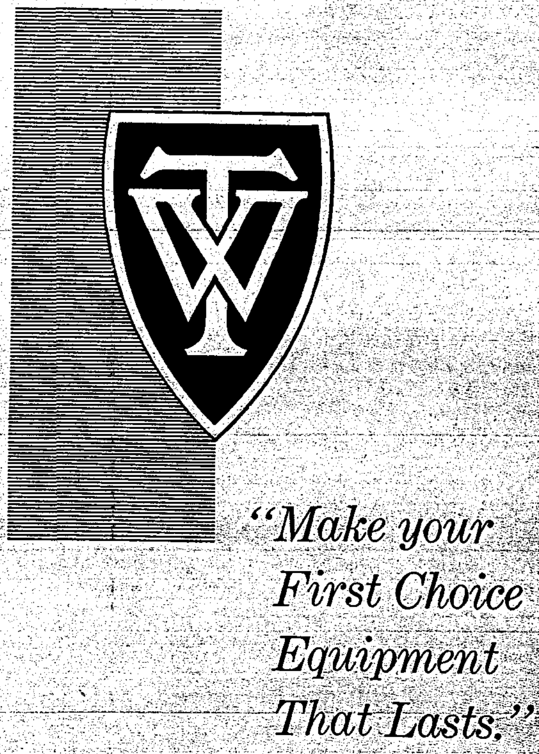

SEWAGE AND INDUSTRIAL WASTES

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Special Features

Twenty-Eighth Annual Meeting—Oct. 10–13, 1955
Ambassador Hotel, Atlantic City, N. J.
(See Page 1102)

[SE]PTEMBER, 1955—VOL. 27, No. 9

TABLE I.—Procedure Used for the Acclimation of Microorganisms from Kanawha River Water

1. A 6-l. container was supplied with air for aeration.
2. Six liters of water from the Kanawha River was placed in the container.
3. Approximately 50 p.p.m. of the organic material being studied was added.
4. Sufficient diammonium phosphate was added to supply the nitrogen and phosphorus required as growth factors.
5. The pH was adjusted to a value between 6.8 and 7.2.
6. The mixture was aerated continuously, and the C.O.D. was determined daily.
7. Additional organic material was added when the C.O.D. values indicated that a significant removal of the organic material had occurred.
8. Growth factors other than nitrogen and phosphorus were added by removing one-half of the liquid volume from the container once each week and adding an equal amount of tap water.
9. A portion of the acclimation mixture was employed as seed for a B.O.D. determination when the C.O.D. data indicated that development of a suitable culture of microorganisms had possibly occurred.

take place within the slime growths that exist on the bottom and banks of the receiving stream. These growths would then serve as a source of microorganisms for the waters of the stream.

The acclimated cultures obtained by the procedure in Table I are highly specific. Natural acclimation of microorganisms in the receiving stream would probably be less specific because of the presence of other organic materials. Therefore, the rate of biological oxidation obtained with the laboratory cultures would probably exceed that obtained in the natural stream.

Summary

The successful acclimation of microorganisms for the oxidation of certain organic chemicals illustrates clearly that the microorganisms employed as seed can be a variable in the B.O.D. determination. To obtain a more reliable evaluation of the biochemical oxygen demand the following procedure is employed in the authors' laboratory:

1. The long-term B.O.D. curve is determined employing an unacclimated culture of microorganisms as seed.

2. If the B.O.D. development is not satisfactory, the acclimation of microorganisms from Kanawha River water is attempted using the procedure in Table I. Acclimation is continued until a thoroughly acclimated culture is developed. If no acclimation occurs within 100 days, it is assumed that the material cannot be oxidized by aerobic microorganisms.

3. The long-term B.O.D. curve is determined employing the acclimated culture of microorganism as seed.

This procedure insures that a reasonable interpretation of the biochemical reactions can be made. Naturally the expenditure of a large amount of time in obtaining the desired culture of microorganisms limits the application of this procedure. However, if the B.O.D. data are required and the first step in the procedure indicates that unacclimated microorganisms are unsatisfactory, acclimated microorganisms should be used.

Stream Pollution

GROUND WATER POLLUTION FROM INDUSTRIAL WASTES *

By W. Fred Welsch

Senior Engineer, Nassau County Department of Public Works, N. Y.

The phenomenal growth in the population of Nassau County, Long Island, N. Y. coupled with the rapid industrial expansion has created a problem in protecting the ground water of the county from pollution. Industrial wastes from the many light industries locating in the area have created a critical situation in some sections.

Geology

Long Island, the largest island on the Atlantic coast of the United States, is entirely surrounded by salt water. Geologically, it is underlain by bedrock consisting of schists and gneisses. In Nassau county this rock formation is approximately 400 ft. below the shore line on Long Island Sound, sloping gently on an incline of 64 ft. per mile in a generally south-easterly direction to a depth of 1,500 to 2,000 ft. below sea level on the south shore along the Atlantic coast. The material between the rock floor and the land surface of the island consists of successive layers of sand and gravel aquifers of considerable magnitude and clay lenses of variable thickness. The aquifers have tremendous storage capacity, serving as storage reservoirs for rain water.

Water Supply

The only source of water supply for utilization by public water supply systems and for private, industrial and agricultural purposes is from rainfall that averages 42 in. per year. Rain water and melted snow percolate through pervious subsoils into the sand and gravel aquifers. Less than 50 per cent seeps into the ground and the balance is lost by evaporation, transpiration and stream runoff into tidal waters.

Water that formerly was discharged into the ground from cesspools and septic tanks is carried off in sanitary sewers to sewage treatment plants discharging effluent into tidal waters, while new building has diverted more and more storm water into natural streams, pipes and culverts.

In line with conservation some storm water recovery is made possible by artificial ground water impounding and recharge basins varying in size up to 9 acres. These basins are strategically and hydraulically located at various places in the county, to permit a large percentage of the storm water runoff to percolate into the aquifer to replenish the ground-water supply.

This area possesses unique characteristics from a sanitary viewpoint because of its complete dependence upon water pumped from shallow and artesian wells. There are 50 public water supply systems serving the villages and water districts of the county.

* Presented at 1955 Annual Meeting, New York Sewage and Industrial Wastes Assn.; New York City, N. Y.; Jan. 20–21, 1955.

Industry

Industry is demanding larger quantities of water for cooling, processing, air conditioning and power purposes. Some industries have wells and others are supplied by public water supply systems. Industrial plants dispose of their wastes through recharge basins and diffusion wells (1). When permitted these wastes are discharged into sanitary sewer systems (2).

During World War II the quantity of hexavalent chromium wastes disposed of by recharging to the ground water through artificial recharge basins contaminated large segments of the ground water before the deleterious effects were detected (3). Chromium was used in aircraft industries for plating and anodizing purposes to enhance the corrosive resistant qualities of aluminum and other metals. An investigation disclosed that deep public wells and shallow private wells were contaminated. Water from one of the public water supply wells in close proximity to a contaminated area was found to contain over 1 p.p.m. hexavalent chromium. The use of this well was immediately discontinued. The industrial plants are now required to treat their waste material in accord with health department requirements, for the removal of chromium before the liquids are disposed to the recharge basins.

The chromium contaminated water was found to be moving slowly underground and apparently with some decrease in concentration (4). In an area immediately south of an aircraft company's seepage basin, chromium concentrations as high as 40 p.p.m. were discovered. The contaminated water covered an area 600 ft. wide by 3,600 ft. long, comprising about 50 acres. Samplings made 16 mo. after the original samplings seemed to indicate a slow movement of this slug to the south, together with some diminution in concentration probably due to dilution. The natural ground-water movement in the area is toward the south.

A continuation of the study revealed the presence of cadmium, a heavier and more toxic metal than chromium, in the ground water. Cadmium is utilized on a large scale in industrial plating operations. An analysis of the water in a recharge basin at an aircraft company plant indicated 1.2 p.p.m. of cadmium. The actual concentrations discharged to the recharge basin were probably higher than this amount, but due to the tremendous dilution through waste discharged from air conditioning and other purposes, the analysis showed a low concentration. A survey conducted on private shallow wells in the area disclosed that two of them in use at the time of the investigation contained 0.6 and 0.34 p.p.m. cadmium, respectively.

Test Well Program

Using the experience gained in previous studies of ground water contaminated by chromium, the Nassau County health and sanitation agencies initiated a thorough program of investigation on cadmium pollution. Field investigations were made in cooperation with the Nassau County Department of Public Works. Several series of 1¼-in. diameter test wells were driven on lines perpendicular to the direction of ground-water flow, just south of the recharge basins in question. A 4-in. diameter test well was driven at the site to a depth of 202 ft. to ascertain the nature of the subsurface materials. The log of the well indicated medium, coarse and fine sand and gravel at various depths and an impervious clay layer 72 ft. below grade. Samples were obtained by means of a soil sampler of the split steel tube type. A mechanical analysis was made of the pervious materials to determine hydraulic characteristics and permeability.

An attempt was made to determine the width of the contaminated water strata, the depth where the cadmium was located and the horizontal course along which this contaminant was being carried by the natural ground-water flow.

The wells were driven by dropping a 200-lb. guided weight on top of 5-ft. coupled sections of 1¼-in. diameter extra-heavy drive pipe, the lowest section had a standard wellpoint attached to the bottom. By means of a pitcher type hand pump water samples were taken at 5-ft. intervals to an average depth of approximately 50 ft. The depth to ground water varied from 2 to 14 ft.

In several instances attempts were made to continue the well driving operation until a sample was obtained in which the contaminant was not detected. By following this procedure it was possible to determine both the vertical distribution and the elevation of maximum concentration of cadmium. Table I is a consolidation of the data on all of the driven test wells. The location of the test wells is shown in Figure 1. The extent of cadmium concentration covered an area of approximately 53 acres to a maximum depth of 60 ft. with concentrations as high as 3.2 p.p.m. The suspected origin of the cadmium was the recharge basins about 700 ft. north of the test area.

The east and west limits of the contaminated section are nearly parallel with a slight divergence as the cadmium travels southward under the influence of the ground-water flow. The most easterly and westerly test wells along the avenues perpendicular to the direction of ground-water flow did not contain significant quantities of cadmium. These borderline wells made it possible to establish the width of the contaminated

TABLE I.—Test Well Data for Cadmium Survey

Test Well No.	Well Depth[1] (ft.)	Cadmium Concentration						Depth to Water Table[1] (ft.)
		Upper Level		Maximum		Lower Level		
		Depth (ft.)[1]	(p.p.m.)	Depth (ft.)[1]	(p.p.m.)	Depth (ft.)[1]	(p.p.m.)	
1	55.4	—	—	entire depth	<0.05	—	—	10.0
2	50.5	13	<0.01	28	1.4	50	<0.01	9.7
3	50.1	18	1.1	31.5	3.2	50.1	1.8	11.6
4	50.4	18	0.44	45.0	1.95	50	1.3	11.6
5	45.1	—	—	entire depth	<0.05	—	—	9.7
6	50.5	13	<0.05	18	0.14	29	<0.05	10.8
7	50.3	—	—	entire depth	<0.01	—	—	11.0
8	58.8	18	<0.01	49	1.92	54	<0.01	10.2
9	55.6	13	0.07	34	1.3	50	0.86	11.7
10	44.3	—	—	entire depth	<0.05	—	—	11.2
11	55.7	13	0.04	29	1.85	50	<0.01	8.2
12	50.3	13	0.04	39	1.12	50	0.26	10.0
13	50.1	18	<0.01	34	0.11	44	<0.01	11.9
14	49.1	28	<0.01	38	0.1	49	<0.02	8.9
15	40.0	—	—	entire depth	<0.01	—	—	11.9
16	48.5	18	<0.01	28	0.17	38	<0.01	10.9
17	50.2	—	—	entire depth	<0.01	—	—	9.0
18	49.6	13	0.05	13	0.05	24	<0.01	8.6
19	49.3	—	—	entire depth	<0.01	—	—	4.9
20	50.5	18	<0.01	34	0.06	39	<0.01	5.2
21	48.7	—	—	entire depth	<0.01	—	—	4.6
22	49.0	—	—	entire depth	<0.01	—	—	6.4

[1] All depths indicated are from ground surface.

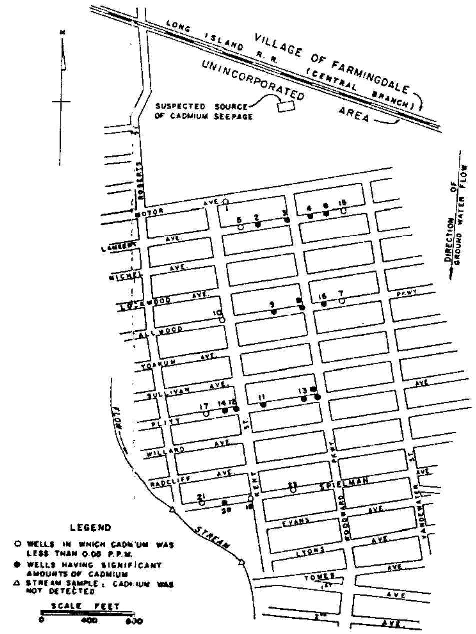

FIGURE 1.—Location of test wells for ground water contamination survey, Nassau County, N. Y.

area. Cadmium was not found in the creek south of the test well area. Other small areas in the county were investigated to detect the effect on the ground water of phenol, fuel oil, chlorine and the wastes from a gas manufacturing plant.

In accord with the classification and standards for underground waters adopted by the New York State Water Pollution Control Board (6), sewage or industrial waste disposal is not permitted within certain distances of a public water supply well or infiltration gallery used as a source of water supply for drinking, culinary, food processing or other purposes. Toxic wastes, deleterious substances, other wastes or heated liquids are not permitted in sufficient amounts to make the water unsafe, and if necessary, treatment of these wastes is required by the health authorities.

Conclusions

The discharge of plating wastes to the ground water is creating a hazardous situation in sections of Long Island. Every effort should be made to prohibit disposal unless the wastes have been treated to remove the toxic and deleterious substances.

Filtration of waste water through the soil structure described does not appreciably reduce the concentration of many chemical contaminants. The potential hazard to a surface and ground-water supply must be considered when contamination is present in the ground water upstream.

Many years may elapse before the effects of rainfall and ground-water dilution will eliminate these contaminants. Now, however, it will be possible to follow the contaminant in the course of its ground-water flow.

Acknowledgments

The laboratory work was conducted under the direction of Maxim Lieber, Division of Laboratories and Research of the Nassau County Department of Health, and field operations by Henry L. Frauenthal of the Nassau County Department of Public Works. The assistance of Terrance McCormack, Director of the Division of Sanitation, Nassau County Department of Health, is appreciated.

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DISCUSSION

By Maxim Lieber

Associate Sanitary Chemist, Division of Laboratories and Research, Nassau County Department of Health, N. Y.

Previous studies have established that the ground-water flow in this area is in a southerly direction. On that premise a series of test wells were driven on several perpendicular planes to the ground-water flow, just south of the recharge basin in question. An attempt was made to determine the width of the contaminated water strata, the depths where the cadmium was located and the horizontal course this contaminant was taking in its natural ground-water flow.

Figure 1 is a graphic illustration of well No. 2. This well is typical of the other driven test wells made during the investigation and shows a variation of cadmium concentrations at different elevations. In this well the maximum concentration was 1.4 p.p.m. at an elevation of 33.19 ft. above mean sea level (M.S.L.), with the lowest concentration of less than 0.01 p.p.m. cadmium at the highest and lowest elevations of the well.

The location of the driven wells has been indicated by Figure 1 of Mr. Welsch's paper. The four streets employed to develop the perpendicular cross sections to the ground-water flow were Lambert Ave., Fallwood Parkway, Plitt Ave. and Spielman Ave. As the cadmium contaminant flows in the ground under the influence of the ground water, it diverges, then flows in a somewhat parallel pattern and finally converges at Spielman Ave. under the influence of ground-water dilution. The pertinent data obtained from each of these

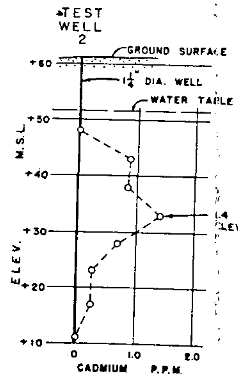

FIGURE 1.—Cadmium concentration of a typical well at varying depths below ground surface.

wells was utilized to develop the perpendicular cross sections to the ground-water flow at each of the four streets. These cross sections show the distribution of cadmium in the aquifer.

Figure 2 is the developed graphic cross section illustration of the aquifer at Lambert Ave. The most easterly and westerly wells (No. 15 and 5) did not contain any cadmium throughout their entire depth. These were called negative wells and gave the graphic limits of the contaminant on this perpendicular *cross section.* The other wells contained significant quantities of cadmium. Alongside each well are recorded the elevations where cadmium was first indicated, last indicated, and the highest concentration that was found. In well No. 3, the highest concentration of cadmium detected in the entire investigation was 3.2 p.p.m. at a depth of 31.5 ft. This was expected because the least amount of ground-water dilution occurred in this first cross section.

On the basis of the information available, it was practical to indicate the probable extent of this cadmium infiltration by the broken line. This is the segment of cadmium contaminated water flowing in the ground as a part of the ground-water flow.

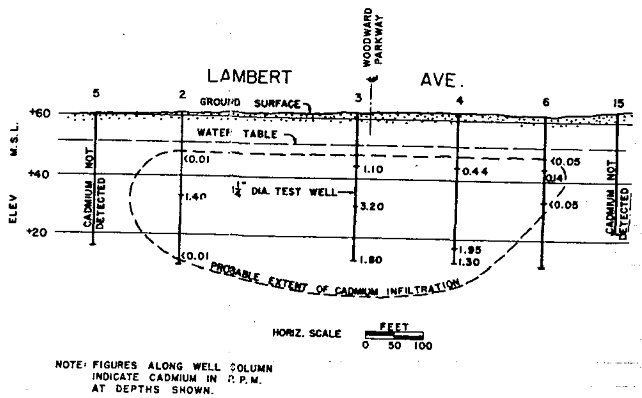

FIGURE 2.—Cross section of aquifer at Lambert Ave.

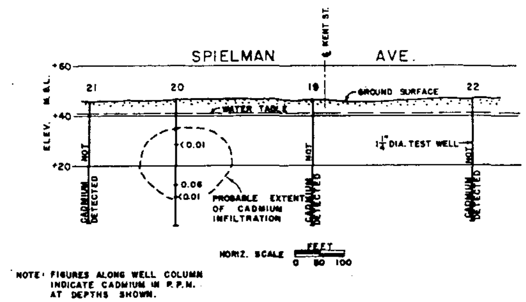

FIGURE 3.—Cross section of aquifer at Spielman Ave.

Similar perpendicular cross sections were developed for Fallwood Parkway, Plitt Ave., and Spielman Ave. At Spielman Ave. (Figure 3) the effects of ground-water dilution are plainly evident. Only a minute quantity of cadmium was detected in well No. 20; 0.06 p.p.m. at a depth of 34.0 ft. Therefore, the probable extent of the cadmium infiltration at this last section was enclosed by the broken line around well No. 20.

It is interesting to note the most southerly aquifer cross section at Spielman Ave. is just above Massatayun Creek. Although this creek is influenced by surface runoff, it is undoubtedly affected by ground-water conditions. Massatayun Creek eventually flows into Massapequa Pond and finally Massapequa Lake. The New York City water supply system obtains water in this area for emergency or auxiliary purposes. The city utilizes the waters of Massapequa Pond, driven wells in the area and infiltration galleries located south of the pond. Samples of water from Massa-

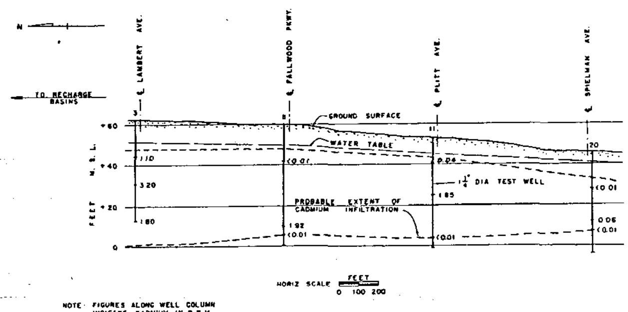

FIGURE 4.—North and south cross section developed from the maximum cadmium concentrations in the aquifer cross sections.

tayun Creek were analyzed for cadmium. The presence of this metal was not detected. However, the potential hazards of this contaminant cannot be ignored when it is present in the ground water above the source of a public water supply.

The prime interest of the survey was to determine as accurately as possible the geographical direction of flow of the cadmium contaminant. This information would be significant as an aid in following the future course of the cadmium in the ground water. A longitudinal section (Figure 4) was developed by utilizing the location of the maximum cadmium levels in each of the perpendicular cross sections of the ground-water flow. This illustration shows the changes in the ground surface and water table elevations from north to south. On the basis of the information available it was possible to indicate the probable extent of the cadmium infiltration. The dashed lines are not closed because the recharge basin where the trade waste originates is located to the north of Lambert Ave., and Massatayun Creek is to the south of Spielman Ave. This longitudinal line of flow coincided with the findings of previous investigations on ground water flow studies in the area.

PENNSYLVANIA ASSOCIATION EULOGIZES TED MOSES

The highlight of the meeting of the Pennsylvania Sewage and Industrial Wastes Association at State College, Pa., August 22–24, 1955 was a surprise "This is Your Life" presentation on August 23 honoring Howard Eugene "Ted" Moses.

In 45 minutes of "Ted Moses Night," the life of the first secretary of the Federation was illustrated by slides, tape recordings, and personal participation by several persons. These included his family, friends and professional associates. Credit for the most successful presentation is due the Association Committee which made primary arrangements for it. Much credit is also due Dr. George E. Symons, who assisted in the preparation and acted as Master of Ceremonies to give the "show" maximum effect.

The life story of Ted Moses started with a picture of his birthplace in Muhlenberg, Pa., in 1875, and continued through his many accomplishments in the Pennsylvania State Department of Health which he has served since 1908. Woven into the story were personal anecdotes and notice of his many services and recognitions. An 1898 graduate of Dickinson College, he has received the Honorary Degree of Doctor of Science from his Alma Mater. Now retired from his duties with the Department of Health, Moses continues to serve the Commonwealth as consulting sanitary engineer. At the conclusion of the presentation, the color slides, a viewer, and the "This is Your Life" volume were given to the honored guest.

Among his many contributions to Federation activities is his service as Secretary from 1928 to 1941 which is truly outstanding. He had served on the organizational Committee of One Hundred and filled the secretary position during the important formative years under the Presidency of Charles A. Emerson (whose recent death is reported elsewhere in this issue). During these years the Federation membership grew to about 3,000 affiliated individuals and at the end of this period full-time employees were needed to carry on the work.

The Federation has recognized the superlative character of the service rendered by Ted Moses by conferring Honorary Membership upon him in 1943, the Kenneth Allen Award in 1945, and the Charles Alvin Emerson Award in 1951.

THE SPREADING OF SINKING PARTICLES IN THE SEA

By Fredrik Beyer

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The sewage from Oslo is discharged to the harbor region of the Oslofjord following primary sedimentation. The resulting sludge is removed in a tank barge and dumped into the fjord. During the summer season, when thousands of people are bathing in the inner fjord, the sludge is dumped between Tofteholmen and Mölen islands (Figures 1 and 2).

In the summer of 1954 the municipal authorities of Oslo investigated the effect of this sludge dumping. The author was engaged in carrying out the field and part of the laboratory work. The chief objective was to check the number of bacteria, in particular the number of fecal coli, in the surrounding surface waters. Hydrographical studies were also included. Currents were observed through the use of drogue-shaped indicators made of plates of galvanized iron, which were dropped behind the barge during dumping. By means of a thin cable of desired length the cross of sheet metal was connected to a small buoy with a flag. Strong wind and the flow of the upper surface water may have modified slightly the drift of the indicators.

The maximum tidal range in Oslo is 24 cm. As a rule, a pronounced eastward component is found in the surface current, due to the discharge of the large Drammen River. This river and others are responsible for the low surface salinities. Most frequently, a density discontinuity layer was found at a depth of about 7 m.

The contents of the barge were of a mixed nature, and varied from time to time. Some of the particles were rather heavy and sank to the bottom rapidly. This was confirmed by the shrimp trawlers, who complained of the amounts of "disgusting" particles that were adhering to the meshes of the trawl when it was used in the dumping area. On the other hand, some of the material sank so slowly that in some cases it could be found in the surface water four hours after the dumping and at a distance of 3–4 km. from the dumping place.

It is remarkable that the "cloud" of polluted surface water remained rather concentrated for such a long period of time. However, with a strong wind, the area of surface water containing particles from the dumping was greatly enlarged. In calm weather, the cloud of polluted surface water moved faster than the current indicator at the one-half meter depth. With wind velocities exceeding that of a gentle breeze, the cloud of sludge particles moved slower than this indicator.

The question arose whether or not there was a subsurface connection between the mass of sludge sinking at the dumping place and the drifting surface cloud. Although excellent for the study of bottom deposits the echo-sounding apparatus on board the vessel hired for the investigations was not able to tell what became of the sludge after having been dumped. On the recommendation of the author, observations were also carried out from the air by means of a helicopter.

The sea water reflects practically no light and appears black or very dark blue when seen from directly overhead. Numerous small particles in