 1942

Editorial

POLIOMYELITIS AND SEWAGE

The approach of the President's Birthday Party, with the attendant "miles of dimes" for the National Foundation for Infantile Paralysis, draws attention to the recent research which links poliomyelitis (infantile paralysis) and sewage more closely than was formerly appreciated. The intense popular interest in infantile paralysis makes the study of its etiology and epidemiology of great significance. Probably no disease is subject to such widespread interest and investigation at the present time.

For many years polio has been known to be a virus disease, only one prominent investigator dissenting and working on the theory that it is caused by streptococci. Some thirty years ago, Landsteiner in Vienna demonstrated transfer of polio from a human being to a *rhesus* monkey, by intraperitoneal injection of virus. Later, intercranial injection was found to be particuarly effective. The infective agent was readily filterable through the finest porcelain filter and would not grow on bacteriological culture material.

Following this work, many studies were made all over the world on *rhesus* monkeys, and although the disease could be transmitted readily by injection, it was impossible to transmit it by feeding, that is, through the intestinal route. Large quantities of virus were fed, but typical polio did not develop. However, one investigator, Kling, reported at Paris in 1912 that he had occasionally transmitted the disease to monkeys through the gastrointestinal route. His results could not be duplicated by other investigators, so for more than 25 years other modes of transmission were suspected. Throughout this period, all investigators found that transfer was quite successful in the *rhesus* monkey through the nasal passages, and epidemiological studies were based on the theory of droplet or air-borne infection.

A remarkable change in viewpoint occurred, however, about 1937, when Harmon in Chicago isolated the virus from the intestinal tract of human beings. Toomey, in Cleveland, had for years stressed the theory that the gastrointestinal tract is the focus of infection. In 1938 and 1939, several investigators, including Burnet in Australia, found that the Java monkey, *Macaca cynomolgus,* was far more susceptible to intestinal infection than the *M. rhesus* monkey. It was discovered that Kling, in 1912, had used some Java monkeys in his work, and the reasons for different results by other investigators in the intervening years became clear.

Another milestone was reached in 1940 when Paul, Trask and Gard at the Yale Medical School announced the isolation of the virus from urban sewage in two out of three large epidemics. Kramer in Detroit also isolated the virus from the stools of healthy contacts during an institutional epidemic.

Various other investigators in the past two years have studied the isolation of the virus from sewage, and now it appears demonstrated that sewage is an important, probably the most important, source of the virus. However, transfer of the disease by feeding the virus is still unsuccessful in many cases, and injection into the peritoneum or cranium is necessary in experimental investigations. This appears to be a gap in the application of Koch's postulates considered essential for demonstrating the etiology of infective diseases.

The use of monkeys limits the scope of laboratory investigations, but fortunately a strain (Lansing) has been transferred with no appreciable loss in virulence to the cotton rat, then to white mice, then back to monkeys. White mice are therefore used as test animals with this strain.

The virus is quite resistant in sewage or water, and it has survived for months in refrigerated feces, in water for four months, and in milk or butter for three to six months. Paul says the question is "whether or not poliomyelitis virus may not be a normal inhabitant of sewage, like tetanus bacilli or tubercle bacilli." If so, we would constantly be exposed to infection, as in tuberculosis, but epidemics would occur only during periods of lowered mass resistance. On the other hand, the virus has been isolated from sewage somewhat more frequently during epidemics or in sewers near hospitals. Paul suggests that we need data on the constancy of presence of polio virus in sewage, to throw light on the danger of sewage as a disseminator of the disease.

In November, 1942, Carlson, Ridenour and McKahn, of the Department of Public Health Engineering and the University of Michigan Department of Communicable Diseases at Ann Arbor reported results of studies of the viability of a virus (presumably polio) in passing through laboratory models of water filters, including alum treatment, sedimentation and filtration. Filtration alone was quite unsuccessful in removal of the virus, but when the inoculated water was pretreated with large quantities of alum and filtered, only one of 54 mice receiving virus developed paralysis. Activated charcoal also was partially successful in removing virus; ultraviolet light was more successful.

Kempf and Soule of the Hygienic Laboratory of the University of Michigan (apparently different from Carlson's laboratory) had reported in 1940 that 1.5 p.p.m. of chlorine inactivated a suspension of virus when applied for 20 minutes, but 1.00 p.p.m. failed to inactivate. In December, 1942, they reported that, in water, 1.5 p.p.m. residual chlorine inactivated the virus and 1.00 p.p.m. did not.

The implications of both these papers are that normal water purification processes may not be relied on to eliminate the virus in mass infection. Kampf and Soul used monkeys in their experiments, possibly a more specific test animal than mice. Two out of six monkeys inoculated with filtered water developed paralysis. Large doses of alum, even without filtration, removed the virus from the supernatant water, but it remained in the settled floc.

In both studies at Ann Arbor the animals were inoculated by injection, not by feeding. This was of course preferable to ingestion into the alimentary tract as a procedure for studying the resistance of the virus to water purification processes, but it still remains difficult to induce the disease by feeding and these experiments did not throw any light on the question of the transmissibility of the disease by drinking infected water. In this connection, Paul stated last March that recent findings "tend, whether rightly or wrongly, to place poliomyelitis in the category of so-called intestinal diseases, which include typhoid fever and dysentery. We are not on the firmest of ground in classifying poliomyelitis this way, for we do not know whether the presence of the virus in the stools of patients is a direct or even an indirect link in the chain which actually leads this agent from one patient to another."

The medical research men are hot on the trail blazed by these findings of recent years. The National Foundation for Infantile Paralysis distributed several hundred thousand dollars to eight or ten medical research laboratories in 1942 (including the two in Michigan) and in August a foundation of $300,000 was given to the Johns Hopkins University for research on poliomyelitis, under the direction of Dr. Kenneth Maxcy, Epidemiologist.

It is important that the sewage works research laboratories become familiar with the technique of isolation and study of the polio virus, and that close contact be maintained between sewage technicians and medical research men working on poliomyelitis. The advances are occurring so rapidly in the medical field that it is difficult to keep up with the most recent findings. Possibly a Committee for this purpose might be appointed by President Schroepfer or Dr. Rudolfs can assign a Sub-committee of his Research Committee to this important task.

F. W. Mohlman

Proceedings of Local Associations

NEW ENGLAND SEWAGE WORKS ASSOCIATION

Fall Meeting

Springfield, Massachusetts, September 23, 1942

The fall meeting of the New England Sewage Works Association was held on September 23, 1942, at the Hotel Kimball in Springfield, Massachusetts. This was a one-day conference and was devoted almost exclusively to subjects pertaining to the war effort. Forty-nine guests were registered for the meeting. The meeting was called to order by President Samuel M. Ellsworth at 11:00 A.M. First were the reports of the Secretary-Treasurer. These were accepted by the membership. The final report of the committee on operators' salaries in New England was submitted by Mr. Frank Flood, Chairman, and Mr. Fleming and Mr. Snow. In the absence of any member of the Committee, portions of the report were read by President Ellsworth. It was voted to have this report mimeographed and distributed to the membership and to appoint a new permanent committee in line with the committee's recommendations.

There was no election of officers this fall as these were elected at the annual spring meeting in Boston. The elected officers for 1943 follow:

President: Roscoe H. Suttie, of New Haven
First Vice-President: Joseph A. Muldoon, of Bridgeport
Second Vice-President: Frank W. Van Kleeck of Hartford
Secretary-Treasurer: LeRoy W. Van Kleeck, of Hartford
Director: Eskil C. Johnson of Providence
Director: Robert Burrell, of West Haven
Director: Thomas R. Camp, of Cambridge.

The first paper was on "Decontamination of Gassed Areas" by Mr. Charles G. Robb, Chief Chemist, Hartford Metropolitan District sewage treatment plant. Mr. Robb gave an interesting lecture from notes. It was suggested that Mr. Robb's notes be submitted in the form of a brief report for mimeographing and for distribution to the membership. Major Brewster of the Office of Civilian Defense suggested at the meeting that this material also be made available to his office for possible distribution around the country.

Following the luncheon in the Embassy Room of the Hotel Kimball, Major John H. Brewster of the Office of Civilian Defense gave a short talk on the need of prompt emergency repairs to sewers, following acts of sabotage or aerial bombardment. He was followed by Mr. William H. Bliss of the War Production Board who spoke on the priorities situation. A number of questions were asked Mr. Bliss following his address.

The afternoon technical session was held in the main dining room and the first speaker was Captain Guy E. Griffin, U. S. Engineer Corps, New England Division, who spoke on the operation and maintenance of army sewage treatment plants.

The last topic was a symposium on the effects of war industrial wastes on the operation of sewage treatment plants. This was opened by Mr. LeRoy W. Van Kleeck of the Connecticut State Department of Health. Following a group discussion of this subject, the meeting adjourned at 4:45 P.M.

LeRoy W. Van Kleeck, *Secretary*

NORTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE

Fourteenth Annual Meeting

Williston, North Dakota, September 21–23, 1942

Minutes

The meeting was called to order by President Pearson at 10:30 A.M., on Monday, September 21, following the showing of films by the Industrial Chemical Sales Company on scenes at the AWWA convention and the picture, Every Drop a Safe One. The address of welcome was given by Mayor Hefengen of Williston. He recalled that this was the first time the city of Williston had played host to the conference, complimented the men in attendance on their efforts in traveling under existing adverse conditions, and welcomed convention delegates to the city. President Pearson called attention to the committee meetings and open house in Bismarck during April and reviewed some of his work in assisting with arrangements for the convention. He complimented the secretary on his efforts, and praised the members in attendance for coming to the meeting.

The minutes of the last meeting were read and approved. A communication received by the secretary from Bill Nordley was read, also a letter of regret from Justin Colsen.

The following committees were appointed by the president:

Auditing committee: M. L. Lovell, Chairman, H. H. Sanborn and R. J. Lockner. *Nominating committee:* O. C. Ayliffe, Chairman, S. K. Svenkeson and William Yegen. *Convention City committee:* William Robinson, Chairman, Dave MacDonald, Larry Fisher and Selmer Endrud. *Resolutions committee:* John Kleven, Chairman, Joe Morrissey and E. A. Tschida.

Report of the Board of Certification was presented by Chairman Pinney. Mr. Pinney reported that two meetings of the Board had been held during the conference year. Fourteen applications had been acted upon, and three additional applications received for future action. Seven certificates were issued, and others will be issued as the two dollar fee is remitted.

Financial report was presented by the Secretary-Treasurer. This report was in two parts; one covering the period from October 10, 1941 to January 20, 1942, which was prepared by H. G. Hanson and audited by a special auditing committee appointed by the president; and the other half covering the period from January 20, 1942 to September 10, 1942. It was recommended from the floor that the report be turned over to the auditing committee.

The report on the AWWA section committee was deferred at the request of Mr. Yegen, since the committee was not as yet prepared to report. At the request of the president the minutes of the April committee meetings were read and accepted.

Under new business a discussion was presented regarding the advisability of empowering the executive committee to defer future meetings if existing conditions make it appear desirable. Mr. Yegen felt the power was more or less inferred, and that action would not be necessary. Moved by Lawrence Kirk and seconded by Harry Swanson that the executive committee be empowered to suspend future annual meetings, should conditions make it appear a logical procedure and that the current officers carry over another year, or until such time as a meeting is called. Discussion followed. Motion carried unanimously.

A communication was read by the secretary as requested by the American Industries Salvage Committee urging the water and sewage works men to cooperate with the vitally important salvage drive.

It was suggested by Harry Swanson that the Wednesday afternoon meeting be held early to permit those desiring so to depart on the afternoon train. Suggestion taken under advisement. President Pearson extended greetings to the Conference from Dean Chandler. On motion the meeting adjourned at 11:50 A.M.

Meeting called to order 4:30 P.M. by President Pearson. Report of the AWWA section committee was presented by R. M. Jenson. On motion the meeting adjourned at 4:45 to the Dutch lunch prepared and served by the city of Williston. Following the Dutch lunch an inspection trip to the Lewis and Clark Irrigation project near Williston was made. Delightful entertainment by the Williston Elks Clown band awaited the group upon its return to the Great Northern Hotel.

The meeting was called to order at 11:10 A.M. on September 23, by President Pearson. The report of the nominating committee was presented by Chairman Ayliffe with the following nominations: *President,* Joe Morrissey; *Vice-President,* Dave MacDonald; *Secretary-Treasurer,* K. C. Lauster; and *Director,* H. H. Sanborn. F. W. Pinney was nominated as candidate for *Vice-President.* Moved by Hulteng and seconded that nominations be closed. Motion carried. Moved by Lovell that the secretary be instructed to cast a unanimous ballot for Morrissey for President, Lauster for Secretary-Treasurer, and Sanborn for Director. Motion seconded by Svenkenson, and carried. Moved by Yegen that the chair call for a secret ballot for the election of Vice-President. Seconded and carried. Results of the ballot were, MacDonald 18, Pinney 17. MacDonald was declared elected.

President Morrissey took the chair.

The convention city committee had no report and recommended that the issue be decided on the floor. Invitations were extended by Devils Lake, Grand Forks, and Valley City. Following the discussion, Robinson moved that the matter be disposed of by secret ballot. Motion seconded and carried. The resulting poll gave Grand Forks 17, Devils Lake 12, and Valley City 6. Grand Forks declared elected.

Chairman Kleven of the resolutions committee presented nine resolutions. It was suggested from the floor that the resolutions be published in *Official Bulletin,* and that the secretary be instructed to furnish copies of the resolutions to the superior officers of those involved. Moved by Pearson and seconded by Yegen that the conference extend its best wishes to those in the armed services and that the dues to the organization for existing members be suspended for the duration. Motion carried. Moved by Demo and seconded by Hulteng that the resolutions be accepted as read. Motion carried.

Moved by Hulteng and seconded by Yegen that the staff of *Official Bulletin* be permitted to combine two to three issues when necessary, and publish when time and stenographic help permit. Motion carried. Auditing committee report was presented by Chairman Lovell and adoption of the report of the Secretary-Treasurer as read, recommended. Moved by Yegen and seconded by Svenkenson that the report be adopted. Motion carried. Moved by Yegen that the meeting adjourn at 12:15 P.M.

General Session

The afternoon general sessions on Monday, September 21, were woven around the Civilian Defense program. The general plan of civilian defense organization was presented by Mr. Herman Veigel, Regional Director, Office of Civilian Defense, Omaha, Nebraska. He illustrated how a plan may be adapted locally, and how each individual may play a part. He defined the organization as the Volunteer Non-Military Army of the United States, whose purpose it is to coordinate activities of all civilian defense organizations. He cited the need for conservation to enable us to fight an offensive war. The necessity for the preparation for future exigencies was emphasized, and that volunteer workers are imperative to accomplish work with which we will be confronted. The organization of the state defense council was outlined.

Major William H. Cary, Jr., Regional Engineer, Office of Civilian Defense, Chicago, explained the position of the water and sewage works personnel in the civilian defense organization. The importance of water supply and the necessity for the integration of waterworks personnel in the civilian defense organization was stressed. He stated that although bombing in North Dakota was improbable, the fact remains that it is possible, and that we must be prepared. Plans for protection against saboteurs in blackouts were recommended. Several items were covered with the request that they not be revealed. He cautioned that the procurement of materials will become increasingly difficult, also that the stress of the times affords an excellent opportunity to sell the City Dads on the worth of a water supply. He recommended development of complete plans of action under any possible emergency or combination of circumstances.

Following a ten minute recess for relaxation, Mr. Jack F. Whalen of Minneapolis presented the paper "Emergency Repairs to Waterworks" originally prepared by D. W. Johnson.

Mr. Everett Lobb, State Health Department, outlined the Mutual Aid Program for North Dakota.

Tuesday, September 22.—The banquet was held at 6:30 P.M. in the bomb shelter. President Pearson presided. Ken Lauster was called on for a few words. Telegrams from L. K. Clark, F. O. Malloy, Frank Haider and Sig Ravnos, and a letter from Wilson Laird were read. He expressed his appreciation both personally and on behalf of the conference to the city of Williston for its hospitality, to the members of the conference who assisted in arrangements, and others who assisted in arrangements and took part in the convention program, and to members of his staff for their assistance, especially Mr. Bavone and those presiding at section meetings. He introduced Mr. H. B. Foote, State Sanitary Engineer, Montana, and Messrs. Wm. H. Cary, Jr., and O. C. Hopkins of the U. S. Public Health Service. The President turned over the remainder of the program to Mr. Harry E. Polk, who so ably acted as toastmaster. Musical numbers were presented by the high school trio. Introductions were made of the Williston city commission, and other prominent Williston citizens, Lester Jolly and Joe Bridston of Grand Forks.

An excellent talk was presented by Mr. Henry Holt of Grand Forks on the subject of the Missouri River Diversion and its relation to municipal water supplies and sewage disposal. He acknowledged with appreciation the work of the North Dakota Water and Sewage Works Conference, the State Department of Health, the U. S. Public Health Service, the U. S. Corps of Engineers, and the Bureau of Reclamation for assistance rendered to the water conservation commission. The program of the water conservation commission was outlined covering the diversion at Fort Peck through Medicine Lake, across the Divide into the Mouse River, into Devils Lake, the Sheyenne and James Rivers, including other related developments. He cited the increase in population, income, jobs, etc., that would result should such a program become an eventuality. Since insufficient water is available within the Red River Basin to care for the needs within that area for water supply and sewage dilution purposes even with careful control, supplementary flows must be provided if satisfactory conditions are to prevail. Such supplementary flows can be obtained only through the Missouri River diversion. He urged the support of the conference in promoting the program as a post-war construction program. Tribute was paid to the Montana program, citing accomplishments in that State, also to Lester Jolly, his pilot, on the trip to Williston. Lieutenant Jolly is conducting air training schools in the state.

At the close of the meeting the drawing for the watch presented by Crane Company and Pomona Pump Company was made. Presentation was made to Mr. J. S. Sorenson of Grenora, the holder of the lucky number.

Wednesday, September 23.—The Wednesday morning general session started with showing the transite pipe film, "Beneath the Surface." William Meyer, State Plumbing Inspector, presented a discussion on the enforcement of the state plumbing code.

A discussion, with slide illustrations, on bio-filters was given by Mr. Bert Nelson of the Dorr Company, Chicago. Since most of the B.O.D. reduction takes place in the upper portion of the filter, designs usually call for shallow filters and two-stage treatment is provided where high reductions are required. The recirculation ratio is a function of the strength and governed thereby, increasing as the strength increases. Some design factors were given. Total discharge heads on recirculation pumps at biofilter plants are generally 8 to 10 feet which permits the use of propeller type pumps placed in wet wells. Elimination of the dry pit thus effects economies. Thirty to sixty million gallons per acre per day are general application rates but as high as 102 million gallons per acre have been used. The costs of such plants are usually considerably less than conventional trickling filter plants or even activated sludge. The flexibility in handling shock loads, decrease or elimination of filter flies, and the maintenance of dissolved oxygen throughout the plant were cited as advantages. By July, 1942, 150 biofilter plants had been installed, 43 per cent of which were two-stage and the remainder single-stage, effecting B.O.D. reductions from 60 per cent to 95 per cent. Because of depth and under-drain design, conventional type filters cannot be redesigned as biofilters. As a means of improving B.O.D. reductions, single-stage biofilters were suggested as preliminaries to standard filters. Some pictures of existing plants were shown.

K. C. Lauster, *Secretary*

CANADIAN INSTITUTE ON SEWAGE AND SANITATION

Ninth Annual Convention

Toronto, Ontario, October 29–30, 1942

The Ninth Annual Convention of the Canadian Institute on Sewage and Sanitation held at the Royal York Hotel, Toronto, Ontario, on October 29–30 was most successful. A new high record was reached in the registration of 190. A further increase in membership also took place. The Institute was favored with the presence of immediate Past

President, A. S. Bedell of the Federation of Sewage Works Associations. The program was balanced between written papers, guided discussions, and social contacts. War problems were prominent throughout the discussions.

The conference was opened by President W. L. McFaul, city engineer of Hamilton, Ontario. The first forenoon was devoted to guided discussions on the subject "Essentials in Municipal Sanitary By-Laws for War and Peace." This was under the chairmanship of Nicol MacNicol, Commissioner of Works, Forest Hill, Ont. This discussion had to do with the contents of municipal sanitary by-laws, as well as changes which were required by the war. The saving of metal, and the use of substitute materials were dealt with. Plumbing installations are conspicuous now in wartime changes. Other subjects considered were the necessity for well-trained local inspectors, the advantages of having the control of plumbing under the health board, and the co-operation which is essential at all times between the health officer and the engineering department.

The afternoon session opened with a paper on "Operating Results at the North Toronto Sewage Treatment Plant," read by N. G. McDonald, Consulting Engineer, Toronto. This summarized the results of the treatment of this activated sludge plant since its construction about 15 years ago. The plant has been enlarged once in that interval, and is now overloaded in some degree again. The results show consistently high removals of suspended solids and B.O.D.

This was followed by two addresses on salvage campaigns for war materials. The first speaker, Charles LaFerle, Director of National Salvage, Ottawa, dealt with the program of securing scrap from garbage and other sources. The entire Dominion has been organized to secure as much as possible of available scrap. $7.00 per ton is paid for this, and much of the money is turned over to war charities. Scrap metal is vital in Canada to-day. A. A. Stanley who is in charge of this campaign for the greater Toronto area emphasized the advantage of having these collections made by existing municipal systems, rather than by setting up new agencies. The results in the Toronto district have been most successful, and very substantial quantities of essential materials have been secured.

The remainder of the afternoon was devoted to a guided discussion on "The Problem of War-Time Industrial Wastes," with R. J. Desmarais, City Engineer of Windsor, as chairman. Delegates referred to overloading of treatment plants, chiefly from war plants and including both organic and inorganic substances. Oils and greases have had a detrimental effect on activated sludge plants.

The afternoon meeting was followed by a banquet and social evening at which over 100 were present. The entertainment was sponsored by the local manufacturers. A. S. Bedell, Past President of the Federation was the guest speaker.

The second day of the conference began with the usual business meeting of the Institute. The Secretary's report showed a gain in membership of 9, and a favorable financial balance. The following officers were elected and will constitute the new executives:

Past President—W. L. McFaul, City Engineer, Hamilton.
President—B. F. Lamson, City Engineer, St. Catharines.
Vice-President—R. H. Parsons, City Engineer, Peterborough.
Trustees—R. J. Desmarais, City Engineer, Windsor.
David Jack, City Engineer, Kingston.
Secretary-Treas.—A. E. Berry, Toronto.

Mr. Bedell reviewed the activities of the Federation, and the work that is being done by the 27 associations which go to make up this organization.

A paper was read by A. E. Griffin, Assistant Director, Technical Service Division of the Wallace & Tiernan Co., Newark, N. J., on "Modern Trends in Chlorination of Sewage." This was a comprehensive review of the field of chlorination in sewage disposal.

"The Application of Trickling Filters to Sewage Treatment" was the subject of the final written paper, and was given by G. G. Reid, Consulting Engineer of No. 1 Command, R.C.A.F., Toronto. In this, a preliminary report was furnished on the use of this type of treatment for the airports in Ontario. It is too early yet to review in detail the operating results from these.

The remainder of the sessions was devoted to guided discussions. The first subject was "Wartime Personnel Problems of Municipalities," under the chairmanship of R. W. Garrett, City Engineer of London, Ontario. This called for much discussion on the difficulties of securing trained personnel at this time, as well as the wages paid, bonuses, and other facilities. Considerable variation occurs in the procedures followed in municipalities, and it is proposed to have a survey made by the Institute on these matters.

Only a limited time was available for discussion of the subject "Procurement and Maintenance of Equipment in Wartime." Reference was made to the procedures required under priorities to obtain supplies for repairs and maintenance. As the war progresses this situation becomes more acute.

The annual luncheon of the Institute was attended by more than 100 delegates. K. M. Cameron, Chief Engineer, Dominion Dept. of Public Works, Ottawa, as guest speaker on the "Post War Reconstruction" emphasized the importance of planning in advance for the program to be adopted later. Public Works can play an important part after the war, but this cannot alone relieve unemployment. He urged engineers to give serious thought to this whole problem.

A. S. Bedell presented an engrossed certificate to Stanley Shupe, who was President of the Institute in 1940–41. This was to serve as a memento of the office.

A. E. Berry

Federation Affairs

FEDERATION OF SEWAGE WORKS ASSOCIATIONS

MINUTES OF MEETING OF 1942 BOARD OF CONTROL

Hotel Statler, Cleveland, Ohio, October 24, 1942

The regular Annual Meeting of the 1942 Board of Control of the Federation of Sewage Works Associations was called to order at the Hotel Statler, Cleveland, Ohio, at 5:30 P.M., October 24, 1942, by President A. S. Bedell.

Roll call indicated the following representation:

PRESENT IN PERSON

Affiliate or Office Represented	*Represented By*
President	A. S. Bedell
Vice-President	G. J. Schroepfer
Past President	C. A. Emerson
Treasurer	W. W. DeBerard
California Sewage Works Ass'n	W. A. Allen
Central States Sewage Works Ass'n	G. J. Schroepfer
Federal Sewage Research Ass'n	J. K. Hoskins
Florida Sewage Works Ass'n	Joe Williamson, Jr.
Georgia Water and Sewage Ass'n	V. P. Enloe
Missouri Water and Sewerage Conf.	G. S. Russell
New England Sewage Works Ass'n	F. W. Gilcreas
New Jersey Sewage Works Ass'n	E. P. Molitor
New Jersey Sewage Conf.	W. Rudolfs
Ohio Sewage Works Conf. Group	F. W. Jones
Pennsylvania Sewage Works Ass'n	H. E. Moses
The Canadian Inst. on Sewage and Sanitation	A. E. Berry
Member-at-Large	A. H. Niles
Member-at-Large	L. H. Enslow
Water and Sewage Works Manufacturers Ass'n	Karl M. Mann
Water and Sewage Works Manufacturers Ass'n	D. S. McAfee
Sewage Works Practice Committee	Morris M. Cohn
Publications Committee	F. W. Gilcreas
Research Committee	W. Rudolfs

PRESENT IN PERSON, ACTING BY PROXY

Affiliate or Office Represented	*Represented By*
Argentina Soc. Engineers, San. Eng. Div.	John H. Brooks, Jr. (For E. B. Besselievre)
Arizona Sewage and Water Works Ass'n	W. D. Hatfield (For P. J. Martin)
Dakota Water and Sewage Works Conf.	W. Q. Kehr (For W. W. Towne)
Kansas Water and Sewage Works Ass'n	J. K. Hoskins (For Earnest Boyce)
Maryland-Delaware Water and Sewerage Ass'n	W. J. Orchard (For H. R. Hall)
New York State Sewage Works Ass'n	Earl Devendorf (For N. L. Nussbaumer)
North Carolina Sewage Works Ass'n	L. O. Williams (For H. G. Baity)
Member-at-Large	W. A. Allen (For A. M. Rawn)
Water and Sewage Works Manufacturers Ass'n	W. B. Marshall (For L. E. Rein)

The above representation constituted a quorum. Also present were F. W. Mohlman, *Editor,* and W. H. Wisely, *Secretary.*

Reading of the minutes of the meetings of the Board of Control held in New York on October 11, 1941, was dispensed with by consent, these minutes having been published in the November, 1941, issue of SEWAGE WORKS JOURNAL. Two corrections were offered, *i.e.,* where reference was made to the budget being submitted by the Executive Committee, the 1942 budget was intended instead of 1941 and, where authorization was made for the appointment of a Financial Advisory Committee, it was intended that the Past President should serve instead of the Vice-President. With these corrections, the minutes were ordered approved.

In a brief statement, President Bedell indicated his enjoyment of the Federation activities during the year and thanked members of the Board of Control, committee chairmen, officers and others for their coöperation.

Secretary Wisely distributed copies of his report covering the activities of his office for the year ended September 30, 1942. The report included the financial statements required of him under Section 5, Article IV of the By-laws.

Treasurer DeBerard presented his report which indicated that the unencumbered balances in the depositories of the Federation totalled $15,520.54, of which $7,751.64 is in the Continental Illinois National Bank and Trust Company of Chicago and $7,768.90 is in the Busey's State Bank of Urbana, Illinois. It was pointed out that these balances substantiate the financial statements contained in the report of the Secretary. It was regularly moved, seconded and carried that the Treasurer's report be accepted subject to the annual audit and that the Executive Committee and Secretary be authorized to arrange for such audit.

Editor Mohlman presented a statistical summary of the cost and editorial content of SEWAGE WORKS JOURNAL which made possible a comparison with previous years. He referred specifically to the increase in plant operation material, of which the JOURNAL contained a total of 574 pages in 1942. It was regulary moved, seconded and carried that Editor Mohlman prepare a written report, including his verbal explanation and statistical information, for publication in an early issue of SEWAGE WORKS JOURNAL and that the report be accepted with deep appreciation. (See *Editorial,* Nov., 1942.)

The report of the Executive Committee, including a recommended budget for the year 1943, was presented by Vice-President G. J. Schroepfer.. Reading from the report, Mr. Schroepfer moved that " the Secretary be authorized to prepare a proper certificate to be presented to such Honorary Members as may be elected in accordance with the Constitution and By-laws." Motion regularly seconded and carried.

Reading further from the report, Mr. Schroepfer moved that the Financial Advisory Committee, consisting of the President, Past President and W. J. Orchard as Chairman, be continued during the coming year. The motion was regularly seconded and carried.

The following resolution, passage of which was recommended by the Executive Committee, was presented by Mr. Schroepfer and its adoption was moved and regularly seconded:

> " WHEREAS, Municipal sewers and sewage treatment works constitute facilities, the continued and efficient operation of which are essential to the health and welfare of the public; and
>
> " WHEREAS, the operation of such facilities require the services of various highly specialized technicians who are qualified both by training and experience in sewerage and sewage treatment plant practice, and
>
> " WHEREAS, in many cases the loss through Selective Service of key personnel employed in municipal sewer departments such as engineers, chemists, superintendents and chief operators may impose a severe hardship on municipalities and make continued efficient operation of specific sewer and sewage treatment facilities impossible due to inability of municipalities to find qualified replacements, and
>
> " WHEREAS, Selective Service Occupational Bulletin No. 10—Re: Scientific and Specialized Personnel—effective June 18, 1942, gives a list of critical occupations and recommends that Local Selective Service boards should give careful consideration for occupational classification ' to all persons trained, qualified or skilled in these

critical occupations and who are engaged in activities necessary to war production or essential to the support of the war effort,' and

"WHEREAS, in many cases it is in the interest of the public health and welfare and essential to the war effort to grant occupational deferments to key personnel in municipal sewer departments:

"*Now therefore, be it resolved,* by the Federation of Sewage Works Associations in Convention assembled at Cleveland, Ohio, on October 24, 1942, and representing the municipal sewerage officials of municipalities in all states, that action should be taken by Selective Service officials or the Man Power Commission or both to assure that key personnel and specialized technicians in the employ of municipal sewer departments will not be inducted to military service in any case where such action will result in imposition of a severe hardship upon a municipality due to inability to obtain qualified replacements or the appointment of persons as replacements with sufficiently good preliminary qualifications to assure proper operation of its sewerage facilities, and

"*Be it further resolved,* that Selective Service Occupational Bulletin No. 10, above referred to, is recommended to be revised by including key positions in municipal sewer departments such as chemists, engineers, superintendents and chief operators, as critical occupations, the incumbents of which should be given careful consideration for occupational classification by local Selective Service boards, and

"*Be it further resolved* that a copy of this resolution be forwarded to General Louis B. Hershey, Administrator of the Selective Service Act, and to the Honorable Paul V. McNutt, Chairman of the Man Power Commission.

Adopted at Cleveland, October 24, 1942."

Roll call on the adoption of the above resolution indicated a vote of 29 "Ayes," 3 "Nays." The resolution was declared adopted.

The report of the General Policy Committee was presented by Vice-President C. A. Emerson. The report contained several controversial issues and a lengthy discussion ensued, following which it was moved, seconded and carried that it be placed on the table for further consideration and action by the 1943 Board of Control.

The following report of the Publications Committee was presented by Chairman Gilcreas:

"The major proportion of the Publications Committee's efforts this year were devoted to the formulation of the program for the Third Annual Convention. The aim was to select a theme that would be of greatest practical interest to the members of the Federation; therefore, the program was developed from the point of view of the effects the war emergency has had on the profession. The task of securing qualified speakers was unusually difficult because of the absence of so many members in military service and the consequent added demands upon the time of those who are still carrying on civilian pursuits. However, through the coöperation of members in both military and civilian ranks, it was possible to provide a program that we hope has, in some measure, accomplished our objective of bringing to the attention of the members any information of war time significance in the field of sewage treatment.

"In connection with the supervision of Federation publications, several matters have been considered by the Committee. On February 13 the rules and regulations regarding publications, which were recommended to and adopted by the Board of Control at the Second Annual Convention, were sent with an accompanying letter to each secretary of the Member Associations. In interpreting rule 1 as it affects the local associations, requests were received from the Texas, North Carolina, and California groups for permission to publish papers presented at their meetings in their local proceedings; the Canadian Institute requested permission to publish its papers in two engineering journals circulated locally. The Publications Committee approved local pre-publication in all cases since it was felt that it would not have any effect on the subsequent appearance of the papers in SEWAGE WORKS JOURNAL.

"Complaints were received during the year from two members regarding delay in publication of material submitted to the JOURNAL. In the first instance, it was found that the delay had been occasioned by the need for rewriting portions of the paper to make it acceptable for printing. This the author agreed to do. In the second instance, the editor decided that the paper was not adapted to publication.

"On another occasion, it was necessary for the Publications Committee to maintain its prior publication rights to an article presented at a Federation meeting because the author felt he was also committed to publish it in another journal.

"A request has been received that the Committee publish in full the program for the annual conventions well in advance of the meetings. The Committee recommends that the system in present use be continued since to make the requested change would result in the publication of the program in commercial journals before it appears in SEWAGE WORKS JOURNAL.

"In connection with the forthcoming ninth edition of *Standard Methods for the Examination of Water and Sewage,* the Federation has been assigned to develop the section of chemical methods for the examination of sewage. Doctor Hatfield's Committee on Standard Methods has been actively engaged in the preparation of this manuscript. It seems only equitable that the Federation share in the editorial responsibility for the new volume on the same footing as the American Public Health Association and the American Water Works Association. The Publications Committee has, therefore, presented this request to both associations. Unfortunately, the executive boards of neither society have as yet had an opportunity to act on the matter. The Secretary of the American Public Health Association has stated that it would be considered this month in St. Louis; the Secretary of the American Water Works Association has written that action will be taken as soon as an opportunity presents itself. Since equal publication and editorial rights should be accorded the Federation in recognition of its activities in developing the chemical methods for the examination of sewage, the Publications Committee recommends that the Board of Control of the Federation give serious consideration to the inadvisability of preparing the material for publication in a volume over which the Federation has no editorial or publication control; and the Committee further recommends that in the event recognition cannot be gained by the Federation, the Board of Control consider developing its own publication on standard methods for the examination of sewage.

Respectfully submitted,

ROLF ELIASSEN
JAMES L. FEREBEE
W. W. MAHLIE
R. S. PHILLIPS
F. C. ROBERTS, JR.
W. W. TOWNE
F. W. MOHLMAN, *Editor*
F. W. GILCREAS, *Chairman*"

Acceptance of the report was regularly moved, seconded and carried.

It was moved by Mr. Orchard that the Committee be continued and that if there proved to be no inclination on the part of the American Public Health Association and the American Water Works Association to acknowledge the participation of this Federation Committee in the revision of the book *Standard Methods of Water and Sewage Analysis,* that the matter be referred to the Executive Committee with power to act for the Board of Control. The motion was regularly seconded and carried.

Chairman Havens, of the Convention Management Committee, reported verbally, saying that any success of the Federation's Wartime Conference at Cleveland should be credited to the members of his Committee and of the sub-committees. He reported, further, that a preliminary accounting of the financial aspects of the meeting indicated that there would probably be a small balance for the Federation treasury after all expenses had been paid. Mr. Havens' report was accepted with thanks and appreciation from the Board.

The report of the Organization Committee was presented by Mr. F. W. Jones, a member of the Committee. The report comprised a review of the activities of the Committee during the past year with recommendations for the further clarification of the Constitutions and By-laws of the South Dakota Water and Sewage Works Conference, the North Dakota Water and Sewage Works Conference and the Missouri Water and Sewerage Conference.

By motion of Mr. Jones, regularly seconded and carried, the revised amended Constitutions and By-laws of the following Member Associations were approved by the Board:

California Sewage Works Association
Federal Sewage Research Association
Michigan Sewage Works Association
New England Sewage Works Association
New York State Sewage Works Association
North Carolina Sewage Works Association
Rocky Mountain Sewage Works Association
Canadian Institute on Sewage and Sanitation.

It was further moved, seconded and carried that the report of the Organization Committee be reproduced for distribution among the members of the Board of Control.

In presenting the report of the Sewage Works Practice Committee, Chairman Morris M. Cohn referred to the informal statement published on page 1147 of the September, 1942, issue of SEWAGE WORKS JOURNAL. He stated further that following a meeting of the Committee on October 24, it was decided to proceed with the preparation of three sections of a manual during 1943. The first manual will pertain to the use of sewage sludge as fertilizer and it is the intention of the Committee to invite Mr. C. E. Keefer of Baltimore to serve as Chairman of the sub-committee on this topic. A second manual is planned to cover maintenance of sewers and sewer appurtenances and Mr. John H. Brooks, Jr., of Worcester, Massachusetts, has consented to serve as Chairman of this sub-committee. Mr. John J. Wirts of Cleveland has already consented to begin preparation of a manual on air diffusion and will present an outline of his proposed manual to the Committee at an early date. The report was accepted with commendation to the personnel of the Committee for the progress made.

The report of the Standard Methods Committee was presented verbally by Dr. W. D. Hatfield, Chairman. He advised that a final report covering recommended changes in laboratory procedures is now in the hands of the Publications Committee and expressed the opinion that he did not believe the new revisions would be incorporated in the book *Standard Methods of Water and Sewage Analysis* for a year or two because of the war emergency. It was further stated that the additional time which was made possible by the postponement of publication could be utilized advantageously by the Committee in developing a more complete and satisfactory procedure for the determination of grease in sewage and urged that the Committee be continued with its present personnel. Upon inquiry, Chairman Hatfield expressed the opinion that the report of the Committee should not be published in SEWAGE WORKS JOURNAL at the present time. Upon motion by Mr. Orchard, regularly seconded and carried, the Committee was ordered continued and the publication of the Committee report referred to the Executive Committee with power to act, pending the outcome of the negotiations of the Publications Committee with the American Public Health Association and American Water Works Association regarding participation by the Federation in distributing the volume *Standard Methods of Water and Sewage Analysis.*

The report of the Research Committee was read by Dr. Willem Rudolfs, Chairman. The Research Committee published a critical review of the literature published during the previous year, interpreting the progress made in the field of sewage treatment, waste disposal and stream pollution. This report was published in the March issue of the JOURNAL and appears to be considered as a contribution which should be continued even during war time.

At a meeting of the Research Committee held in Cleveland on October 22, 1942, it was agreed after considerable discussion, that coordination of research was not a function of this or any other committee of the Federation. On the other hand, the stimulation of research by letters from the committee and to stimulate publishing results of research projects in the JOURNAL was considered a definite function of the committee.

As an extension of the activities of this committee, a list of titles of research projects under way and undertaken by the members of the various associations will be published once a year in the JOURNAL in an effort to aid the research workers in appraisal of their own problems. It is the intention to list the titles of the projects, together with the name of the investigator, under different headings somewhat similar to those used in the review of the literature published annually in the March issue of the JOURNAL.

The chairman of the Research Committee will appoint, with the advice of the Secretary of each association, a member who will collect the information desired and forwarded it to the Research Committee for compilation.

It was agreed that a further extension of the committee should be to act in the nature of a clearing house for research problems. It was agreed that the committee could obtain, compile and publish information on research problems and opportunities in research. It occurs frequently that a member of the federated associations has a particular problem which he cannot study for lack of time, money, help or facilities. Such calls for help could be published in the JOURNAL and the problem handed over to anyone who is in a position to undertake the work. The chairman of the Research Committee will compile and submit to the JOURNAL for publication a listing of problems which are deemed desirable to study.

Chairman F. W. Jones reported verbally for the Committee on Sewage Nomenclature. Mr. Jones referred to the difficulty of carrying on the activities of this Committee by correspondence, in view of the fact that it must work jointly with similar committees in the American Society of Civil Engineers and American Public Health Association. He advised that some work had been done by correspondence, however, and that a report is in preparation to be rendered to the American Society of Civil Engineers in January. Mr. Jones' remarks were accepted as a progress report, with instructions for the Committee to proceed, insofar as possible, in its duties by correspondence.

The report of the Awards Committee, prepared by Chairman Charles Gilman Hyde, was read by the Secretary as follows:

> " It is recommended that, as opportunity offers, four types of awards be established within the Federation of Sewage Works Associations and that consideration be given to the establishment of a fifth at some future date, if such an award shall at that time appear to be desirable.
>
> " The recommended awards are:
>
> GEORGE WARREN FULLER MEDAL (for Research).
>
> " For outstanding research contributing in important degree to the existing knowledge of the fundamental principles or processes of sewage treatment and as comprehensively described and published during any stated year in SEWAGE WORKS JOURNAL; such description and discussion to outline the problem, the method of attack, the conclusions reached, and the application to the science and art of sewage treatment.
>
> GEORGE BRADLEY GASCOIGNE MEDAL (for Operation).
>
> " For outstanding contribution to the art of sewage treatment works operation through the successful solution of important and complicated operational problems; and as comprehensively described and published during any stated year in SEWAGE WORKS JOURNAL.
>
> CHARLES ALVIN EMERSON MEDAL (For Services to the Federation as a Whole).
>
> " For outstanding service in the sewerage and sewage treatment works field as related particularly to the problems and activities of the Federation of Sewage Works Associations in such terms as the stimulation of membership, improving standards of operational accomplishments, fostering fundamental research, etc., and to be given yearly, if feasible, to some member of the Federation.

KENNETH ALLEN AWARDS (For service in Local Member Associations).

"For outstanding service in the sewerage and sewage treatment works field, as related particularly to the problems and activities of any Member Association; to be in the form of a certificate issued from the headquarters of the Federation of Sewage Works Associations and bearing proper and adequate signatures; and to be granted to any one local group once in three years, according to schedule, in rotation with other local Member Associations.

"The award recommended for consideration and possible future establishment is:

HARRISON PRESCOTT EDDY PRIZE (for Design).

"For outstanding contribution to the original and successful design of some feature or features of sewage treatment works as related to construction or to operation, or both, after such feature or device shall have been thoroughly demonstrated in actual use to be of practical value, and shall have been comprehensively described and published in SEWAGE WORKS JOURNAL; this award to be made in the form of a certificate plus a money prize.*

"*Note:* It is recognized that the Federation of Sewage Works Associations and its JOURNAL should leave to such technical organizations as the American Society of Civil Engineers the matters of engineering design and construction of sewerage and sewage treatment works. For that reason, the last named prize (or award) is suggested with some trepidation and very tentatively. It may be, however, that such an award would stimulate originality in the design of certain or many features of sewage treatment works.

Mechanism of Awards.

"It is recommended that the determination of the recipients of the George Warren Fuller, the George Bradley Gascoigne and the Charles Alvin Emerson Medals be placed for the immediate and indefinite future in the hands of a Committee on Awards to be appointed annually by the Board of Control of the Federation of Sewage Works Associations; that this Committee consist of three members selected from the membership at large and not members of the Board of Control; and that this Committee set up rules and regulations for its guidance, which rules and regulations, prior to being administered, shall be formally approved by the Board of Control.

Respectfully submitted,

E. SHERMAN CHASE
GAIL P. EDWARDS
CARL C. LARSON
HOWARD E. MOSES
CHARLES G. HYDE, *Chairman.*"

It was moved by Mr. Orchard, regularly seconded and carried, that the incoming Board of Control set up a suitable committee, that the Financial Advisory Committee be requested to determine ways and means to finance the awards, beginning with the next annual meeting, that action on this report be published in an early issue of the JOURNAL and that the Secretaries of all Member Associations be promptly informed of this action for the information of their members.

The report of the Committee on Operation Reports, prepared by Chairman A. F. Dappert, was read by the Secretary. The report recommended a suitable award to be presented at the recommendation of an operation report rating committee to the operator presenting the most meritorious plant operation report during the year. Provision is made for the sifting of reports submitted in each Member Association, with each Association thus entering one report annually to the Federation rating committee for the Federation award. The standard form of annual report and rating schedule in use by the New York State Sewage Works Association was recommended for consideration in connection with the Federation plan. The Committee report also contained detailed

* By such prize, competition among the younger designers may be stimulated.

recommendations for other rules to govern the competition. By motion which was seconded and carried, the report was referred to the Sewage Works Practice Committee which will present its recommendations to the Executive Committee, the latter being delegated authority to act.

The report covering the activities of the Committee on Publicity and Public Relations, prepared by Newell L. Nussbaumer, Chairman, was read by the Secretary. Mr. Nussbaumer indicated that he had experienced a lack of response by certain Committee members and offered the following suggestions for current consideration:

> "1. That during war time, representatives of the Sewage Works Association and various sewer department and sewage works staffs, attempt to coöperate with local officers of civilian protection, not only in organizing their own departments, but also in consultation on the over-all program of defense in their community.
>
> "2. That members of the profession, in their local community, coöperate with planning officials, particularly when large industrial or housing developments are proposed which might dislocate existing facilities which, due to war time restrictions, could not be expanded to take care of additional growth.
>
> "3. Abandon the educational program which has been in effect in many places to attempt to familiarize the public with the sewer system and sewage treatment works by visiting the plant and otherwise gaining local publicity. When the war is over, this phase should again be resumed.
>
> "4. Coöperate with various public officials in suggesting substitute methods of properly continuing services where usual materials or equipment are not available due to the war.
>
> "5. Assist where possible local departments to secure better wage scales where they are controlled by Civil Service by emphasizing the importance of the work, the necessity for competent men with skill and training who in other comparable lines would probably secure considerably more than amounts set in the civil service scale.
>
> "6. Where functions as above described have been successfully carried out by members, that publicity be given to the matter, if such publicity would be a benefit to those concerned and the profession in general."

It was moved by Mr. Schroepfer that the report be accepted, and that a new Committee be appointed with instructions to proceed to develop recommendations for publicity and public relations functions on a reasonable basis, pending the termination of the war.

The report of the Operators' Qualifications Committee, prepared by Chairman H. G. Baity, was read by the Secretary as follows:

> "(*a*) To develop a code of sound and reasonable qualifications for operators of the various types and sizes of sewage treatment plants, and to suggest the acceptance of such uniform qualifications on a national basis.
>
> "(*b*) To study the various systems of regulation now in effect in various parts of the country, such as civil service, state health department qualifications, volunteer licensing plans, etc., and to suggest means of achieving substantial compliance with uniform standards in all the states.
>
> "In both of these phases of its work, the Committee desires to examine carefully the qualifications which have been established in several states and the machinery employed for applying and enforcing the regulations. The judgment and experience of these agencies should be helpful and suggestive, but the Committee has no disposition to attempt to strike a 'common denominator' of current practice. It wishes to approach its task unhurriedly and with an open mind, and to arrive at its recommendations through the exercise of independent judgment. While the Committee is deeply concerned with the professional status of operators and the protection of competent personnel against influences which would displace them from hard-earned positions, it interprets its function as being of far greater scope and value than serving as the architect of a protective association. It expects to be guided solely by its concept of what constitutes proper operational standards for

sewage treatment works of various degrees of importance and complexity. It believes that operators can attain prestige and warrant protection only by developing the knowledge and competence to meet reasonably high standards, and not by the mere creation of licensing agencies.

During the year all members of the Committee have been engaged in war activities, and most of them have been away from their normal stations. In spite of this, the group has made considerable progress in exchanging ideas and in gathering data relative to standards of qualification and systems of licensing now in effect in various states of the country. This work will continue as rapidly as conditions permit, but it is the opinion of the Committee that a final report should not be presented before two or three years' study, and, in any event, it seems desirable to postpone the report until after the present emergency. There are many conflicting thoughts and standards that should be considered and reconciled, if possible. There are perhaps many unforeseen conditions that will be created by the war.

Respectfully submitted,

BENJAMIN BENAS
M. W. TATLOCK
PAUL J. KLEISER
A. F. DAPPERT
H. G. BAITY, *Chairman*."

It was regularly moved, seconded and carried that the report be accepted and that the incoming Board of Control be requested to continue the Committee, with instructions to proceed with its functions despite the exigencies of the war.

A lengthy report, prepared by Chairman Ralph E. Fuhrman of the Committee on Civilian Defense, was ordered received by title with instructions to the Secretary to distribute copies among the members of the Board of Control.

In presenting the report of the Financial Advisory Committee, Chairman W. J. Orchard made a comparison of actual receipts and expenditures for the first nine months of 1942 as against the 1942 budget, pointing out that a substantial improvement in the Federation's financial position is taking place this year. He referred to the desirability of investing some Federation funds so as to maintain bank balances within the $5,000 limit covered by Federal deposit insurance. He concluded his report with commendation of the administrative personnel of the Federation for careful attention to financial matters. The report was accepted by motion regularly seconded and carried.

The following letter advising of the dissolution of the New Jersey Sewage Conference group was read by the Secretary:

"This is to inform you that the New Jersey Sewage Works Conference Group will be dissolved, effective December 31, 1942.

"The dissolution of the New Jersey Sewage Works Conference Group has been voted by the members of the group in the form of a letter ballot.

"Correspondence and records of the group have been deposited in the office of the former chairman and are available for inspection or removal if the Board so desires.

By: W. RUDOLFS,
Chairman, Research Committee."

For the benefit of the record, the Secretary reported on the results of letter ballots of the Board on various matters during the past year. The following resolution was adopted by letter ballot closed on November 1, 1941 by a vote of 30 "Ayes," 1 "Nay," 7 not voting.

"WHEREAS: At the meeting of the Election Committee in New York City on October 11, 1941, at the time of the annual meetings of the Board of Control of the Federation of Sewage Works Associations, a certain degree of confusion arose in the interpretation of Paragraph (*e*) of Section 3 of Article IV, and Section 5 of Article IV of the Constitution,

"AND WHEREAS: A Director-at-Large was elected at the said meeting who immediately tendered his resignation, feeling that the intent of the Constitution had been violated by his election, "*Now therefore, be it resolved:* That it is the sense of the Board of Control of the Federation of Sewage Works Associations that a change in the classification of any Director cannot be construed as making him eligible for election as a Director under another classification, and

"*Be it also resolved:* That this resolution be spread on the records of the Board of Control as a part of or an addenda to the minutes of the meeting of the current Board of Control held at the Hotel Pennsylvania, New York City, on October 11, 1941."

By letter ballot, closed May 15, 1942, (*a*) The Busey State Bank of Urbana, Illinois, was designated as an official depository of Federation funds, (*b*) the General Chemical, General Electric Company, American Well Works, Inc., and Limestone Products Corporation of America were admitted as Associate Members and (*c*) following amendment to Section 5 of Article IV of the Federation was approved:

"In the event that the Secretary or Treasurer shall be unable to sign checks against the funds of the Federation, the President or Vice-President shall be authorized to countersign such drafts in his stead."

The vote on the above matters was 26 "Ayes," 0 "Nays," 12 not voting.

By letter ballot, closed June 15, 1942, the New Jersey Sewage Works Association was admitted to the Federation as a Member Association by a vote of 32 "Ayes," 0 "Nays," 6 not voting. It was moved, seconded and carried that the above reports of letter ballots be accepted as binding upon the Board of Control and so recorded in these minutes.

President Bedell issued a call for the meeting of the Election Committee to immediately follow this meeting and announced that a meeting of the 1943 Board of Control would follow that of the Election Committee.

Upon motion made, seconded and carried, the Board adjourned *sine die* at 9:10 P.M.

(Original Signed)
A. S. BEDELL, *President* W. H. WISELY, *Secretary*

MINUTES OF THE ELECTION COMMITTEE ON BOARD OF CONTROL

Hotel Statler, Cleveland, Ohio, October 24, 1942

At the conclusion of the meeting of the 1942 Board of Control, held at the Hotel Statler, Cleveland, Ohio, on October 24, President A. S. Bedell called to order the regular meeting of the Directors representing all Member Associations to function as an Election Committee.

Officers present were President Bedell and Secretary W. H. Wisely. Roll call of Directors follows:

PRESENT IN PERSON

Member Association Represented	*Director*
California Sewage Works Ass'n	W. A. Allen
Central States Sewage Works Ass'n	G. J. Schroepfer
Federal Sewage Research Ass'n	J. K. Hoskins
Florida Sewage Works Ass'n	Joe Williamson, Jr.
Georgia Water and Sewage Ass'n	V. P. Enloe
Missouri Water and Sewerage Conf.	G. S. Russell
New England Sewage Works Ass'n	F. W. Gilcreas
New Jersey Sewage Works Ass'n	E. P. Molitor
Ohio Sewage Works Conf. Group	F. W. Jones
Pennsylvania Sewage Works Ass'n	H. E. Moses
The Canadian Inst. on Sewage and Sanitation	A. E. Berry

PRESENT IN PERSON, ACTING BY PROXY

Member Association Represented	*Director*
Argentina Soc. Engineers, San. Eng. Div.	J. H. Brooks, Jr. (For E. B. Besselievre)
Arizona Sewage and Water Works Ass'n	W. D. Hatfield (For P. J. Martin)
Dakota Water and Sewage Works Conf.	W. Q. Kehr (For W. W. Towne)
Kansas Water and Sewage Works Ass'n	J. K. Hoskins (For Earnest Boyce)
Maryland-Delaware Water and Sewerage Ass'n	L. H. Enslow (For H. R. Hall)
North Carolina Sewage Works Ass'n	C. A. Emerson (For H. G. Baity)

The above representation constituted a quorum.

Upon call for nominations for the office of President, George J. Schroepfer (Central States) was nominated and a motion to close the nominations was duly seconded and carried. By *viva voce* vote, the election of Mr. Schroepfer to the office of President was confirmed and so declared.

A. M. Rawn (California) was nominated to the office of Vice-President in response to a call for nominations to that office. There being no further nominations, a motion was made, seconded and carried that the nominations be closed. The election of Mr. Rawn as Vice-President was confirmed by *viva voce* vote and so declared.

In response to a call for nominations to the office of Treasurer, the name of W. W. DeBerard (Central States) was offered and the nominations closed by passage of a regularly seconded motion. By *viva voce* vote, the election of Mr. DeBerard to the office of Treasurer was confirmed and so declared.

Upon call for nominations to the office of Director-at-Large, with term expiring in October, 1945, Mr. W. J. Orchard (New Jersey) was nominated, after which the nominations were closed by motion regularly seconded and carried. His election to the office of Director-at-Large was confirmed by *viva voce* vote and so declared.

Upon motion duly made, seconded and carried, the meeting adjourned *sine die* at 9:16 P.M.

(Original Signed)
A. S. BEDELL, *President* W. H. WISELY, *Secretary*

MINUTES OF MEETING OF 1943 BOARD OF CONTROL

Hotel Statler, Cleveland, Ohio, October 24, 1942

Upon the termination of the meeting of the 1942 Election Committee, President A. S. Bedell called to order the first meeting of the 1943 Board of Control at 9:20 P.M.

Roll call indication representation as follows:

PRESENT IN PERSON

Affiliate or Office Represented	*Represented By*
President	G. J. Schroepfer
Past President	A. S. Bedell
Treasurer	W. W. DeBerard
California Sewage Works Ass'n	W. A. Allen
Florida Sewage Works Ass'n	Joe Williamson, Jr.
Georgia Water and Sewage Ass'n	V. P. Enloe
Missouri Water and Sewerage Conf.	W. Q. Kehr
New England Sewage Works Ass'n	J. H. Brooks, Jr.
New Jersey Sewage Works Ass'n	E. P. Molitor
New York State Sewage Works Ass'n	C. G. Anderson
Ohio Sewage Works Conf. Group	C. D. McGuire
Pennsylvania Sewage Works Ass'n	H. E. Moses
Rocky Mountain Sewage Works Ass'n	L. O. Williams
The Canadian Inst. on Sewage and Sanitation	A. E. Berry
Member-at-Large	W. J. Orchard

Affiliate or Office Represented	*Represented By*
Member-at-Large	A. H. Niles
Water and Sewage Works Manufacturers Ass'n	Karl M. Mann
Water and Sewage Works Manufacturers Ass'n	Bart Marshall
Water and Sewage Works Manufacturers Ass'n	D. S. McAfee

Present in Person, Acting by Proxy

Affiliate or Office Represented	*Represented By*
Argentina Soc. Engineers, San. Eng. Div.	L. H. Enslow (For E. B. Besselievre)
Arizona Sewage and Water Works Ass'n	W. D. Hatfield (For P. J. Martin)
Central States Sewage Works Ass'n	C. C. Larson (For B. A. Poole)
Dakota Water and Sewage Works Conf.	F. W. Gilcreas (For W. W. Towne)
Maryland-Delaware Water and Sewerage Ass'n	M. M. Cohn (For H. R. Hall)
North Carolina Sewage Works Ass'n	G. S. Russell (For H. G. Baity)
Sewage Division—Texas Section, S. W. W. A.	C. A. Emerson (For W. S. Mahlie)
Member-at-Large	W. A. Allen (For A. M. Rawn)

The above representation constituted a quorum. F. W. Mohlman, Editor, and W. H. Wisely, Secretary, were also present.

President Bedell requested the Secretary to read the report of the Election Committee. The following officers were reported to have been elected: George J. Schroepfer, President; A. M. Rawn, Vice-President; W. W. DeBerard, Treasurer (all to serve until October, 1943); W. J. Orchard, Director-at-Large (to serve until October, 1945).

Mr. Bedell relinquished the chair to President-elect George J. Schroepfer who presided over the remainder of the meeting.

By motion, duly seconded and carried, W. H. Wisely was reappointed to the office of Executive Secretary for a two-year term, with compensation for the year 1943 to be at the same basis as during the past year.

President Schroepfer pointed out that it was unnecessary to consider, at this time, the reappointment of Editor Mohlman, in view of the fact that he had been appointed in October, 1941, to serve a three-year term.

To expedite appointment of the various constitutional and standing committees, Past President Bedell presented a recommended schedule of appointments. After discussion and minor revision, various committees were approved by motion regularly seconded and carried (see November, 1942, issue, page 1353).

A communication from the Chemical Foundation, indicating that they would be glad to continue handling the mechanical production of advertising in Sewage Works Journal for the coming year at a cost of $1,200 plus postage and miscellaneous expense was read by the Secretary. Mr. Emerson reviewed his personal contacts with Chemical Foundation, pointing out that the suggested increase of $200 was made necessary by increasing costs. The proposal was accepted by motion, regularly seconded and carried.

Chairman Orchard of the Financial Advisory Committee presented the following budget for the year 1943 as approved by the Executive Committee and moved adoption. The motion was duly seconded and carried:

Budget for 1943

Receipts	
Member Dues:	
Active	$ 6,300
Corporate	100
Associate	1,100
Non-Member Subscr.	1,200
Advertising (Net)	7,800
Net Sale Misc. (Public)	300
Mfgrs. Contribution	5,000
Miscellaneous	—
Total Receipts	$21,800

Expenses

JOURNAL Printing	$12,200
Editor	
Salary	900
Assistant	360
Expenses	540
Executive Secretary	
Salary	2,500
Office Salaries	1,600
Office Rent	0
Office Expense	600
Office Equipt.	100
Travel Expense	750
Exp. Other Officers	500
Committee Expense	500
Convention Expense	600
Contingencies	650
Total Expenses	$21,800

The following communication, received from the Water and Sewage Works Manufacturers Association, was read by the Secretary:

"The Sewage Works Division Executive Committee, at a meeting held at Cleveland, Ohio, on Saturday, October 24, passed the following resolution:

"RESOLVED: that the Board of Governors of the Water and Sewage Works Manufacturers Association be requested to appropriate Five Thousand Dollars ($5,000) to the General Fund of the Federation of Sewage Works Associations for the year 1943, payable $1,250 January 15; $1,250 April 15; $1,250 July 15 and $1,250 October 15, 1943.

"The Executive Committee of the Sewage Works Division advises the Board of Governors of the Water and Sewage Works Manufacturers Association of its completely satisfactory relationship with the Federation of Sewage Works Associations. Though it is recognized that in these uncertain times it is unwise to make firm commitments for longer than one year in advance, the Executive Committee requests the Board of Governors by resolution to declare that so long as the present relationship exists between the Federation of Sewage Works Associations and the Water and Sewage Works Manufacturers Association, it will be the intention of the W. and S. W. M. A. to continue such contributions to the General Fund of the Federation as circumstances and general conditions shall from time to time indicate."

It was moved, seconded and carried that the generous offer of the Manufacturers Association be accepted with thanks and that the Federation record its gratitude for the complete and hearty support which has been afforded during the past two years and particularly at the Third Annual Meeting when exhibits were provided at considerable sacrifice on the part of the participating companies.

By motion, regularly seconded and carried, it was ordered that the existing bonds covering the offices of Treasurer and Secretary be continued in the amount of $5,000 for each office.

Chairman Orchard of the Financial Advisory Committee pointed out that the Continental Illinois National Bank and Trust Company of Chicago and the Busey's State Bank of Urbana, Illinois, had been previously approved by the Board of Control as depositories for Federation funds. He moved that the Executive Committee be delegated with power to invest funds of the Federation in any securities legal for savings banks, with such action to be based only upon the recommendation of the Financial Advisory Committee. The motion was regularly seconded and carried.

Proposals by George J. Curzon, Public Accountant, and the Bresee-Warner System, Public Accountants, regarding the annual audit of the Federation's financial accounts, were read by the Secretary. It was regularly moved, seconded and carried that George J. Curzon, Public Accountant of Champaign, Illinois, be employed to perform an audit on the Federation books as at December 31, 1942, for a fee of $40.00.

The following report of the Convention Place Committee was read by the Secretary:

"This Committee unanimously recommends that the Federation should plan at this time to hold an annual meeting in 1943.

"Invitations from the cities of St. Paul, Minnesota, Detroit, Michigan, and Chicago, Illinois, were presented for consideration. Following a detailed discussion of probable travel and other restrictions which may affect *any* convention in 1943, it is unanimously recommended that the 1943 meeting be held at the Hotel Sherman, Chicago, Illinois, October 21–23.

Convention Place Committee

Daniel McAfee (For Denis O'Brien)
Karl Mann (For L. E. Rein)
C. A. Emerson
A. T. Clark
G. J. Schroepfer
W. H. Wisely
A. S. Bedell, *Chairman*"

By motion, regularly seconded and carried, the report was adopted.

The President was delegated with power to proceed with the appointment of a Convention Management Committee to make arrangements for the 1943 meeting in Chicago, by motion regularly seconded and carried.

Three formal nominations to Honorary Membership in the Federation were presented by the Secretary (see Nov., 1942, issue, page 1356).

Mr. Emerson offered remarks regarding the eligibility and high qualifications of the three nominees and moved that they be elected to Honorary Membership. The motion was seconded and carried.

Mr. Orchard suggested that it might be desirable to set up a more definite procedure in connection with the election of Honorary Members and moved that a committee on Honorary Membership be authorized, comprising the President and living past Presidents to a total of five, this committee to have as its function the reception of recommendations from Member Associations and others and to submit all nominations to the Board of Control. The motion was seconded and carried.

The Secretary was instructed to prepare and direct letters of appreciation and thanks to the Statler Hotel, members of the Convention Management Committee, the City of Cleveland and the Ohio Conference on Sewage Treatment for their respective efforts in connection with the arrangements and management of the Third Annual Meeting.

In order to expedite conduction of business at the Annual Meetings of the Board of Control, Mr. Enslow moved that the retiring Board and Election Committee meet the evening before the opening of the next Annual Meeting of the Federation and that the new Board hold its meeting on the evening of the last day of the Convention. Also that all committee reports be mimeographed and sent to each member of the Board at least two weeks in advance of the Annual Meeting, insofar as possible. The motion was regularly seconded and adopted.

In accordance with action taken in the last meeting of the 1942 Board of Control, the report of the General Policy Committee was taken from the table for consideration.

The first recommendation offered in the report, as presented by Mr. Emerson, provided for the appointment of a committee on Member Associations to review existing practices and policies and to submit recommendations as to uniform procedures. By motion, regularly seconded and carried, it was ordered that this recommendation be submitted to the Executive Committee for revision and then to be submitted to the Board of Control for a letter ballot.

The following recommendation for the appointment of a committee on membership promotion was adopted by motion, duly seconded and carried:

"Unquestionably sincere and sustained efforts should be made to increase the membership of the several Member Associations to as near the saturation point as is possible.

"The General Policy Committee is of the opinion that efforts of local committees in each Member Association, working under the general direction of the officers of the respective associations, and with the stimulation and assistance of the Executive Secretary of the Federation, will be more appropriate and effective than a Central Membership Committee representing the Federation as a whole.

"It is suggested that the Directors representing the Member Associations could render valuable service to the Federation if each would lead such a movement in his own Association."

A recommendation that the operation of short schools remain in the hands of Member Associations, because of widely varying conditions in various parts of the country, was adopted by motion, regularly seconded and carried.

The following recommendation that the activities of the Federation be divided into technical divisions was adopted, upon motion made, seconded and carried:

"The General Policy Committee believes that benefits would accrue through discussion and coöperative study by men of like interest but the majority of the Committee believes the matter should be left in abeyance for the present as most of the Member Associations are too small to be profitably divided into specialty groups and the Federation has not yet developed a membership of sufficient size to warrant segregation into separate divisions.

"This problem is one which it is believed should be reconsidered by a future General Policy Committee. As a preliminary and trial procedure, it is suggested that the Publications Committee consider arrangement of the program for one-half day of the next Annual Meeting for concurrent sessions of several groups which might be designated as Plant Management; Laboratory Control and Research; and Industrial Wastes Groups, to permit presentation and adequate discussion of a wider range of specialty papers than would be possible at one general session."

A recommendation that specific limits be established to the territory included within the various Member Associations was referred to the new General Policy Committee for further study.

A recommendation that there be residential requirements governing membership in all Member Associations, located within the continental U. S. A., was referred to the 1943 General Policy Committee with instructions to report to the Executive Committee in sixty days and if action is recommended, that the matter be submitted to the Board of Control by letter ballot.

By motion, duly seconded and carried, the meeting adjourned at 11:25 P.M.

(Original Signed)
G. J. Schroepfer, *President* W. H. Wisely, *Secretary*

REPORT OF SECRETARY

For Period

OCTOBER 1, 1941–SEPTEMBER 30, 1942

Despite the entrance of the United States into the War, the Federation has continued to make progress during the past year. New problems have confronted the sewage works field because of the War, problems of such importance that they must be given precedence over certain activities which have been given attention by the Federation in the past. Insofar as currently limited resources have permitted, a modest approach to these new problems has been initiated; continuation and extension of this work must be afforded primary consideration in planning for the immediate future.

Activities of Secretary's Office

As provided for by the Board of Control in October, 1941, the Secretary has served on a part-time basis, with one full-time assistant and occasional part-time clerical help. This staff has functioned in the offices of the Urbana-Champaign (Illinois) Sanitary District at no rental charge. All details of business management, including sale of publications, maintenance of mailing lists, collection of funds, bookkeeping, and preparation of financial statements, as well as other services listed herewith, have been performed by the Secretary's staff.

Sewage Works Journal.—The Secretary has continued to coöperate with Editor Mohlman in compiling text material for the Journal by assuming full responsibility for "The Operator's Corner," intended to meet the demand for practical, plant operation. A total of 265 pages of Journal text was furnished during the year at considerable expense in time and effort. Suggestions for the improvement of this feature of the Journal will be welcomed.

Advertising solicitation in collaboration with the Advertising Manager demanded significant attention. The Secretary was successful, by correspondence and personal contact, in arranging the use of space by several advertisers and prepared an information and data sheet for the promotion of advertising sales in general. He also maintained contact with and assisted the advertising solicitors under contract with the Federation.

Requirement of an export license by the Board of Economic Warfare for mailing the Journal outside of the United States and Canada has entailed additional attention by the Editor and Secretary since distribution of the May, 1941, issue. The delay involved in awaiting approval by the Censor has made it difficult to meet the regular publication schedule.

Mailing list maintenance duties have been unusually time-consuming, due to the many address changes now required. The War has also interferred with the delivery of foreign subscriptions to the Journal, requiring some adjustments in procedure.

Coöperation With Member Associations.—Only four Member Association meetings were attended by the Secretary during the year, several scheduled trips having been cancelled due to war-time travelling restrictions. In addition to these meetings, listed below, the Secretary participated in the program of the Army Sewage Treatment Plant Operators' Conference held at the Illinois Institute of Technology on September 23, at the invitation of the United States Engineer Corps. Member Association meetings attended were:

Date	Association	Place
October 6–7, 1941	Central States	Ft. Wayne, Ind.
October 9–11, 1941	New York (and Federation)	New York, N. Y.
November 20–21, 1941	Iowa	Ames, Iowa
April 25–27, 1942	California	Bakersfield, Calif.
June 18–19, 1942	Central States	Minneapolis, Minn.

Other Member Association contacts were made by President Bedell in his attendance of the meetings of the North Carolina Sewage Works Association at High Point, North Carolina, on November 3–5, 1941, and of the New England Sewage Works Association at Boston, Mass., on May 26–28, 1942.

The Secretary's office was available at all times for assistance as requested by Member Associations.

Coöperation with War Production Board.—One of the most important war-bred problems is that of materials procurement and contact was made with the Power Branch of WPB early in 1942 with an offer of assistance by the Federation insofar as was possible. In May, the Power Branch requested the Secretary to visit Washington for a discussion of the estimated, overall requirements of materials for maintenance, repair and operation of sewage treatment and collection works. Such estimates were furnished on May 8.

In September, 1942, the Governmental Requirements Branch of WPB expressed a desire for more accurate and detailed data and a questionnaire, prepared with the assistance of a representative of that office, was distributed to 100 sewage works officials. Vice-President G. J. Schroepfer accepted the responsibility for compiling and summarizing the questionnaire returns, and will assist the Governmental Requirements Branch in the interpretation of the data.

Every effort was made to keep the membership informed of changes in materials procurement procedures through SEWAGE WORKS JOURNAL, however, the bi-monthly publication schedule reduced the effectiveness of this service.

Preparations for Third Annual Meeting.—As an ex-officio member of the Convention Management Committee, the Secretary coöperated wherever possible in the arrangements for the War Time Conference at Cleveland. These functions included distribution of publicity material; supervision of printing and distributing the formal announcement, badges and program; arrangements for the Priorities Clinic; and preparation of business for the attention of the Board of Control.

FEDERATION OF SEWAGE WORKS ASSOCIATIONS

NET MEMBERSHIP OF MEMBER ASSOCIATIONS *
SEPTEMBER 30, 1942

Member Association	Membership—September 30, 1942				Total Memb. Sept. 30, 1941	Net Increase
	Active		Corp.	Total		
	Full Subscr.	Alternate Subscr.				
Arizona	20	—	—	20	26	− 6
California	213	30	—	243	279	− 36
Central States	398	—	13	411	481	− 70
Dakota						
North	11	—	—	11	10	1
South	18	—	—	18	22	− 4
Federal	48	—	—	48	54	− 6
Florida	36	—	—	36	20	16
Georgia	28	—	—	28	32	− 4
Iowa	45	—	—	45	43	2
Kansas	18	—	—	18	20	− 2
Maryland-Delaware	22	—	—	22	25	− 3
Michigan	95	17	—	112	136	− 24
Missouri	9	—	—	9	5	4
New England	157	1	—	158	175	− 17
New Jersey (Conf.)	49	—	—	49	66	− 17
New Jersey (Ass'n)	11	—	—	11	—	11
New York	508	4	—	512	616	−104
North Carolina	38	—	—	38	80	− 42
Ohio	107	1	—	108	96	12
Oklahoma	5	—	—	5	1	4
Pacific Northwest	77	—	—	77	72	5
Pennsylvania	162	—	1	163	198	− 35
Rocky Mountain	28	—	—	28	38	− 10
Texas	20	—	—	20	19	1
Argentina Soc. Engrs.	—	—	—	—	3	− 3
Canadian Inst.	88	—	—	88	131	− 43
I.S.E. (England)	31	—	—	31	50	− 19
I.S.P. (England)	82	—	—	82	91	− 9
Totals	2324	53	14	2391	2789	−398

* Does not include dual members.

Membership

One new Member Association, the New Jersey Sewage Works Association, affiliated with the Federation during the year. The application was approved by letter ballot of the Board of Control, closed June 15, 1942, by a vote of 32 Ayes and none dissenting. There are now 27 Member Associations in the Federation.

Membership of the Member Associations decreased 14.3 per cent during the year from a net of 2,789 on September 30, 1941, to 2,391 as of September 30, 1942. The decrease is less than had been anticipated to take place in view of the increase in dues which became effective January 1, 1942. A detailed membership tabulation is shown on page 149.

A total of 58 Associate Members are affiliated as of September 30, 1942, an increase of three over those recorded in the 1941 report.

Financial

The Secretary furnished each member of the Board of Control with summaries of receipts and disbursements dated December 31, 1941; March 31, 1942; and June 30, 1942, in accordance with Section 5, Article IV of the By-laws. Each member of the Financial Advisory Committee was provided with bi-monthly, accrual basis, income and expense statements.

Acknowledgments

The whole-hearted coöperation of Officers, Directors, Committees, and many individuals during the past year, is gratefully acknowledged.

Respectfully submitted,

W. H. Wisely, *Secretary*

REPORT OF CIVILIAN DEFENSE COMMITTEE

Your Committee on Civilian Defense was a result of the General Policy Committee Report made to the Federation in October, 1941. Its objectives were stated, "to cooperate with committees of other organizations and with governmental agencies in matters relating to the protection and insured operation of sewerage and sewage treatment facilities." While a broad interpretation of these purposes might lead to priorities and allocations considerations, the Committee has limited its interest to civilian defense activities in the sense of protection of sewerage works operation during air attack and restoration of service after such attack.

Since the appointment of this Committee, no occasion has arisen which led to any collaboration with committees of other organizations. The Committee has maintained contact with the Office of Civilian Defense, Washington, D. C., and its general programs now in operation throughout the country. In the few months of OCD program, methods and organizations have been set up and developed to a most productive level. While local organizations vary as do local needs, all steps have contributed to the final results. Many changes have been necessary—many more are sure to become necessary with time. Likewise, many new methods and procedures will be developed to care for situations for which no remedy exists today.

The Committee does not feel that summarizing and so reprinting already published material is of great benefit at this time. Also, such a procedure might yield a report half outmoded before it is presented. It does feel, however, that information on the practices of the past and present should be referred to by all in order to attain the required familiarity with this vital subject. To this end, a bibliography listing sources of such information is cited.

While each sewerage works is a problem unto itself, it is a part of the local OCD outfit and therefore would act under emergency according to the local OCD policies and plans. General considerations must include items as protection against sabotage, proper blackout and operation under blackout conditions, shelter areas for employees, and protection of important operating equipment from fragments. Similarly, sources of auxiliary power, fire control and protection from gas should receive considerable thought from those charged with operation of sewerage works. Bombing of sewered areas would probably give abnormal quantities of debris and oil in the sewers and sewage treatment plants.

Some elements of civilian defense, such as adequate plans of lines, manholes, and treatment plants, and an inventory of equipment and supplies with location are simply elements of good sewerage system operation. The application of these data to civilian defense needs is a great but single example of their value, rather than a justification of a record good for the " duration " only.

To exemplify the organization of sewerage facilities for emergencies, the following excerpt from the Manual of Emergency Sanitation Services, prepared by Mr. Earl Devendorf, New York State Coordinator of Water and Sewer Service, is given.

The Preparation of Sewerage Facilities for Emergencies

" The damages which may result to sewer systems and treatment works from bombing attacks or sabotage may be extensive and produce great discomfort and confusion in a community through disruption of sewer service. Although not as vital as the service of water supply, it is essential that sewer service be maintained effectively and that arrangements be made in advance for prompt repairs. This is particularly important in view of the fact that generally repair of sewers must be accomplished before permanent repairs to water lines are made.

" In bombing, sabotage or fifth column attack, destruction of pumping stations, force mains, or sewer lines may result in stoppages and backing up of sewage in sewer lines causing flooding of basements and contamination of stored foods and create gross nuisances through discharge of sewage into streets through surcharged manholes.

" In bomb craters both water and sewer lines are apt to be broken, thus permitting contamination of water lines and flooding of craters with sewage. Destruction of a sewage treatment plant might cause serious public health hazards through the additional loads placed on water treatment plants downstream, although there are many precautions which can be taken to mitigate the seriousness of such an eventuality, such as stepping up treatment of the water supply and temporary chlorination of bypassed sewage.

" To prepare in advance for such emergencies, there is a need for organization, training and development of emergency sewer repair crews, the incorporation of the sewer department and its employees as a unit in the civilian protection organization under the local war council and for an arrangement whereby the sewerage works personnel, equipment, materials and supplies of all sewer departments can be made available to stricken communities under a mutual assistance plan."

Mutual Aid Plan for Sewer Service

Purpose.—Prepare the state and all of its municipalities to effect and maintain sewer service under any emergency conditions.

" The specific objectives are briefly indicated as follows:

" 1. File a detailed inventory of sewerage works personnel, equipment, materials and supplies with a Coordinator so that the resources and facilities of all communities within each zone and within the state can be drawn upon to provide needed assistance promptly to any local sewer officials when confronted with a serious emergency.

" 2. Under the local council incorporate sewer departments and their employees as a unit in the local defense organization and organize, develop and train emergency sewer repair crews to function in the repair and maintenance of sewers during emergencies.

Organization and Delimitation of Fields of Effort

" The Mutual Aid Plan for Sewer Service as approved by the Director of Civilian Protection provides for an organization and fields of efforts which are a counterpart although not as extensive as those provided under the Mutual Aid Plan for Water Service.

"The State Water Supply Coordinator (Assistant Director of the Division of Sanitation) will serve also as a State Coordinator for Sewer Service. The sewer service zones are the same as the water service zones established under the Mutual Aid water plan, except in Nassau and Westchester Counties the Zone Water Supply Coordinators will have no functions in respect to operation of the Mutual Aid Plan for Sewer Service. In the other counties, District Engineers of the State Department of Health will serve as Zone Coordinators.

"In the field of civilian protection (organization, development and training of emergency sewer repair crews, etc.) the mutual aid organization will operate as a Division of Emergency Sewer Repairs under the direction of the Director of Civilian Defense.

"The arrangement will be identical to that discussed in previous chapters of this manual under "Division of Water Main Emergency Repairs" except for the substitution throughout of local sewer officials for local water officials, etc.

"The State Coordinator is technical advisor to the Director of Civilian Defense and Zone Coordinators are technical advisors to deputy directors, the chairman of local councils and local sewer officials on all matters related to sewerage or sewage treatment.

"The local sewer official or person in charge of the sewer system is the technical advisor and responsible directive authority of the local council in relation to all emergency sewer service matters. The local sewer official will utilize regular sewer department employees to perform and direct the functions of repairs and maintenance.

"With reference to emergency repairs to sewers, the local sewer official will, on behalf of the local council, have auxiliary or volunteer personnel enrolled and directed to this protective service by the civilian mobilization representative.

"Standards for such enrollees as formulated by the State Coordinator and issued to the State Director of Civilian Mobilization by the Director of Civilian Protection are the same as formulated for volunteer personnel assigned to water service duties. The local council will authorize and arrange for appropriate insignia for volunteer personnel assigned to emergency sewer service duty.

"It is the duty of the local sewer official to formulate plans for the organization and training of auxiliary or volunteer personnel to be utilized as foremen or members of emergency repair crews or in other capacities and furnish copies thereof to the Zone Coordinators. It is also a responsibility of the local sewer official to train the auxiliary or volunteer personnel in the duties and technical work required for the efficient performance of emergency work.

"No syllabus or outline of a training course for use of sewer officials in training auxiliary personnel will be prepared by the State Coordinator since the principles involved in making sewer repairs are relatively simple and without technical complications. Each local sewer official is regarded as competent to give volunteer or auxiliary personnel sufficient training to enable them to perform emergency work satisfactorily. Zone Coordinators, however, will give guidance and assistance in such training wherever it is requested.

"In respect to the channels of communication, these shall be the same as previously discussed under the Mutual Aid Water Plan, except 'sewer officials' shall be substituted for 'water officials.'

"*Sewer Systems.*—Injury to sewers in streets, especially trunk sewers, constitutes a serious menace to public health, public comfort and possibly even the military effort itself. Therefore attention should first be directed to prompt repairs of any street sewers that may be damaged by sabotage or bombing. While the damage from bombing may naturally be much more extensive than peace time cave-ins, nevertheless the methods of repair do not vary much from ordinary routine. While in general, repairs to damaged sewers would usually be of a permanent nature, there will be occasions when larger size sewer pipe is unavailable and it might be necessary to provide temporary wooden flumes to keep the sewer in service.

"Where basements have been flooded due to broken sewers, they should not only be pumped out or drained but thoroughly washed, brushed and scrubbed with water, following which a disinfecting solution of chloride of lime should be applied. Curtains, rugs, furniture and clothing which have been flooded with sewage should be thoroughly cleaned, disinfected and if possible, dried in the sunshine before being used again.

"*Sewage Pumping Stations.*—To prepare for possible damage to pumping stations or power failure, it would be well to make provisions in advance for chlorination of the sewage and bypassing it to the nearest watercourse if such is available. In case of the smaller pumping stations portable gasoline engine driven pumps should be provided.

"*Intercepting Sewers and Outfalls.*—Damage to these structures can frequently be relieved by use of temporary ditches or connections to nearby streams with proper chlorination of the bypassed sewage. Where the stream is used as a source of public or industrial water supply below the point of discharge, the fact of such bypassing should be made known immediately to the water users.

"*Sewage Treatment Works.*—Power failure in highly mechanized sewage treatment works or actual physical damage to some of the units can probably be relieved only through arrangements for bypassing the various units and provision for heavily chlorinating the bypassed sewage. Here again the downstream water users should be notified immediately. These suggestions are largely remedial emergency measures and should not be looked upon as a permanent method of relief. The permanent relief measures should be taken after careful study of the extent of the damage, available materials for repairs and the sanitary needs of the situation.

"*Personnel.*—The needs for duplicate man power cannot be overemphasized and reference should be made to the section in the water supply part of this manual relating to Organization and Training of Repair Crews and Reserve Personnel. It is also believed that a list of local contractors should be kept and that some definite understanding should be made with these contractors so that they may be available on short notice with appropriate equipment and crews of men."

Of great interest and value to all concerned with operation of sewerage works during the war is the Sanitary Engineering Bulletin No. 2, just issued by the U. S. Office of Civilian Defense, Washington, D. C. This pamphlet is entitled "Municipal Sanitation Under War Conditions" and is a companion bulletin to "Protection and Maintenance of Public Water Supplies under War Conditions." These booklets may be obtained without cost by request of the U. S. Office of Civilian Defense, Washington, D. C. or its various Regional Offices. The twenty-six pages of "Municipal Sanitation Under War Conditions" comprise sections on Sewerage and Sewage Disposal, Municipal Waste Collection and Disposal, and Plant Protection with several informative appendices. There are several illustrations indicating various emergency features that may be made necessary by air attack.

The portion concerning Sewerage and Sewage Disposal is filled with useful information on coping with emergencies, as the following outline shows:

Sewerage and Sewage Disposal.

- I. Scope of the problem.
  - *A.* General.
  - *B.* Sanitation problems and damage resulting from fractured sewers.
  - *C.* Sanitation problems created by failure of water supply.
- II. Planning to meet emergencies in the local community.
  - *A.* General.
  - *B.* Inventories.
  - *C.* Personnel.
  - *D.* Deployment of equipment, material and personnel.
  - *E.* Relation of local civilian defense organizations to municipal sewer department.
- III. Repair of damage to sewers.
  - *A.* Inspection.
  - *B.* Emergency equipment and materials.
  - *C.* Repair crews.
  - *D.* Repairing the broken sewers.
- IV. Sewage treatment plants.
- V. Emergency sanitation when water-carried waste disposal fails.

The final section includes the development by the civilian defense authorities of a sanitary excreta bag which fits a water closet and may be disposed of by house to house collection, with or without garbage or refuse.

The pamphlet gives a comprehensive bibliography on the subject, and while the list of publications is growing daily, this list is all inclusive and offers much of value to one seeking information on the subject.

In conclusion, it should be stated that work, preparation, and expenditures for civilian defense should be undertaken only after thorough study and planning of the specific problem. Time for preparation, though it must not be long, should be taken to learn from the experience of others.

Respectfully submitted,

R. F. Goudey
W. F. Welsch
L. S. Kraus
W. B. Redfern
Dana Kepner
Ralph E. Fuhrman, *Chairman,*
Committee on Civilian Defense,
Superintendent,
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Reviews and Abstracts

VORTICELLA AS AN INDICATOR ORGANISM FOR ACTIVATED SLUDGE

By T. B. Reynoldson

Nature, 149, 608 (May, 1942)

Preliminary observations of the activated sludge plant at Huddersfield (England) indicated that the ciliates were limited in variety probably due to the high percentage of chemical wastes in the sewage. Counts of the Vorticella in the aeration tank liquor and the three minute oxygen absorption from acidified potassium permanganate and B.O.D. of the effluents were determined daily for a period of six weeks. Correction was made for the variation of the activated sludge per unit of aeration tank liquor. The results were subjected to statistical analysis. The correlation between oxygen absorption test and the Vorticella abundance was very high and negative. A similar result was obtained for the relation between B.O.D. and Vorticella numbers. The numbers of Vorticella varied from 400 to 5,000 per ml.

H. Heukelekain

TREATMENT OF VEGETABLE CANNERY WASTES

By N. H. Sanborn

Industrial and Engineering Chemistry, 34, 911 (Aug., 1942)

The disposal and treatment of waste from the food canning processes grows more important and more serious with the rapid expansion of the industry. In vegetable canning the production period is seasonal and usually short. Large volumes of water, approximately 25 gallons per case of 24 No. 2 cans are used for washing produce, blanching, cooling, and maintaining sanitary conditions in the plant.

Plants are usually near the source of raw produce, in small communities where during the summer months, streams are small, sluggish and inadequate to receive the increased organic load. Also such sewage disposal plants as these communities may have are seldom large enough to handle additional wastes from canneries.

Wastes produced by vegetable canneries fall into the following groups:

(1) *Cooling Tank Water.*—These wastes contain little or no organic matter and can be discharged directly into the stream.

(2) *Pea or Corn Silage Juice.*—Pea silage juice has a B.O.D. of 61,000 to 78,000 p.p.m. The pH is about 4 and the juice has a very disagreeable odor. The most satisfactory method of disposal is by collection in underground tanks and then either hauling the juice away to an isolated dump or by discharge into the stream during high flow at a rate which will not greatly effect the oxygen balance.

(3) *Gross Solids.*—The solids such as trimmings, screenings and material obtained from clean-up operations are usually returned to the fields for its organic matter, dumped or salvaged for hog or cattle feed.

(4) *Processing Water with Organic Content.*—Waste water from washing operations, cleanup, spillage, blanching, etc., contains organic matter in solution and suspension. The characteristics of these wastes vary considerably. In general the 5-day B.O.D. ranges between 1,000 to 4,000 p.p.m.

The manner of dealing with cannery wastes will depend on the volume and character of the waste, stream conditions and financial considerations.

Regardless of further treatment, thorough screening is essential. Forty mesh screen is recommended for all vegetables but tomatoes. Tomato wastes require a 20-mesh screen. The several types of screens available include rotating screens with water sprays, to prevent clogging, and vibrating screens. Vibrating screens produce a drier, more compact and more easily handled material. Mechanical screening as the sole method of treatment can be used only when sufficient stream dilution is available to absorb the load.

Chemical treatment of cannery wastes after screening will effectively reduce their pollutional strength. A carefully operated chemical plant will remove a good portion of the colloidal material as well as the suspended solids. Removals of 67 per cent of the total organic solids and 78 per cent of the B.O.D. were obtained. Precipitation is obtained by adjusting the pH to 10 or 11 with lime followed by the addition of ferrous sulfate or alum in the following proportions:

Waste	Lime, Lb.	Other Chemical, Lb.
Pea	7	3 Ferrous sulfate
Beet	10	4 Ferrous sulfate
Corn	9	8 Ferrous sulfate
Carrot	5	1 Ferrous sulfate
Tomato	4	1 Alum

The fill-and-draw method, using a battery of three tanks in consecutive order, was found advantageous over continuous flow treatment. The cost of a plant for a two-line cannery is approximately $3,000. Operating costs including all fixed charges amount to one cent per case of 24 No. 2 cans of peas.

Biological filters for treatment of cannery wastes are practically precluded because of the large initial investment, the necessity for conditioning filters prior to the canning season and the failure of existing filters, because of overloading, to show any substantial advantage. Experimentally it has been shown that high rate filters with recirculation to secure six passes of waste through the filter can reduce the B.O.D. approximately 70 per cent. Final settling tanks will increase this reduction to 80–85 per cent. Because of overloading, high-rate filters discharge an acid effluent. Liming does not completely overcome this acidity because the formation of CO_2 in the filter reacts with the lime to form insoluble $CaCO_3$. The use of soda-ash removes this difficulty. In a series of tests on a municipal plant treating 99 per cent cannery waste, the plant efficiency, based on pounds of B.O.D. removed per cu. ft. of rock, was increased from 30 per cent to 49.3 per cent at a loading rate of 2.7 cu. ft. of rock per pound of B.O.D. In another test, the use of soda-ash made possible an increase in filter loading from 6.4 cu. ft. per pound B.O.D. to 4.6 cu. ft. with a slight increase in efficiency from 78 to 79 per cent.

Another method of treating these wastes which has proved effective is lagooning in shallow lagoons with the addition of sodium nitrate to maintain aerobic conditions during the first period of rapid decomposition. The second stage of decomposition occurs slowly over a long period of time. Absorption of atmospheric oxygen and the growth of algae and higher forms of aquatic life permit nearly odorless decomposition of the remaining organic matter. Experiments indicate that only enough sodium nitrate to satisfy 20 per cent of the initial 5-day B.O.D. is required to maintain satisfactory conditions. The cost of chemical added is 0.35 of one cent to the cost of a case of 24 No. 2 cans.

The ideal solution to the treatment of cannery wastes like that of all other wastes, would be to discharge it into the municipal system and treat it along with the domestic sewage. However very few plants are built to handle the tremendous increase in organic load from a cannery during the canning season. Much more data are needed before this goal can be reached. Financial arrangements between the canner and municipality are also a determining factor in this scheme of treatment.

E. Hurwitz

CHEMICAL TREATMENT OF LAUNDRY WASTES

By Foster Dee Snell and Mitchell Fain

Industrial and Engineering Chemistry, 34, 970 (Aug., 1942)

Laboratory tests to determine the most effective use of chemicals to treat wastes from a laundry averaging about 60,000 g.p.d. indicated that the best results were obtained with 360 p.p.m. alum and 96 p.p.m. of sulfuric acid. A substantially clear effluent was obtained and the treatment resulted in more than 90 per cent removal, based on oxygen consumed values. The results of some of these tests are given in the table below:

Series No.	Alum Used P.P.M.	Sulfuric Acid 66 Be. P.P.M.	Per Cent Sludge Under Clear Upper Layer After		Oxygen Consumed		
						Reduction	
			3 Hr.	24 Hr.	P.P.M.	P.P.M.	Per Cent
1	0	0			1590		
	360	96	8.8	4.0	83	1507	95
2	0	0			1110		
	360	0	5.2	4.8	75	1035	93
	360	96	4.4	3.6	95	1015	92

On the basis of these results a plant was designed to treat 75,000 gallons per day. The waste water from the heat reclaimer was discharged into a sewer in the building. Chemicals in the form of a mixture of aluminum sulfate and 5 per cent sulfuric acid was fed into this sewer. The dosage was adjusted to discharge 3 gal. of mixed chemicals per 1,000 gal. of waste. After the addition of chemicals, the waste flowed into a baffled mixing chamber and then into a settling tank of 3,000 gal. capacity. The sludge, which amounts to about 3,750 gal. from the 75,000 gal. of waste, was pumped onto drying beds.

The cost of treatment by this method, based on 60,000 g.p.d. was distributed as follows:

180 lb. aluminum sulfate at $1.35 per cwt. $2.43
48 lb. sulfuric acid at $1.80 per cwt. 0.87
Total cost of chemicals $3.30

E. Hurwitz

A SUGGESTED METHOD FOR NEUTRALIZING WASTE PICKLING ACID EFFLUENTS

By F. Smith

Chemistry and Industry, 61, 68–69 (Feb. 7, 1942)

Disposal of waste acid is a difficult and expensive problem. Most of these waste acid solutions are ferrous sulfate in dilute sulfuric acid. The ferrous sulfate in solution prevents the acid being used continuously in the pickling bath.

One method of treating the waste is to cool it and crystallize out the ferrous sulfate and return the acid to the pickling vats. The most common method, however, is to neutralize the acid waste with lime or soda ash but many local sewer authorities do not permit the ferrous sulfate in the waste, which entails adding sufficient soda ash to precipitate the ferrous sulfate as ferrous carbonate.

The author undertook laboratory experiments to see whether the waste sludge from a lime-soda water softening plant might not be used for removal of the ferrous sulfate from solution as well as for neutralization of the acid.

Results of the experiments showed that:

(*a*) If neutralization, only, is required then lime-soda sludge will lessen the amount of lime, soda ash and/or caustic soda required.

(*b*) If suspended solids must be removed in addition to neutralization then a filter plant or an evaporator would be a necessary addition to (*a*). In case of a filter plant installation the weaker alkaline lime-soda sludge is an advantage as it does not precipitate so readily the basic ferrous sulfate, $Fe_2O_3SO_3$.

(*c*) If the waste liquor must have the ferrous sulfate removed in addition to neutralization and suspended solids, then the lime-soda sludge is of no value and soda ash is the best precipitant.

The author adds a note to the effect that slaked lime, which is a by-product of plants making acetylene and calcium carbide, might be an effective treating agent.

H. Gladys Swope

CALIFORNIA SEWAGE WORKS JOURNAL

Volume 14 (1942)

The Evaluation of Industrial Wastes in the East Bay. By Roy E. Ramseier, pp. 26–37. This paper describes the methods used in conducting wastes investigations for the East Bay Cities Sewage Disposal Survey. The region includes an area approximately 20 miles in length and roughly 4½ miles average width. Included are the cities of Alameda, Albany, Berkley, Emeryville, Oakland, Piedmont and Richmond. Industrial wastes make up one-third to one-half the sewage load.

It was not possible to directly measure and sample the flow as a great many of the sewers are periodically flooded by tide water. The method used in evaluating the sewage was that of integration, or synthesis.

In eleven widely separated sewers measuring flumes were installed and week long sampling schedules were maintained. From these the following values for domestic sewage were found.

Sewage flow per capita—43.9 gal. per day.
5-day B.O.D. per capita—0.104 lb. per day.
Suspended solids per capita—0.107 lb. per day.
Grease per capita—0.109 lb. per day.

In conducting the survey of the industries the following information was obtained for each industry evaluated; the amount of raw product used, the amount of plant output, the quantity of water used by the plant, and the amount of waste produced by a given number of units of activity.

Cannery wastes are an important part of the industrial wastes of the region. During the peak of the canning season these wastes increase the B.O.D. and suspended solids load by 50 per cent over the load from domestic and non-seasonal industrial sewage.

The paper includes a table showing the amount of water, 5-day B.O.D., suspended solids, and grease per unit of plant activity for various industries.

Sewage Disposal Practice at Military Establishments in California. By E. A. Reinke and J. W. Pratt, pp. 38–45. Due to defense activities many sewage disposal problems have arisen in California. The Bureau of Sanitary Engineering has investigated disposal problems for 48 government camps, 10 privately owned air schools, 8 housing projects, and 36 "satelite cities."

Various bases of design for sewage treatment plants have been set up which are similar and in general provide for separate sludge digestion, oxidizing filters with rather heavy loadings, and chlorination. The fundamental data assumed for design purposes are as follows:

Sewage flow—70 gal. per capita per day.
Peak flow—210 gal. per capita per day.
5-day B.O.D.—0.17 lb. per capita per day.
Suspended solids—0.27 lb. per capita per day.
Grease—0.088 lb. per capita per day.

To date the Bureau of Sanitary Engineering has conducted tests at camps on one standard trickling filter, one single-stage bio-filter, one two-stage bio-filter, and one standard filter operated with recirculation. One two-stage bio-filter for a city was also tested. Results are summarized in the following table.

	Design	Max.	Min.	Avg.
Sewage Flow, G.P.C.D.	70	129	56	67
B.O.D., Lb./Cap./Day Raw	0.17	0.157	0.070	0.122
B.O.D., Lb./Cap./Day Final	0.008–0.07	0.027	0.008	0.016
Susp. Solids, Lb./Cap./Day Raw	0.27	0.143	0.060	0.100
Susp. Solids, Lb./Cap./Day Final	0.014–0.027	0.027	0.008	0.017
Chlorine Demand (Effl.) Lb./M.G.	290*	357	27	148

* Capacity provided at 2 lb. per 100 men per day.

The population served by these plants varied from 1,500 to 26,000, and the flow from 0.095 to 1.5 m.g.d.

Design of Treatment Units

Manually cleaned bar screens with 1 in. clear openings have been provided at most of the plants. Several comminutors have been installed at navy camps; none at army camps.

Design practice in bio-filtration plants has not been uniform. Primary clarifiers have been designed to give 1.2 to 2.7 hours settling based on raw sewage plus recirculation, with detention based on raw sewage flow from 3.1 to 8.1 hours. Scum removal is generally provided.

Secondary clarifiers are usually the same size as the primary units and differ in the omission of scum removal and sludge collecting mechanisms. Usually liquor is pumped from the bottom of the final clarifier to the primary unit. All sludge comes to the digesters through the primary tanks.

Primary bio-filters have been designed on a basis of 1.74 to 3.3 lb. per day raw B.O.D. per cubic yard if used as single stage, complete treatment; if followed by a secondary filter they are loaded from 1.17 to 4.9 lb. per day. The secondary unit is usually a duplication of the primary filter. Areas used permit a rate of application of 10 to 75 m.g.a.d. to each filter, including recirculation. Depths vary from 3 to 6 feet, the 3 ft. depth being the most common. The tendency has been to use coarse rock, 2½ to 3½ in. on single-stage filters and 1½ to 2½ in. on secondary filters. Rotary distributors have been used on all filters.

Generally the practice has been to recirculate clarifier effluent to the filter with the excess flow from the primary stage going to the secondary recirculation pump, and the excess from the second stage going off as plant effluent. Rates vary 2.5 to 8 times the raw sewage flow.

Heated sludge digesters have been designed for 2.5 cu. ft. per capita. Both single-stage and two-stage digesters have been used.

Drained sludge drying beds have generally been designed to provide one square foot per capita, while undrained beds are usually designed on the basis of 3 sq. ft. per capita.

The Evaluation of Sewage Treatment. By W. J. O'Connell, Sr., pp. 46–57. This paper is a discussion of terms and values in present day usage for expressing plant performance. It is pointed out that there are many factors; such as seasonal changes, urban habits, industrial developments, collection system characteristics, design, capacity, and flexibility which make performance comparisons difficult. Performance variations, to be understood, must be based on quantity and character of input loadings in relation to "flowing through periods," the nature of loading variation and the theoretical maximum removals for various types of input loading at calculated detention of flows.

It is suggested that more general use of "equivalent population" figures be made. Differences in problems can be indicated by a series of "population equivalent" expressions. These might include flow, suspended solids (raw and final), B.O.D. (raw and final), and flow (average 6 hours maximum, 6 hours minimum flow, and 12 hours median flow).

Included in the paper are a number of graphs illustrating variations in flow and plant loading.

Better Methods for the Determination of Grease. By Harvey F. Ludwig, pp. 58–60. This paper discusses the Standard Methods procedure for the determination of grease in sewage and industrial wastes and describes three new methods proposed. These are, direct wet extraction method, the filtration method with preliminary boiling and freezing, and the filtration method with preliminary chemical flocculation. The disadvantages of the present Standard Methods procedure are discussed. The conclusion is that the filtration method with preliminary boiling and freezing gives the most reliable results.

Design of Sewage Disposal Plant from the Standpoint of Defense Ratings and Materials. By F. C. Roberts, Jr., pp. 61–66. This paper discusses the problems encountered at present in designing and building a plant, particularly as regards materials available and the difficulty of obtaining them. Despite higher prices for materials and labor the opinion is expressed that a plant built today will increase in value in five years.

With present uncertainty as to materials the difficulty of estimating the cost of a plant is pointed out. The cost of a plant for communities in defense areas is not of great concern as many of these are financed in large part by a federal grant.

The design for a defense project varies from that for municipal systems in that time is of utmost importance and that a large number of persons must be satisfied with the design.

Army standards for design are discussed briefly. The standards suggest a detention period of 3.0 hours ahead of trickling filters and 1½ hours ahead of activated sludge. A sliding scale for peak flows is provided, with a ratio of peak to average of 5 : 1 for 1,000 population and 2.28 : 1 for 50,000 population.

T. L. Herrick

SCUM REMOVAL FROM SEDIMENTATION TANKS

By E. S. Hamlin

The Surveyor, 101, 321–322 (Sept. 18, 1942)

The author has taken notes from the annual operating report of the Johannesburg, South Africa, sewage treatment works.

Johannesburg sewage contains much fat, grease, oil and "unspent" soap which formed unsightly scums on the settling tanks and interfered with purification processes.

Three methods of scum removal were developed, each method being an improvement over the previous method. The first method was a fixed trough located inside the scum board of the sedimentation tank and draining into a sludge withdrawal line. Floating solids were hosed toward the trough and when collected were lifted into it. In the second method a 6-inch diameter pipe was laid radially from a central stilling well to a peripheral collecting channel. A 90-degree sector was cut from the pipe and the pipe arranged for rotation to permit the scum and grease to enter the cut-out section. A gate valve was installed in the pipe to provide for discharge of scum from the pipe.

Because hosing grease from the tanks had to be done frequently and this operation required considerable time, a third method was developed. A 1½-inch air supply main was laid around the periphery of the tank. From this main six ¾-inch laterals were laid radially to the center of the tank being spaced equidistantly, with the first pipe immediately behind the scum withdrawal pipe mentioned in the second method. The ¾-inch pipe are drilled with ⅛-inch holes spaced at 6-inch centers and all holes lying in a plane parallel to the water surface and just below the water surface. In the grease removal operation air is let into the ¾-inch pipe immediately behind the scum pipe. The air drives grease and scum around the tank and past the second ¾-inch lateral. The air in the first lateral is then shut off and the operation repeated until scum is finally blown into the scum pipe.

Air used is at 10 pounds per square inch pressure.

K. V. Hill

SYNOPSIS OF THE PRACTICAL DIFFICULTIES OF RIVER POLLUTION PREVENTION

By A. Seaton

The Surveyor, 101, 363–364 (October 23, 1942)

The author cites the difficulties in sewage treatment and stream pollution prevention in a small densely populated country lacking large rivers to provide adequate dilution for natural or semi-natural methods of sewage purification. He refers especially to the industrial midlands where the volumes of sewage are large and where the streams are very small and their sources are near. Here he suggests that a very high grade effluent is necessary to protect the stream and points out that unless works are so designed as to produce a high grade effluent, a small increase in sewage quantity may cause bad stream pollution.

The Royal Commission has suggested a minimum standard for sewage effluent in those areas where the stream dilutes the effluent at least eight times and has also suggseted that boards should be set up to decide local standards to be attained. The author regrets the suggestions were not adopted.

The author acknowledges the economic problem attached to sewage treatment and cites several enabling Acts designed to accelerate and induce local interest in financing the construction of sewage works. Among these the Public Works Facilities Act, 1930, provided a simple and expeditious procedure for local authorities to construct works utilizing unemployed labor. This Act remained in force for about two and one half years.

Local Government Acts, 1929 and 1933, enabled County councils to contribute to the expenses of local authorities undertaking water supply and sewage disposal projects. Many authorities have taken advantage of these Acts and are receiving annual contributions. The provisions of the Acts in this respect are now superseded in practice by Section 307 of the Public Health Act, 1936.

Storm water is cited by the author as often contributing serious pollution to streams containing as it does washings from streets, highways, yards, and roofs. Storm washings contain heavy concentrations of organic matter in suspension and dilution and much heavy inert material. The former putrefy and cause offensive conditions and the latter may cause silting and obstructions to flow. The author would like to see this storm water treated. He would also provide for treatment of six times the dry weather flow of sewage.

The author discusses briefly and in very general terms trade wastes, particularly pickling wastes, tar and oil, wastes from collieries and quarries and milk wastes and points to the need for the diligence and cooperation of all concerned to prevent serious stream pollution where these wastes are involved.

K. V. Hill

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☆NORDSTROM Lubricated Plug Valves

EMCO Sewage Gas Meter

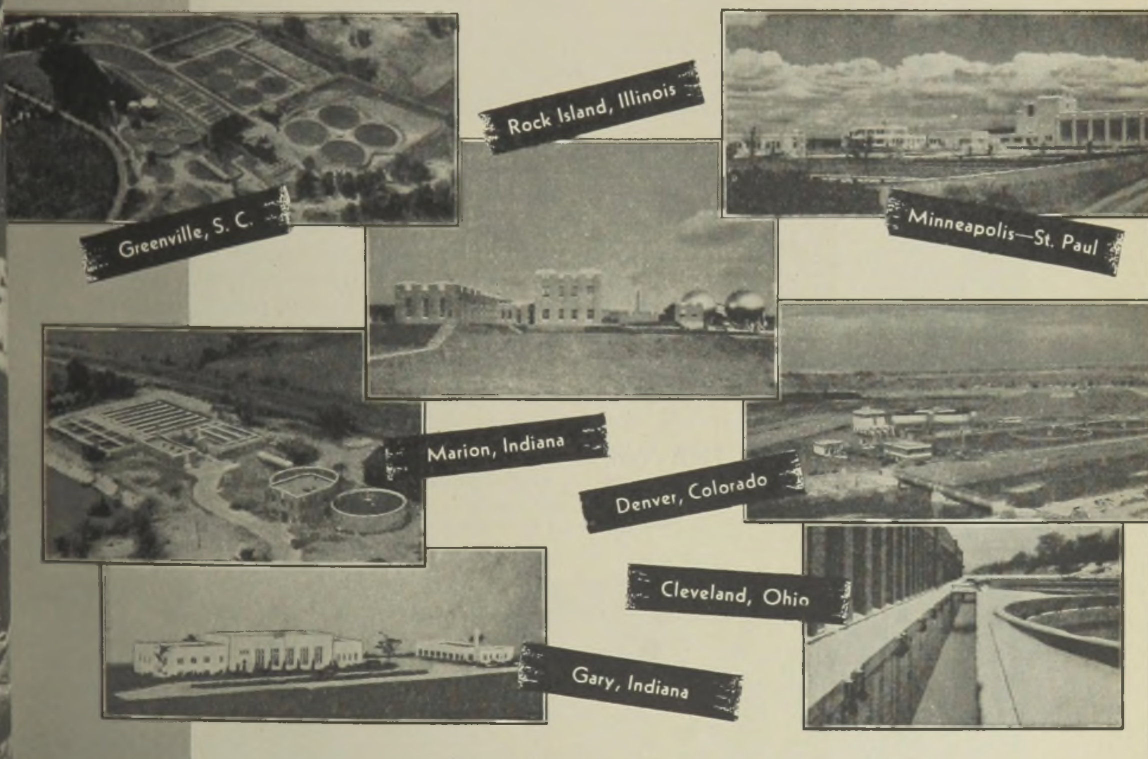
Pittsburgh Hot and Cold Water Meter

Nordstrom Lubricated Plug Valve

SEWAGE treatment and disposal practice has made tremendous strides during the past decade. The sewage plants erected during this era, and those projected, will function with the highest degree of efficiency and dependability through the foresight of their designers in the careful selection of all equipment. They will have a favorable effect on the health and well-being of large and small population centers alike for many years to come.

We are proud of the fact that our meters and valves have been specified for use in the majority of the largest sewage treatment plants that have been erected.

Accuracy in measurement and control is important to the efficient operation of any size plant. EMCO Sewage Gas Meters can be relied upon for the accurate measurement of all gas generated during sludge digestion which is used as a source of heat and power. Pittsburgh Hot and Cold Water Meters will definitely determine the cost of the large quantity of water consumed in and about the plant. Nordstrom Valves, due to their leak resistance, corrosion-proof construction, and easy, positive operation, provide absolute control and assure the most satisfactory service on all lines in sewage treatment plants.



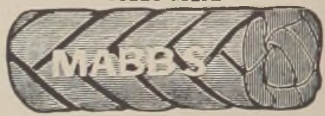
PITTSBURGH EQUITABLE METER COMPANY

MERCO NORDSTROM VALVE COMPANY

Main Offices: Pittsburgh, Pa.

KANSAS CITY SEATTLE
PHILADELPHIA HOUSTON

DIRECTORY OF ENGINEERS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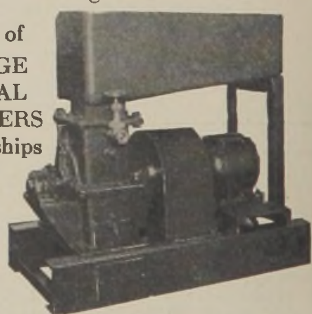
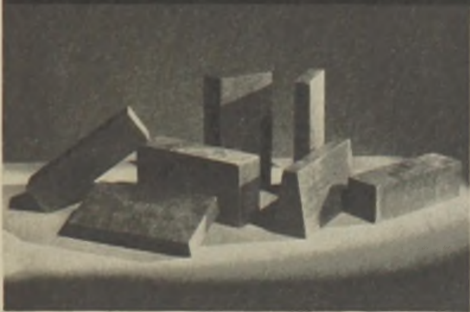


Norton POROUS MEDIUMS — *Filtration-Aeration-Incineration*

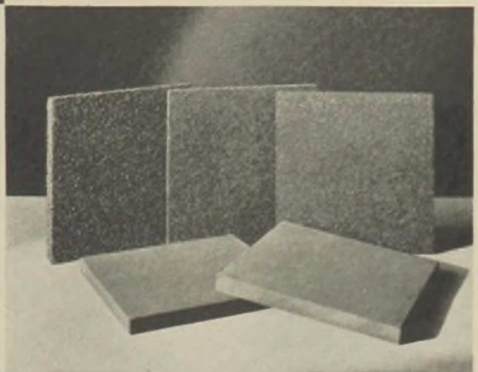


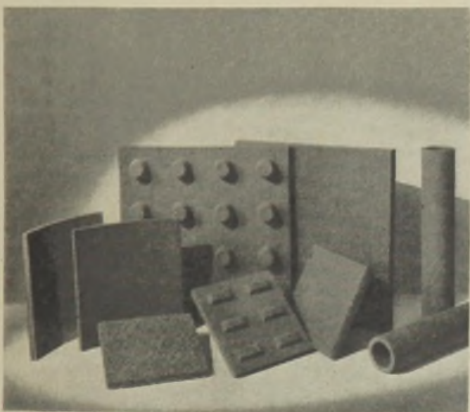
CRYSTOLON BRICK FOR INCINERATORS

For municipal incinerators Norton *Crystolon* (silicon carbide) brick provide great refractoriness at bigh temperatures. They are chemically resistant to the erosive action of slag and so dense that molten ash will not take hold by penetration.

POROUS PLATES FOR RAPID SAND FILTERING

Because they are ruggedly designed, chemically stable and uniform, Norton Porous Plates are being selected for rapid sand filtering. Special plates with legs are available when substructure is not desirable. The plates can be joined by durable cementing and caulking materials, and rabbeted or beveled edges can be supplied.





POROUS PLATES AND TUBES FOR ACTIVATED SLUDGE SEWAGE PLANTS

"Controlled structure" in the manufacture of Norton Porous Plates and Tubes assures uniform air distribution and regulated wet pressure loss. These efficiently designed Porous Mediums will deliver air to the sewage in amounts and at rates of flow calculated to give the best results.

NORTON COMPANY
Worcester Massachusetts

NORTON ELECTRIC FURNACE FUSED POROUS MEDIUMS

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