The drifting sand forms a volcano-like cone that continuously drifts away and is being replaced with the washed sand from the sand washer, leaving a round top body of stationary sand below, resting upon the filtered water collecting system. The final purification is dependent on this body of stationary sand. The rate of flow of water passing through the by-pass may be varied in such a way as to suit the conditions of the raw water. In times of high turbidity the speed of the drifting sand is accelerated by decreasing the flow of raw water through the by-pass and increasing the flow through the standpipe. When in operation the stationary body of sand is found to be hard and compact with a cone-shaped-like surface, which is hard to penetrate.

The drifting sand is quite buoyant and spongy and offers little resistance to penetration. In practice it is found that the slope of the drifting surface cone is a minimum of about 32 degs. and the slope on the surface of the cone forming the stationary sand is about 64 degs. The initial loss of head in the filters is 6 ft. and in the process of operation this gradually increases to 11 ft., when the filter is backwashed.

Length of run of filters ranges between one and seven days according to the physical condition of the raw water and the amount of alum applied. Backwashing is accomplished by reversing the flow of filtered water through the bottom of the filter. The water is obtained from an elevated tank having a capacity of 200,000 gals. and which, on account of its elevation, supplies a natural head of 40 lbs. Half the contents of the tank are passed through the filter at a gradually increasing rate, the first 100,000 gallons taking fifteen minutes, whilst the remaining quantity is passed through rapidly, the whole operation being completed in 20 minutes. The filter is then run to waste for 20 minutes, after which it is put into commission. The amount of dirty waste water passing through the sand washer is 2%, whilst an additional 1% to 2% is used for backwashing and waste purposes.

On a big plant, embracing an entirely new system, it was expected that numerous problems would be encountered, particularly when the plant was put in commission, but with few exceptions, the difficulties have, or will be shortly, overcome, and in no case can they be considered serious. In the early days, the biggest problem was to get a high grade sand. About two-thirds of the sand originally placed in the filters, amounting to over 4,000 cubic yards, had to be taken out and replaced at the expense of the contractors. At present the sand, whilst being satisfactory, is not quite uniform, having an effective size which varies between .35 and .4 mm. In the chemical house some inconvenience was caused by the corrosive action of the aluminum sulphate solution on the slotted trunk through which the solution is discharged into the raw water. The trunk was made of vanadium silver, which has since been replaced by one made of pure copper. Tests are at present being conducted in the laboratory on a composition consisting of copper 92 parts, lead 8 parts containing 1% of antimony.

The question of sand scour has been the most troublesome. When the filters were first put in commission, the cast-iron throats did not wear as long as was expected, and they were relined, first with extra heavy black iron pipe and finally with similar pipe carbonized. Porcelain was tried but was unsuitable and experiments with rubber are now under way. Most of the scour observed has been traced to a tail eddy which forms at the back of the sand nozzle by the water passing it. By using the modified sand washer the scour has been greatly reduced, and a number of new washers are being installed.

Some trouble was caused in one filter by too rapid backwashing, which resulted in the disturbance of the gravel. The filter was emptied and the gravel replaced by 4 ins. of 1-in. gravel, and 6 ins. of cemented gravel, in the proportion of 15 of gravel to 1 of cement. The gravel used was the material which passed through a screen having three meshes to the inch and was retained on a screen having five meshes to the inch. This has proved to be very satisfactory.

TABLE 1.—AVERAGE AMOUNT OF WATER FILTERED DAILY, TOGETHER WITH MONTHLY AVERAGE OF APPLIED ALUMINUM SULPHATE AND TURBIDITY IN THE RAW AND FILTERED WATER

Month	Av. Amt. of Water Filtered, Million Imperial Gallons	Av. Amt. of Aluminum Sulphate Applied in Grains per Gallon	TURBIDITY — Raw Water Max.	Raw Water Min.	Raw Water Av.	Filtered Water Max.	Filtered Water Min.	Filtered Water Av.
January	30.95	0.98	80	1	6.2	Under 1	Under 1	Under 1
February	33.16	0.65	24	1	3.9	"	"	"
March	33.63	0.92	54	1	12.7	3	"	"
April	32.49	1.48	160	1	27.9	18	1	2.4
May	32.74	1.04	7	1	2.1	Under 1	Under 1	Under 1
June	31.76	0.82	2	1	1.3	"	"	"
July	39.13	0.61	3	1	1.5	1	"	"
August	38.00	1.08	10	1	1.8	1	"	"
September	36.9	1.02	25	1	2.8	Under 1	"	"
October	40.61	1.2	4	1	1.4	"	"	"
November	44.19	1.07	35	1	2.9	"	"	"
December	37.7	1.3	75	1	21.3	"	"	"
Yearly average	36.0	1.027	..	.	....			Under 1

The average amount of chlorine applied to the water was 0.2 parts per million.

TABLE 2.—AVERAGE NUMBER OF BACTERIA PER CC. GROWING ON STANDARD AGAR 24 HOURS AT 37-39 DEGS. C., IN THE RAW, FILTERED AND CHLORINATED WATER, TOGETHER WITH PERCENTAGE REDUCTION

Month	Raw Water	Filtered Water	Mixed Mechanical and Slow Sand Water Chlorinated
January	42.2	3.3	1.2
February	7.4	1.2	1.0
March	43.0	3.2	1.6
April	73.4	5.6	1.0
May	28.7	5.7	1.1
June	108.5	11.4	2.8
July	97.1	19.9	1.4
August	653.0	67.3	2.4
September	738.7	82.5	1.4
October	1,382.5	29.1	2.5
November	779.8	78.1	2.7
December	534.4	33.3	1.4
Yearly average	369.5	53.4	1.72

Per Cent. Purification Effected in Agar:—

A.—Average of 303 samples:—Raw water, 369.5; filtered water, 53.4. Average of 1,900 samples, chlorinated water, 1.72. Total average reduction:—In filtered water, 85.4%; in chlorinated water, 99.5%.

B.—Same exclusive of three results for reasons specified in article:—Raw water, 303.6; filtered water, 34.7; total average reduction, 88.4%.

Preliminary Experiments

Prior to the completion of the new drifting sand plant at Toronto, extensive laboratory experiments were carried out over a period of eighteen months, the object being to collect as much data as possible that would likely be of value when the plant was put in commission. After six months' observation it became evident that the water of Lake Ontario was going to be an extremely difficult water to treat mechanically; that is to say, the purification effected after coagulation, under apparently the same physical conditions, varied from time to time It was generally known that the quality of the water was governed by the meteorological conditions, which also controlled the temperature of the water.

In the summer months, when the water was warm and the wind from an unfavorable direction, there was invariably pollution. During the winter months the same unfavorable meteorological conditions produced a polluted water which showed a drop in temperature instead of an increase