

nocuous is very great, so that water at the centre of the lake is comparatively pure.

Where the sewage in great quantity is poured into the lake, especially near the mouths of rivers upon which large cities are situated, the zone of polluted water is wide and a greater distance toward the lake centre must be traversed before pure water is secured. With the growth of urban populations on the lake shore, this zone of polluted water is continually widening, and waterworks intakes have been repeatedly moved farther out to secure better water. In the danger of polluted water entering waterworks intakes there is another factor besides the ever widening zone of polluted water, viz., the action of currents.

Direction and velocity of the currents of Lake Erie may be said to depend entirely upon the wind.

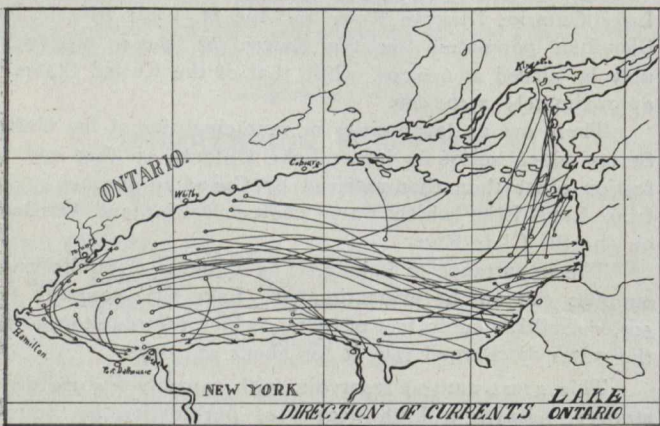
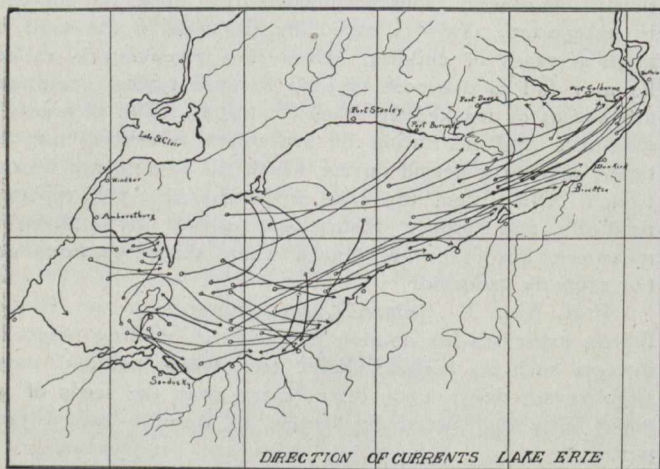


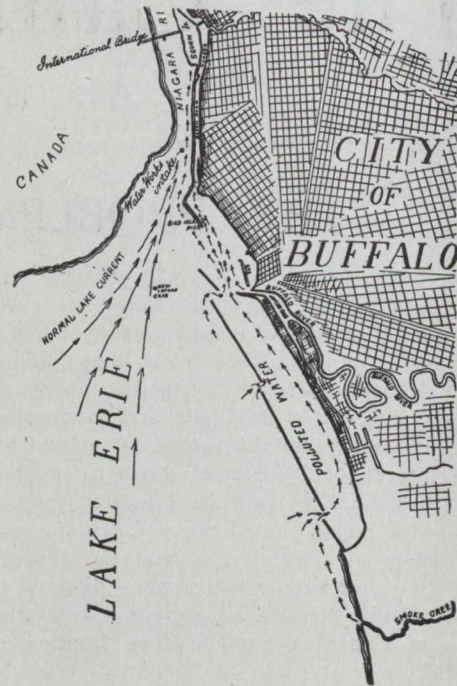
Fig. 2.

The frictional action of wind upon bodies of water operates in three ways:

- (1) Surface current in the direction of or "with" the wind.
- (2) Piling up of the water on the shore directly opposed to the direction of the current and lowering of the water at the opposite end.
- (3) Alteration of temperature by mixture and by im-por-tation of waters of different temperatures.

The first and second effects of wind action are the most important from a sanitary standpoint. The first because of its direct carriage of polluted water for considerable distances. The second operates in two ways—(1) the rapid lowering of water level carries the polluted water in the low end of the lake out of harbors into the lake; (2) after the piling up of water at the high end of the lake and without a change of wind, pollution is carried out of harbors by a "backwash" or undertow in spite of the persistence of a

surface current toward the shore. The third effect, altera-tions of temperature, probably has little sanitary signifi-cance.



Currents in Vicinity of Buffalo, N.Y., U.S.A.

When an unusual disturbance of a large body of water occurs due to strong winds, the immediate results are as indicated above—a surface current in the direction of the wind, a piling up of the water on the lee shore, and a fall of the water on the weather shore. The return to stable equilibrium is effected by a series of rhythmic oscillations about a central nodal line. These rockings or oscillations are of decreasing amplitude until stable equilibrium is established, and in a comparatively long and narrow lake, with the wind in the direction of the long axis of the lake, resemble the motion of a child's seesaw or teeter.

The report of the deep waterway commission shows that in a period of four years, winds on Lake Erie from the south-west, west and north-west prevailed 56½ per cent. of the period, and winds from the south-east, east, and north-east 27 per cent. of the time. The general observations of meteorological stations show a great lack of dependency on the wind direction across this lake. The supposition that westerly winds protect the intakes entails the assumption that sewage pollution is carried at or near the surface of the water. The surface current near the shore is in the direction of the wind and the general trend of the lake water in quiet weather is toward the east, but only at a rate of one-eighth to one-sixth mile per day.

In time of storm, with strong gales blowing for days in one direction, there is not only a surface current in that direction, but also a deeper current in an opposite direction. The amount of pollution that this deeper current carries depends upon local conditions, but to assume that all sewage pollution is carried at or near the surface is unsafe. It is certain that this deeper undercurrent carries gross pollution out of harbors and river mouths in times of flood even when the wind is blowing directly inshore, making a surface current toward the harbor and raising the level of the harbor water several feet.

The curious dependence upon the fallacious belief that protection was afforded to lake intakes by the position of the intake to the westward of the source of pollution is paralleled by the faith which citizens of towns on the Niagara