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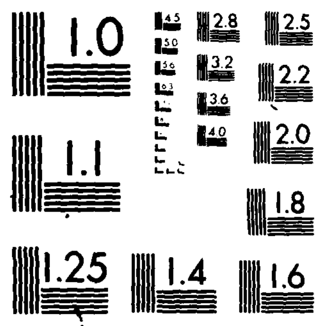


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This bibliography provides a reference that will be of aid to those individuals and/or agencies planning or initiating limnological research on Lake Erie and/or its tributaries. The bibliography is divided into five sections: biological, chemical, engineering, physical, and socio-economic. Pertinent information from both United States and Canada are documented. The papers cited in the annotated bibliography are located at Great Lakes Laboratory of the State University College at Buffalo unless otherwise noted.

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by


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# I. INTRODUCTION

The purpose of this study, which was sponsored under Contract DACW 49-74-C-0102 from the Buffalo District of the U. S. Army Corps of Engineers, was to provide a reference that would be of aid to those individuals and/or agencies, planning or initiating limnological research on Lake Erie and/or its tributaries. The task was divided on the basis of disciplines into five (5) sections - biological, chemical, engineering, physical and socio-economic.

The holdings of libraries in both the United States and Canada were surveyed. Each pertinent reference was abstracted and examined with respect to the location(s) in which the study was conducted, parameters measured and techniques employed. In addition, the last known address of the agency or senior author was included to assist in locating the author if further communication is desired.

Unless otherwise noted, the papers cited in the annotated bibliography are located at the Great Lakes Laboratory of the State University College at Buffalo.

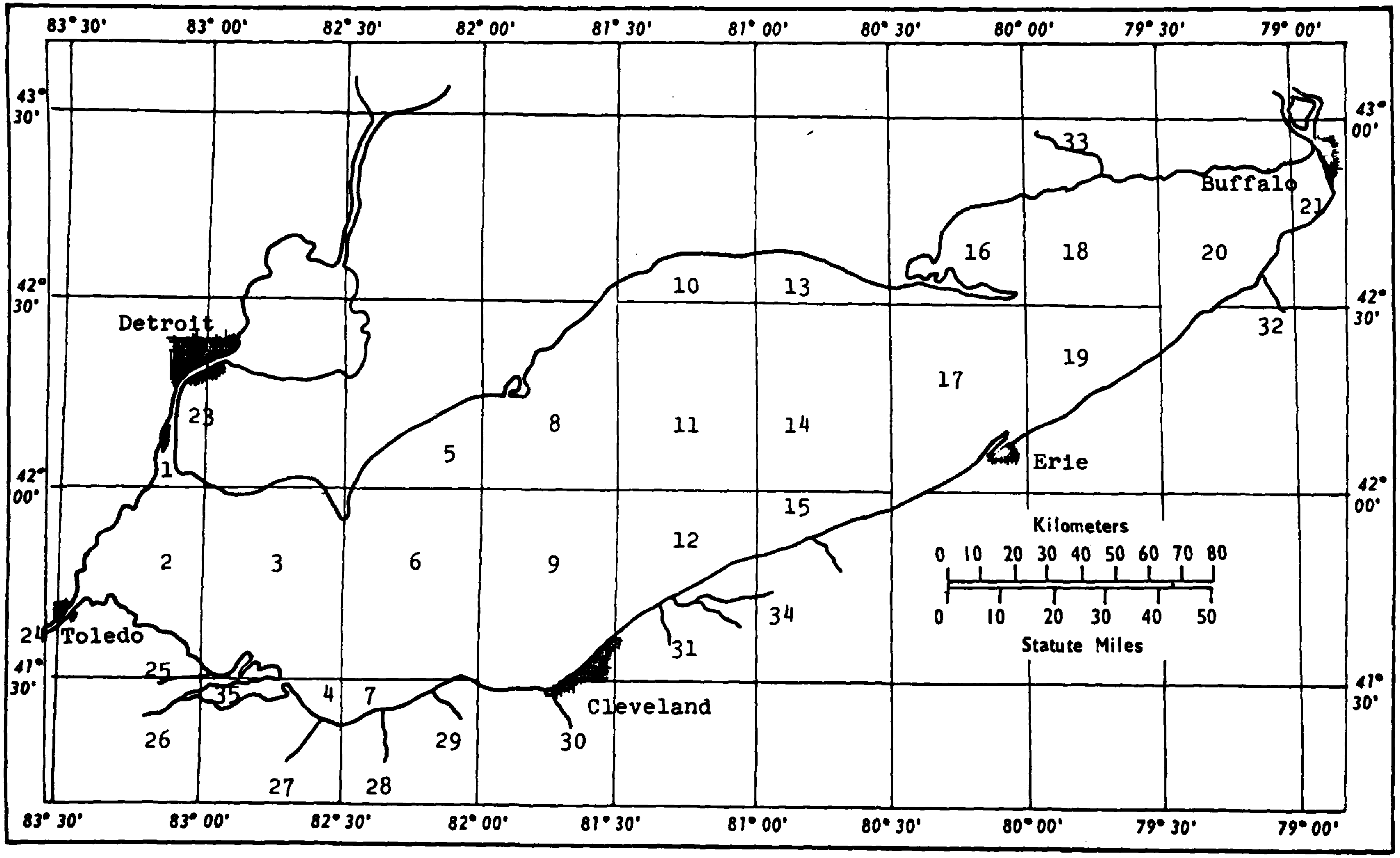
Due to limitations in time, we were unable to secure copies of all the references that may contain information relative to Lake Erie. These have been included in this paper.

## II. SUBJECT INDEX

The number following each, refers to the number of the paper listed in Section III. Lake Erie was divided into twenty-one (21) regions, which are shown in Figure 1. The number twenty-two (22) refers to lake-wide studies; while numbers twenty-three (23) through thirty-four (34) concern specific tributaries to the lake. Thirty-five (35) concerns Sandusky Bay; while thirty-six (36) includes other tributaries.

### A. Study Regions

Figure 1 - MAP OF LAKE ERIE




22 = Lakewide 36 = Other Tributaries

KEY TO FIGURE 1

| # | Numerical | # | Alphabetical |
|---|---|---|---|
| 1 - 21 | Quadrants in Lake Erie | 29 | Black River |
| 22 | Lakewide | 32 | Cattaraugus River |
| 23 | Detroit River | 31 | Chagrin River |
| 24 | Maumee River | 30 | Cuyahoga River |
| 25 | Portage River | 23 | Detroit River |
| 26 | Sandusky River | 34 | Grand River (Ohio) |
| 27 | Huron River | 33 | Grand River (Ontario) |
| 28 | Vermilion River | 27 | Huron River |
| 29 | Black River | 22 | Lakewide |
| 30 | Cuyahoga River | 24 | Maumee River |
| 31 | Chagrin River | 25 | Portage River |
| 32 | Cattaraugus River | 35 | Sandusky Bay |
| 33 | Grand River (Ontario) | 26 | Sandusky River |
| 34 | Grand River (Ohio) | 28 | Vermilion River |
| 35 | Sandusky Bay | | |
| 36 | Other Tributaries | | |

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Air-Sea - Waves - 18, 29, 59, 71, 127, 132, 142, 153, 155, 156, 157, 194, 206, 227, 237, 252, 276, 277, 278, 298, 301, 302, 303, 307, 321, 341, 348, 349, 372, 392, 393, 397, 406, 407, 417, 418, 427, 428, 431, 445, 457, 460, 480, 484, 487, 493, 496, 498, 505, 525, 534, 542, 564, 569, 581, 582, 583, 602, 629, 645, 648, 654, 662, 667, 728, 732, 733, 736, 737, 740, 751, 753, 757, 759, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 776, 777, 778, 779, 781, 783, 785, 789, 792, 794, 795, 798, 809, 815, 816, 819, 835, 858, 901

Air-Sea - Wind Stress - 3, 51, 53, 76, 86, 127, 141, 163, 174, 186, 194, 247, 248, 250, 251, 258, 259, 307, 312, 316, 321, 324, 343, 348, 351, 391, 392, 393, 397, 418, 432, 465, 484, 486, 494, 533, 534, 558, 559, 581, 585, 587, 589, 595, 607, 620, 635, 636, 647, 656, 729, 733, 735, 736, 738, 740, 741, 751, 760, 762, 767, 776, 777, 778, 779, 786, 795, 815, 816, 835, 839, 897, 898, 902, 906

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Bottom and Shore - Age - 25, 63, 70, 99, 112, 116, 117, 118, 119, 120, 121, 122, 123, 128, 148, 149, 152, 177, 210, 213, 214, 215, 216, 228, 242, 254, 255, 256, 261, 262, 263, 329, 336, 337, 339, 340, 341, 346, 348, 351, 371, 391, 397, 407, 412, 422, 430, 437, 444, 445, 447, 450, 451, 452, 453, 454, 457, 496, 507, 508, 509, 510, 514, 545, 564, 584, 597, 599, 653, 676, 677, 684, 687, 694, 704, 713, 716, 723, 726, 816, 835, 851, 852, 866, 876, 893, 894, 907, 921

## C. TECHNIQUES and INSTRUMENTATION

## III. ABSTRACTS

1. Abbe, C. 1898. The rainfall and outflow of the Great Lakes. Mon. Wea. Rev. 26(4):164-166.

A study of the rainfall over the Great Lakes, the variations in the surface levels, and the eventual discharge at the respective outlets. Lake Erie, with an outflow of 250,000 cu.ft./sec., has an inflow of 227.5 inches, giving a surplus of 263.5 inches in depth. Compared to the measured outflow, the computed outflow was 30 per cent less, approximately the same error found in the calculations for the other Great Lakes. (BECPL)

2. Abbe, Cleveland. 1898. Waterspouts on the lakes. Mon. Wea. Rev. 26(8):364.

Description of waterspouts observed from conception to death near Astabula, Ohio. The Great Lakes are subject to waterspouts fairly often. (BECPL)

3. Abbe, Cleveland. 1900. Influence of the wind and of rhythmic gusts on the level of Lake Erie. Mon. Wea. Rev. 28(3):112.

Heavy westerly winds force the water through the channels between the islands and into the main body of the lakes, causing a lowering of the water level at the head of the lake and a corresponding rise at Buffalo. The change of level at Cleveland is generally less than one foot, showing that the wind effect is mostly at the two ends of the lake. Atmospheric pressure also affects the water level. (BECPL)

Abbott, William L. - See: Clifford Risley, No. 623.

4. Abram, S., D. Astry, R. Macer, K. Seckinger and J. Jones. 1969. Water quality of Lake Erie and its tributary streams in western New York. Lake Erie Environmental Studies. New York State University College at Fredonia. Tech. Data Rept. 1. 37 p.

The data in this study on water quality is plotted and analyzed graphically for Cattaraugus, Silver, Walnut, Canadaway, Little Canadaway, Walker, and Chautauqua Creeks and Crooked Brook.

5. Acres Consulting Services, Ltd. 1972. Evaluation of procedures for removing and decontaminating bottom sediments in the lower Great Lakes. Canada Centre for Inland Waters. Burlington, Ont. 132 p.

This report investigates the feasibility, effectiveness, and costs of removal and/or decontamination of contaminated bottom sediments in the lower Great Lakes. Two examples of problems in the Great Lakes currently receiving widespread attention that are briefly described are mercury and phosphorus contaminated sediments. A total of 30 examples of previous experiences related to environmental problems with sediments, or where sediment treatment formed a potential solution, are described in detail. (CCIW)

Addis, James T. - See: N. Wilson Britt, No. 67.

Addis, James T. - See: N. Wilson Britt, et al, No. 68.

Alden, Jon C. - See: Daniel G. Bardarik, et al, No. 30.

6. Allee, P.A., T.B. Harris and R. Proulx. 1970. Atmospheric constituents near Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 779-789.

During the fall seasons of 1968 and 1969 an ESSA Research Flight Facility DC-6 aircraft probed the atmosphere above and in the vicinity of Lake Erie. Various meteorological conditions were investigated, although special emphasis was placed upon those days when the lake effect snowstorms were present. Among the parameters measured during these flights were the concentration of Aitken nuclei, cloud droplet condensation nuclei, and ice nuclei. On specific fair weather flights in the vicinity of Buffalo, New York, additional measurements were made of the concentration of carbon dioxide, oxidant, reductant, and ozone. Local anthropogenic contributions to the concentration of these atmospheric constituents can be detected, and measured, and some observations suggest possible effects upon the weather.

Allen, H.E. - See: J.R. Kramer, et al, No. 413.

Anders, H.K. - See: L.J. Walters, et al, No. 882.

7. Anderson, B.G. 1948. The apparent thresholds of toxicity to Daphnia magna for chlorides of various metals when added to Lake Erie water. Trans. Am. Fish Soc. 78:96-113.

The apparent threshold concentrations of toxicity to Daphnia magna are presented for 25 cations when added to Lake Erie water. In general, the Daphnia and related forms are more susceptible to cations than are fish. In light of this, the maximum safe concentrations in which wastes may be permitted to enter natural waters should not exceed the threshold concentrations discussed. (BU)

Anderson, D.V. - See: J.P. Bruce, et al, No. 78.

8. Anderson, D.V. 1961. A note on the morphology of the basins of the Great Lakes. J. Fish Res. Board Canada. 18(2):273-277.

Neuman (1959) has suggested the elliptic sinusoid as a model for an average lake. Area-depth curves for the Great Lakes are compared with the corresponding curves given by the Neumann model which, it is suggested, should be useful in idealized calculations on a lake. The assumed elliptic sinusoid model is shown to be good for Michigan, Huron, Ontario, and Georgian Bay but poor for Superior and Erie.

9. Anderson, D.V. 1964. Geophysical research on the Great Lakes. Ont. Dept. Lands and Forests. Tech. Ser. Res. Rept. 55. 39 p.

A proposal for specific observational work for the west basin of Lake Erie is included in this report.

10. Anderson, D.V. and G.K. Rogers. 1964. Lake Erie: Recent observations on some of its physical and chemical properties. Ont. Dept. Lands and Forests. Res. Branch. Res. Rept. 54. Pt. 1. pp. 1-66.

This report presents charts showing the temperature of Lake Erie in the summer of 1955, and in the summer and fall of 1960. Measurements of water temperature from 1955 to 1959 at Wheatley, Ontario are included as well.

Anderson, R.C. - See: L. Horberg, No. 336.

Anderson, T.W. - See: C.F.M. Lewis, et al, No. 457.

11. Andrews, T.F. 1948. Temporary changes of certain limnological conditions in Western Lake Erie produced by a windstorm. Ecology. 29(4):501-505.

The after effects of a northeast April windstorm on certain conditions in two limnologically distinct bodies of water in Western Lake Erie are present. Limnological changes that were recorded are wind velocity, lake level, horizontal variations in turbidity, seston and temperature, and the horizontal variations in abundance of *Cyclops* and *Diatomus*. It was discovered that the windstorm deflected the turbid discharge of the Maumee River and the usual trends in turbidity, seston and abundance of *Cyclops* and *Diatomus* were reversed by the windstorm with the exception of the usual temperature changes. (BU)

12. Andrews, Ted F. 1953. Seasonal variations in relative abundance of *Cyclops vernalis* Fischer, *Cyclops bicuspidatus* Claus, and *Mesocyclops leuckarti* (Claus) in Western Lake Erie from July 1946 to May 1948. Ohio J. Sci. 53(2):91-100.

Seasonal variations in mean water temperatures are presented and the durations of ice covers are indicated. (BU)

Angelo, A. - See: D. L. Harris, No. 299.

13. Anonymous. 1904. South shore of Lake Erie. In: F. Severance (Ed.), Publications of the Buffalo Historical Society. Buffalo Historical Soc. Buffalo, N.Y. 7:365-376.

Reprint of a journal of a survey made in 1789 on Lake Erie's South shore and tributaries. Each day, from Fort Erie to Detroit (June 28 to August 1) an entry indicating general weather conditions, location, soundings, and general description of the geomorphology of each area visited was made. Included are sketches of Presque Isle (with soundings), Point Eleno, and Eastern Lake Erie. (LO)

14. Anonymous. 1968. Federal grant to help restore Cleveland beaches. Civil Eng. 38(6):85.

Cleveland, Ohio has received a grant to restore beaches polluted largely by overflows of combined sewers and to expand recreational opportunities for the area. Control and treatment methods to be used in this project include: experimental use of polymers to reduce overflows from the combined sewers by increasing the flow-carrying capacity of interceptor sewers; hypochlorination of the major overflows and creek water entering Lake Erie; implementation of a sewer-flushing program during dry weather to reduce the discharge of solids when it rains; and screening of overflows and streams. (SE)

15. Anonymous. 1969. Lake Erie will be a little bit cleaner. Am. City. 84(11):14.

$1.31 million dollar secondary sewage treatment facilities built at Tiffin, Ohio, on the Sandusky River is described. (BU)

16. Anonymous. 1970. Applies existing technology for a cleaner Lake Erie. Am. City. 85(4):18.

The Detroit Metropolitan Water Service is putting existing technology into effect to help decelerate the aging of Lake Erie. Proposed programs include: solids reduction by addition of mechanisms to the regional waste water plant, coliform removal through chlorination, phosphate reduction using pickle liquor from steel mills, waste oil and grease removal using oil skimmers, construction of phenol-removing systems, and installation of smokestack air cleaners to prevent air pollution. A monitoring system to reduce stormwater overflows is also being built to warn of approaching rainfall, thus allowing sewers to be pumped before the storm. (BU)

17. Anonymous. 1971. You don't necessarily need aerobes. Am. City. 86(4):61-62.

Discussion of the studies for the liquid waste treatment plant in Rocky River, Ohio, that utilizes granular carbon filters to reduce suspended solids content to 50 mg/l. (BU)

18. Anonymous. 1973. Fighting the shoreline erosion battle. Limnos. 5(4):25-31.

This article contains a very general discussion of erosion in the Great Lakes shore areas. The role of waves, variations of lake levels and their causes, and shoreline problems are included. On Lake Erie, these factors contribute to a seasonal variation of 1.5 feet. The article predicts that the lake level for April 1974 will be 1 foot lower than the level for April 1973.

Anthony, E. H. - See: F. R. Hayes, No. 311.

Applegate, V. C. - See: J. F. Carr, et al, No. 125.

19. Archer, R. J. and A. M. La Sala. 1968. A reconnaissance of stream sediment in the Erie-Niagara Basin, New York. N.Y. Cons. Dept. Water Resources Comm. Basin Planning Rept. ENB-5. 34 p.

Measured instantaneous sediment discharge for Cattaraugus Creek at Gowanda is in the order of 610,000 tons per year. Peak suspended-sediment concentrations in the range of 2,600 to

5,300 (ppm) were observed at three stations in the Cattaraugus Creek Basin, as well as at Buffalo, Cazenovia, and Cayuga Creeks. Included in the report is data on drainage, deposition, sediment characteristics, and the discharge of the sediment.

20. Archer, R. J., A. M. La Sala and J. C. Kammerer. 1968. Chemical quality of streams in the Erie-Niagara Basin, New York. N.Y. Cons. Dept. Water Resources Comm. Basin Planning Rept. ENB-4. 104 p.

The report contains chemical analyses of more than 700 samples collected mainly during 1963 and 1964, of which the Cattaraugus Creek is included, and also samples of precipitation and overland flow. Utilizing these data, maps and graphs show significant regional and time variations in the natural water quality.

21. Arnold, D. E. 1969. Ecological decline of Lake Erie. N.Y. Fish and Game J. 16(1): 45 p.

Changes in Lake Erie due to natural processes and the activities of man are discussed with respect to geology, hydrology, pollution, chemistry, plankton, benthos and fisheries. In all of these areas, it is shown that many changes have taken place and that the rate of change has accelerated in recent years. Most of these changes are harmful to the lake's value as a resource for man and as a habitat for its natural fauna. Several proposed ideas for reversing this trend are reviewed.

22. Arnold, D. E. 1971. Lake Erie alive but changing. Conservationist. Dec.-Jan. 1970-71. pp. 23-30, 36.

A brief mention of the history of geologic and physical change of Lake Erie in regard to sedimentation and the effects on the environment.

Astry, D. - See: S. Abram, et al, No. 4.

23. Atwater, Caleb. 1826. Facts and remarks relating to the climate, diseases, geology and organized remains of parts of the state of Ohio. Am. J. Sci. and Arts. 11(2):224-231.

General survey of Ohio and mention of deposition of rocks by icebergs in the glacial times in the vicinity of Lake Erie. Explanation as to the origin of rock type is given for the

local vicinity.

Ayers, J. C. - See: C. F. Powers, et al, No. 596.

24. Ayers, John C. 1960. Status and programs. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:61-74.

A discussion of the 1959 pilot study of the usefulness of collateral data in studies on Lake Erie. Not all the data sources are representative of open lake water, due to local runoff from tributary streams into Lake Erie. A current pattern study was initiated to determine open water parameters that are representative. Comparison of alkilinity values from the Bass Island area and from Lorain , Ohio, was made from September 1938 to December 1945. Also included is a brief discussion and graphical data on turbidity in the Island area and Lorain and also on water levels in Lake Erie from the nineteenth century to the present. (RL)

25. Ayers, John C. 1962. Great Lakes waters, their circulation and physical and chemical characteristics. Am. Assoc. Adv. Sci. 71:71-89.

Included in the general discussion of the Great Lakes is direct mention of Lake Erie in regard to lake levels (graph showing reconstructed levels of Lake Erie from 1800 to 1860), regularity of frequency of the Lake Erie seiches, chemical history of Lake Erie and its euthrophication in relationship to the other Lakes. All chemical constituents have been raised in Lake Erie in the past century with the exception of iron and silica which have decreased, which is believed to be the constituents in mineral nutrition of at least some of the phytoplankton. The geological age has been cited as 9,600 years showing Lake Erie to be the oldest and yet for its chemical load, it is not a natural accumulation. Two factors that indicate heavy chemical loading are erosion and increased human population densities in the past century.

26. Bagley, C. T. 1953. Subsurface study of glacial deposits of Cleveland, Ohio. Ohio J. Sci. 53(2):65-71.

The study area considered is 3 miles south of Lake Erie in the valley of the Cuyahoga River. From a number of soil borings in the area, continuous till sheets alternating with lacustrine clay beds are identified. Glacial streams and high-level stages of the post-glacial lakes are discussed. (SE)

27. Bajorunas, L. 1963. Natural regulation of the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:183-190.

The water level in the Great Lakes changes very gradually and the outflow is extremely uniform despite the large variation in water supply and the inflow or outflow corrections by man. Methods and equations are presented to evaluate that natural adjustment of lake levels and outflows. Two examples are shown. In the first example, the effects are computed from an imaginary man-made change in inflow, and the second example evaluates the effects of ice-jamming in one of the rivers.

28. Baker, David B. and Jack W. Kramer. 1973. Phosphorus sources and transport in an agricultural river basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 858-871.

The mean annual export of total phosphorus (as P) from a 3237 sq km (1251 sq mi) portion of the Sandusky River Basin was determined to be 454 metric tons (500 short tons). Annual point source inputs of phosphorus within the study area were observed to be 118 metric tons (130 short tons). Assuming all point source phosphorus leaves the system, a minimum diffuse source component of the output would be 336 metric tons (370 short tons) or 74% of the total output. This represents a diffuse phosphorus loading coefficient of 103 kg/yr/sq km (591 lb/yr/sq mi), a value 2.4 times as large as the 44 kg/yr/sq km (250 lb/yr/sq mi) which is used to calculate rural runoff in much of the Lake Erie Basin. During 1972, a year of high runoff, in excess of 980 metric tons (1078 short tons) of phosphorus moved out of the study area.

It is suggested that the diffuse source loading coefficient represents a eutrophication index related to land use in the study area. The reduction of phosphorus loading into Lake Erie from diffuse sources will require comprehensive land use planning and implementation. Reduced values for the diffuse phosphorus loading coefficient, corrected for annual variations in runoff, would provide a measure of progress towards less eutrophic land use management in the basin.

Baker, Robert F. - See: Robert Chieruzzi, No. 142.

Ball, Robert C. - See: James J. Roosen, No. 632.

29. Barbalas, L. X. 1973. Great Lakes Research Project Forecasts Directory - 1973. NOAA. Lakes Survey Center. Tech. Memo. NOS LSC D 5. 280 p.

This directory was compiled from information received through April 1973. The project names that are pertinent to the physical aspects are as follows: 1) Chemical and Sediment Movement from Agricultural Land into Lake Erie, 2) Development of a Thermal Model of Lake Erie, 3) An Ecological Evaluation of a Thermal Discharge, 4) Environmental Investigations of a Potential Power Plant Site on Sandusky Bay, 5) Geobiology of Heavy Metals in the Sediment-Water Interface Zone in Lake Erie, 6) Lake Erie Jetport Project, 7) Optical Instrumentation for Water Diagnosis with Applications to Lake Erie, 8) Palynological Investigations of Western Lake Erie Sediments, and 9) Transfer of Heavy Metal Pollutants from Lake Erie Bottom Sediments to the Overlying Lake Water.

Project dates, summaries, chief scientists were included in the report.

30. Bardarik, Daniel G., Jon C. Alden, Robert L. Shema and Albert R. Kupiec. 1971. A study of the effects of heated discharges on the ecology of Presque Isle Bay, Erie, Pennsylvania - interim report. Environmental Sciences Inc. Pittsburg, Pa. 235 p.

The factors affecting the distribution and dissipation of the heated water discharge from Front Street Station into Presque Isle Bay are wind direction and velocity, relative humidity, ambient air temperature, and gross generated megawatt hours.

Under the most unfavorable conditions, the maximum observed increase in surface water temperature was 16 degrees F above ambient beyond the harbor line. Under the most favorable conditions, surface water temperatures rarely exceeded ambient water temperature outside the confines of the boat basin. Water quality in Presque Isle is influenced by numerous treated and untreated municipal and industrial waste discharges, and these are cited in the report. Included in the appendix (178 p.) is the data collected from May to September 1971 pertinent to the study.

31. Barrientos, Celso S. 1971. An objective method for forecasting winds over Lake Erie and Lake Ontario. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 401-411.

An objective method for forecasting surface winds over Lake Erie and Lake Ontario is presented. The developmental data consisted of 1000-mb geostrophic wind and sea-level pressure forecasts from the Subsynoptic Advection Model for eight United States cities near the two lakes, as well as marine observations made by anemometer-equipped vessels during the 1968 boating season. Two sets of regression equations for forecasting wind speed were derived by applying screening regression. The first yields wind speed by vectorial addition of two directional components; the second yields wind speed directly. Comparison of the two methods further verifies that wind speed forecasts made by combining components are negatively biased. The resulting operational program is described, and verifications based on the 1969 observations are discussed.

Baulne, G. W. - See: J. R. Kramer, et al, No. 413.

32. Beall, R. M. 1968. Storage required to maintain flows. Erie-Niagara Basin Surface Water. N. Y. Cons. Dept. Water Resources Comm. Basin Planning Rept. ENB-2. pp. 86-105.

Water requirements that exceed naturally occurring minimum streamflows may be met by providing surface storage. Maximum utilization at any site in the Erie-Niagara Basin can be achieved only if excess runoff is stored for later release during low-flow periods. The aim is to provide storage-yield relations based on readily determined streamflow characteristics and related to probability of deficiency or failure. Mention is made of Cattaraugus Creek and other regional streams.

33. Beaver, William C. 1942. Bacterial activity in the sub-aquatic soils of Lake Erie. Ohio J. Sci. 42(3):91-98.

During the summers of 1939 and 1940, a bacteriological study was made of the bottom soils of Lake Erie and its tributaries. Numerous samples were taken in different regions in order to study the role of micro-organisms in various physico-chemical phenomena. (SE)

Beeton, A. M. - See: J. E. Gannon, No. 246.

34. Beeton, A. M. 1960. Environmental changes in Lake Erie. Trans. Am. Fish. Soc. 90(2):153-159.

Comparison of data compiled over the past 60 years with those of the author show the various changes that have occurred in Lake Erie. Among the parameters that are mentioned are those concerning transparency and temperature (The mean annual water temperatures are shown to be 2°F warmer during the study than during the 1918-1928 period.).

35. Beeton, Alfred M. 1960. Great Lakes limnological investigations. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:123-128.

Discussion of the status of Lake Erie and the acceleration of eutrophication in the Erie Basin are presented. Change in the water quality, with reference to oxygen and temperature, is presented and data is also provided on other chemical qualities. (RL)

36. Beeton, A. M. 1962. Light penetration in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Pub. 9:68-76.

Measurements have been made of incident and subsurface light intensities at several depths in Lakes Erie, Michigan, Huron, Ontario, and Superior. At least one study was made of the special distribution of ambient irradiance in each of the lakes. Blue light penetrated to the greatest depth in Lake Huron, green in Lakes Superior and Michigan, and orange in Lakes Erie and Ontario. Measurements were made of the changes in light intensities at several depths from sunrise to sunset in Lake Erie, Lake Michigan, and Frains Lake--a small inland lake. The percentage of incident irradiance at depth was greatest at sunrise and sunset in Lake Erie and Frains Lake. This situation occurs since incident irradiance is shifted towards the red end of the spectrum at sunrise and sunset. Consequently, a greater percentage of the incident light was in the orange region of the spectrum that penetrates deepest in these lakes. Shorter wave lengths penetrate to greater depths in Lake Michigan.

37. Beeton, A. M. 1963. Limnological survey of Lake Erie, 1959 and 1960. Great Lakes Fish. Comm. Tech. Rept. 6. 32 p.

Federal, provincial, state, and university organizations participated in cooperative limnological surveys of Lake Erie in September 1959 and August 1960 to determine the extent and severity of the low dissolved-oxygen content of the hypolimnetic waters. Observations were restricted to the central basin in 1959, but were lake-wide in 1960. Approximately

70 percent of the bottom waters of the central basin had a serious oxygen deficiency during both years. Data were obtained also on the distribution of temperature, transparency, specific conductance, pH, and phenolphthalein and total alkalinity. The distributions of the chemical values are discussed in terms of their relationships to each other, and to thermal stratification, river outflow, lake morphometry, and lake currents.

38. Beeton, A. M. 1965. Eutrophication of the St. Lawrence Great Lakes. Limnology and Oceanography. 10:240-254.

On the basis of morphology of the lake basin (mean depth 17.7 m), transparency (low), total dissolved solids (high), specific conductance (high), and dissolved oxygen content of the water (low), Lake Erie is classified as eutrophic. Total dissolved solids in the lake have increased by almost 50 ppm during the past 50 years. (BU)

39. Beeton, Alfred M. and David C. Chandler. 1963. The St. Lawrence Great Lakes. In: D. G. Frey (Ed.), Limnology in North America. Univ. Wisc. Press. Madison, Wisc. pp. 535-558.

This report deals with the Great Lakes in general and references to Lake Erie are made throughout the report. Among the topics discussed are as follows: general data on the physiography and bathymetry of Lake Erie, general data on discharge, relationships of onshore processes to open lake conditions, bedrock, wind set-up and seiches, ice conditions, thermal stratification, chemical data on the lake, history of limnological research from pre-1900 to the time of the report and the activities of representative agencies concerned.

40. Beeton, A. M., J. W. Moffett and D. C. Parker. 1969. Comparison of thermal data from airborne and vessel surveys of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 513-528.

A study of the applications of airborne infrared equipment for detecting water masses and currents of the Great Lakes is described. Infrared scanners were used to make thermal strip maps and an infrared radiometer was used to obtain surface temperatures of the western end of Lake Erie and the lower Detroit River. Simultaneously, surface water temperatures were taken and water samples were collected for chloride

determinations from four vessels making a 4 day synoptic survey of the test area. The remote infrared measurements are compared with shipboard temperature data to evaluate their usefulness in demonstrating thermal structure, water masses, and currents in the test area.

41. Beeton, A. M. and H. B. Rosenberg. 1968. Studies and research needed in regulation of the Great Lakes. In: Proceedings of the Great Lakes Water Resources Conference, June 24-26. Eng. Inst. Canada. Toronto, Ont. pp. 311-342.

Proposal of flow regulation along the western shore of Lake Erie from the Detroit River inflow to improve the water quality in this area. Paper discusses the marshes in Western Lake Erie and the effects that water levels has upon the ecology in this area.

42. Beier, C. J. 1972. A submersible automatic dissolved oxygen-temperature monitoring system. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. 182 p.

In July of 1970, five submersible monitors were moored in the Central Basin hypolimnion of Lake Erie. The monitors' function was to measure and record simultaneously both water temperature and dissolved oxygen at each of five Central Basin locations. The monitors proved to be both durable as well as reliable, having provided continuous data for a period of fifty days, during which any changes in either of the parameters were documented as they occurred in the hypolimnion. Preliminary evaluation of these data strongly suggests that they will materially aid limnologists in not only defining depletion rates, but will serve as a guide in explaining the cause and mechanics of deoxygenation in the Central Basin hypolimnion.

Benninghoff, W. S. - See: Anne L. Stevenson, No. 695.

43. Benson, R. H. and H. C. MacDonald. 1962. Preliminary report on Ostracodes from Lake Erie and their stratigraphic implications. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9:140-149.

Ten cores, collected by personnel on C.M.S. Porte Dauphine from the central and eastern basins of Lake Erie, were examined for ostracodes at the University of Kansas. The cores varied in length from several inches to 35 ft. The ostracodes present suggest changes in the lake's thermal history from colder to warmer conditions and differential rates of sedimentation. Analyses of valve shapes and muscle scar patterns of predominantly cypridacean Ostracoda indicate the presence of at least ten species. Of these species three are new, and seven have been described from living forms. One cold-water species appears to be nearing extinction.

The ostracodes were found in abundance throughout most of the length of the cores, generally in a ratio of 20 to 1 compared with the occurrence of pelecypod and gastropod shells. One ostracode species, previously described from Pleistocene peri-glacial lakes and ponds of Kansas, has been found to be diminishing in abundance from the bottom to the top of the cores. This seems to indicate a progressive warming. The initial stages of lake formation are not indicated and are believed to lie beneath the sediments studied.

The shorter cores obtained from the southern edge of the lake contain relic, shallow, colder-water sediments. The longest core (35 ft), obtained from the deepest part of the lake off Long Point, seems to have penetrated only the later stages of lake formation. The ostracode fauna of this core contains one species previously found in semi-euxinic waters. Longer cores from this area should contain ostracode faunas representing the early stages of lake formation.

44. Berg, Clifford O. 1966. Middle Atlantic States. In: David G. Frey (Ed.), Limnology in North America. Univ. Wisc. Press. Madison, Wisc. pp. 191-237.

Regional discussion with brief references to Lake Erie mentioning weather influences and chemical data.

45. Berg, D. W. 1965. Factors affecting beach nourishment requirements at Presque Isle Peninsula, Erie, Pennsylvania. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:214-221.

Analysis of available data on Presque Islc Peninsula, Erie, Pennsylvania, indicates apparent correlation of initial high erosion rates of placed beach fill with sand size characteristics of the fill and the mean level of Lake Erie for the period over which measured losses occur. Although erosion of the fill has been more than anticipated, the data indicate that nourishment requirements for replenishing the beaches, should decrease as the beach profiles become readjusted through selective sorting of the fill material to incident wave forces reaching the peninsula.

46. Berg, D. W. and D. B. Duane. 1968. Effect of particle size and distribution in stability of artificially filled beach, Presque Isle Peninsula, Pennsylvania. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 161-178.

Presque Isle Peninsula, a sandy spit on the south shore of Lake Erie, has experienced continued erosion of its lakeside shoreline ever since first attempts to stabilize and halt its natural eastward migration. For nearly 150 years numerous structures have been built on the shoreline in attempts to slow down or halt the deterioration and migration of the Peninsula and consequent loss of valuable land.

In 1965, approximately $1.27 \times 10^4$ cu m of sand fill, coarser than fill previously used as well as coarser than that which naturally existed on the Peninsula, was placed on a section of the beach; subsequently annual data collection surveys were made in the fill area and in adjacent parts of the Peninsula.

Analysis of the data indicate the test area involving coarse sand fill has undergone minimal material loss and maintained a relatively stable profile. On the basis of this experiment it is judged that definite shore stabilization occurs, with attendant benefits such as substantially reduced nourishment requirements, from the utilization of sand fill that has size characteristics superior to that originally found on an eroding beach.

Berry, G. T. - See: J. B. Bryce, No. 85.

47. Berst, A. H. and H. R. McCrimmon. 1966. Comparative summer limnology of Inner Long Point Bay, Lake Erie, and its major tributary. J. Fish. Res. Board Canada. 23(2):275-291.

Long Point Bay, on the northern shore of Lake Erie, is 28.2 sq mi in area, with a maximum depth of approximately 10 ft. Big Creek, the major tributary, drains a watershed of 317 sq mi and discharges 4700 million cu ft of water into the bay annually. Summer water temperatures in the creek and the bay were positively correlated with air temperatures in 1962. The water in the bay was subject to considerable seiche action. Levels of nutrients and suspended materials were characteristically higher in the creek region than in the bay. Gross reductions in levels of turbidity, total dissolved solids, nitrates and phosphates occurred in the lower section of Big Creek and the adjacent area of the bay. The path of Big Creek discharge through the bay to Lake Erie was defined by an analysis of total dissolved solids and soil phosphate data. (SM)

Berti, A. A. - See: C. F. M. Lewis, et al, No. 457.

48. Bierly, Eugene W. and E. Wendell Hewson. 1963. Atmospheric diffusion studies near a lake shore. J. Applied Meteor. 2(3):390-396.

Experiments designed to measure atmospheric diffusion in transitional states have been carried out for several years over the western end of Lake Erie. The concept of diffusion in transitional states, both in general and for such a shoreline location, is described. The methods of data analysis which have been used are explained and their advantages and limitations outlined. Results of the experiments are presented in terms of Sutton's parameters n, $C_z$ and $C_y$. Values of $C_y$ are generally larger than those which have been measured over more uniform sites. One experiment is described in detail to illustrate diffusion in a transitional state which was due to the advection of warm air aloft.

49. Biggs, W. Gale and Maurice E. Graves. 1962. A lake breeze index. J. Applied Meteor. 1:474-480.

Since the mathematical equations describing the lake breeze phenomenon are too complex to yield exact solutions, approximation techniques are often used. To obtain the important parameters upon which the solutions depend, a dimensional analysis is then employed. The study shows that two dimensionless parameters describe the balance of forces that distinguish between lake breeze days and non-lake breeze days. A lake breeze index is established and a critical value is found. If a narrow transition zone is recognized, then the lake breeze index has an accuracy of 97 per cent.

50. Bigsby, J. J. and J. Delafield. 1922. Notices of the sulphate of strontian of Lake Erie and Detroit River. Am. J. Sci. 4(9):279-282.

Samples of sulphate of strontian taken from an island near Put-in-Bay are described as to physical characteristics (mineralogy) and occurrence. Some foliated celestine also occurs on this island and numerous adjacent islands as well as at Sandusky Bay and near the Detroit River. (BECPL)

51. Blanton, J. O. and A. R. Winklhofer. 1971. Circulation of hypolimnion water in the central basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 788-798.

Hypolimnion water temperature and currents were monitored in the central basin of Lake Erie. A semi-permanent tilt to the thermocline was clearly associated with the dominant southwest winds. The thermocline was shallowest along the Canadian coast.

Fluctuations in the southwest wind component correlated with fluctuations in thermocline positions and with current speeds in the hypolimnion. Peak southwest winds caused increased flow of hypolimnion water toward the Canadian coast.

Coastal upwelling regions whose areal extent have been well documented can account for a large portion of the net flow toward the Canadian coast. We estimate that about $4 \times 10^3$ cu m/sec of hypolimnion water can be transported northwestward and upwelled at the coast during typical southwest wind conditions. Only a 200 sq km upwelling area is required to mix this water with epilimnion water.

52. Blanton, J. O. and A. R. Winklhofer. 1972. Physical processes affecting the hypolimnion of the central basin of Lake Erie. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 9-38.

Central Basin water temperature, currents, wind, and hypolimnion dissolved oxygen were monitored in situ as part of "Project Hypo". A semi-permanent tilt of the thermocline was clearly associated with the dominant southwest winds. The thermocline was shallowest along the Canadian shore. Fluctuations in the southwest wind component correlated with fluctuations in thermocline position and with maximum current speeds in the hypolimnion. Peak southwest winds caused increased flow of hypolimnion water toward the Canadian coast. Eastern Basin inflow to the Central Basin and hypolimnion outflow in upwelling zones cannot account entirely for the measured hypolimnion volume fluctuations that were attributed to vertical entrainment. Periods of low wind energy, followed by brief periods of high wind energy coincided with hypolimnion volume increases.

The average hypolimnion dissolved oxygen depletion rate, from four in situ monitors, was 3.3 mg $l^{-1}$ $month^{-1}$. The measured dissolved oxygen fluctuations were related to water movements, and fluctuations solely attributable to the presence of algae were not detected.

53. Blust, F. A. 1963. The water levels of Lake Erie. Inland Seas. 19(1):27-29.

Based on monthly average levels, the average seasonal rise and fall of Lake Erie has been about 1.6 feet. The maximum seasonal increase occurred in 1947 when the lake rose 2.75 feet between March and June. The maximum seasonal decline occurred between April 1930 and March 1931 when the lake fell 3.17 feet. (BU)

Boesel, M. W. - See: V. E. Shelford, No. 655.

54. Bolsenga, S. J. 1967. Great Lakes snow depth probability charts and tables. Corps of Engineers. Great Lakes Res. Center Rept. 5-2. 43 p.

This report presents the result of snow depth calculations from available data for a network of stations in the Great Lakes. The calculations are presented in tabular and graphic form.

55. Bolsenga, S. J. 1967. Snow depth probability in the Great Lakes Basin. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. Great Lakes Res. pp. 162-170.

Snow depth probability was computed for 45 stations in the Great Lakes basin using data on snow depth at the end of the month. Probability patterns of snow cover, for the basin and for each lake region, are presented using isoline charts, graphs, and tables.

For the basin, probability charts indicate marked increases from the extreme southern to the extreme northern portion of the basin. For each lake region, the probable occurrence of selected depths is analyzed using graphs of probability as a function of station location.

56. Bolsenga, S. J. 1967. Total atmospheric water vapor aloft over the Great Lakes Basin. Corps of Engineers. Great Lakes Res. Center Rept. 5-3. 7 p.

Values of atmospheric water vapor aloft were estimated from surface moisture for 29 stations in the Great Lakes Basin using empirical equations developed at three reporting radiosonde stations. Monthly isoline charts indicate the distri-

bution pattern and quantity of water vapor over the basin.

57. Bonney, T. G. 1891. The origin of the Great Lakes of North America. Nature. 43(1105):203-204.

The conclusion to which these investigations point is that in pre-glacial times the Great Lakes did not yet exist, but their site formed part of a system of river valleys, which ultimately coalesced in one main channel, now concealed beneath the waters of the eastern part of Ontario. Lake Erie, which is less than 84 feet, also exhibits a buried system of ramifying valleys and a line of discharge into Ontario by way of a deep valley, now choked with drift, which can be traced several miles to the west of the present course of the St. Lawrence. (BU)

58. Bouchette, Joseph. 1832. British dominions in North America. Inland Seas. 12(3):212-214.

A description of the Lake Erie Basin during the 1830's including geographical descriptions, tributaries, major settlements, navigation, commerce. (CCIW)

59. Bowman, Richard S. 1953. Sedimentary processes along Lake Erie shore, Sandusky Bay, vicinity of Willow Point. In: H. J. Pincus (Ed.), 1951 Investigations of Lake Erie Shore Erosion. Ohio Dept. Nat. Resources Geol. Surv. Columbus, Ohio. Rept. Invest. 18. pp. 119-138.

Investigations of the sedimentary processes active along Willow Point shore, especially concerning the erosional processes. Included are type and source of sediment deposited on the shore, modes of transportation (especially current transport), and engineering structures offshore modifying direction and rate of waves and current movement. (SM)

60. Boyce, D. 1974. Great Lakes Navigation Center. Mariners Weather Log. 18(1):17-22.

Shore and aerial observations (using Side-Looking Airborne Radar) of the ice cover on the Great Lakes are compiled in the form of ice charts and verbal summaries. This is a very good general report but a SLAR image and its graphic analysis of Lake Erie are included.

Braidech, L. L. - See: C. E. Herdendorf, No. 324.

Braidech, Thomas - See: C. O. Kleveno, et al, No. 398.

61. Braidech, Thomas, P. Gehring and C. O. Kleveno. 1972. Biological studies related to oxygen depletion and nutrient degeneration process in the Lake Erie Central Basin. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 51-70.

This report includes a study of the algal sedimentation processes in the Central Basin in regard to sediment oxygen depletion. Among the other parameters mentioned was light penetration.

62. Braun, E. Ruth and John A. Jones. 1970. Thermal loading in Dunkirk Harbor. Lake Erie Environmental Studies. N. Y. S. Univ. College at Fredonia. Tech. Data Rept. 5. 12 p.

The results of a study comparing Dunkirk Harbor to Barcelona Harbor in terms of effluent, temperature, thermal gradients, and humidity are given. Temperature anomalies of more than $3^{o}$ C were found to exist in Dunkirk Harbor year-round.

63. Bretz, J. Harlen. 1963. Correlation of glacial lake stages in the Huron-Erie and Michigan Basins. J. Geol. 72:618-627.

Since 1915, the Huron-Erie and the Michigan glacial lake levels, with proposed correlations, have had the most attention. Out of these studies have come, since 1951, the two different concepts (Leverett and Taylor) herein considered regarding correlation of the stages. (BL)

64. Brinkhurst, R. O. 1969. Changes in the benthos of Lakes Erie and Ontario. In: R. A. Sweeney (Ed.), Changes in the Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25(1):45-68.

Following the article in the Bulletin is a discussion following Brinkhurst's speech and one of the points of discussion was the study of chironomid species succession with time thru deep core work in the western and central basins of Lake Erie. In the article, there is mention of the distribution of chironomid larvae in Lake Erie which is displayed graphically from samples taken in Lake Erie. It has been found that a number of environmental factors have contributed to the marked difference in species of the chironomid fauna that exist in Lake Erie at this time. It can be concluded that to this time in the article, no work has been done on the geologic succession of the chironomids.

65. Brinkhurst, R. O., A. L. Hamilton and H. B. Herrington. 1968. Components of the bottom fauna of the St. Lawrence, Great Lakes. Univ. Toronto. Great Lakes Inst. No. PR 33. 49 p.

Bottom fauna samples were collected at 60-80 stations in Lakes Erie and Ontario, and in Georgian Bay to determine their distribution. The physical information deals with bathymetric and oxygen saturation maps (2) of the Great Lakes sampled in this report.

Britt, N. Wilson - See: E. J. Skoch, No. 664.

66. Britt, N. Wilson. 1955. Stratification in Western Lake Erie in summer of 1953: Effects on the Hexagenia (Ephemeroptera) population. Ecology. 36(2):239-244.

This particular study incorporates the unusual thermal stratification that occurred in the Western Basin of Lake Erie in 1953. Temperature recordings are listed graphically, plotted against the depth of the particular recording station.

67. Britt, N. Wilson and James T. Addis. 1966. Limnological studies of the Island area of Western Lake Erie 1959-1965. Ohio State Univ. Nat. Resources Inst. Columbus, Ohio. Spec. Rept. 141 p.

This study was to determine what, if any, relationships exist between changing limnological conditions and the sport and commercial fishery. The report summarizes data gathered in the Island region of Western Lake Erie over a span of seven years.

68. Britt, N. Wilson, James T. Addis and Ronald Engel. 1973. Limnological studies of the Island area of Western Lake Erie. Ohio Biol. Surv. Bull. 4(3):1-89.

Analysis was made of data collected at lake stations near Bass Island, Western Island area of Lake Erie, in terms of physical, chemical, and biological limnological parameters. The observations for turbidity, temperature, transparency, pH, and ions present were similar to those of past workers except for observations on the occurrence of periods in which low dissolved oxygen concentrations extended throughout the

Western Basin. From measurable parameters, the upper portions of Lake Erie waters are still of relatively high quality. (CCIW)

69. Britt, N. Wilson, E. J. Skoch and K. R. Smith. 1968. Record low dissolved oxygen in the Island area of Lake Erie. Ohio J. Sci. 68(3):175-179.

The first recorded severe oxygen depletion over an extensive area in the Western Basin of Lake Erie occurred in 1953. Because sampling in the past was done at irregular intervals, it has been difficult to determine the severity, or duration of these low-oxygen conditions. In order to get more reliable data, a program of daily sampling was initiated. From 22 June to 31 August 1966, data were collected daily at a single station south of Rattlesnake Island. Dissolved oxygen near the bottom fluctuated greatly during this time, reaching a low of 0.1 ppm on 1 July, the lowest value ever recorded from this area, and a high of 9.2 ppm on 19 July. Following this, two more periods of low dissolved oxygen occurred, the first of 3.7 ppm on 7 August and the other of 3.0 ppm on 30 August. In each of these cases, the low-oxygen condition was accompanied by an average wind speed of about six knots and an air temperature of about 26$^{o}$ C. In each case the drop in oxygen near the bottom was very rapid. The mean dissolved oxygen near the bottom for the summer was 5.0 ppm (61.6 percent saturation). Statistical analysis indicates a significant relationship between wind speed and dissolved oxygen.

70. Broecker, Wallace S. 1966. Glacial rebound and the deformation of the shorelines of proglacial lakes. J. Geophys. Res. 71(20):4777-4783.

A simple isostatic model explaining the pattern of deformation of the shorelines of proglacial lakes. Rate of glacial retreat before the formation of shoreline can be derived from the curvature of its uplifted portion. Rate calculated in this way for the retreat preceding the formation of Lake Algonquin is 120 km/1000 yr. Implications of the model are discussed. General article of the Great Lakes, with no direct mention of Lake Erie. (BU)

71. Brown, C. J. D., Clarence Clark and Bruce Gleissner. 1938. The size of certain Naiades from Western Lake Erie in relation to shoal exposure. Am. Mid. Nat. 19(3):682-701.

During July and August of 1937, three ecologically distinct habitats were studied in the Island area of Western Lake Erie, in an attempt to correlate, if possible, the limnological factors operating in these habitats with the size of certain mussels living there. (BU)

Brown, R. A. - See: G. E. McVehil, et al, No. 475.

72. Brown, R. A., R. L. Peace and G. E. McVehil. 1967. A study of hydrologic and energy budgets of Lake Erie with emphasis on evaporation measurements. Calspan. Buffalo, N. Y. CAL Rept. No. RM-2342-0-3. 38 p.

The purpose of this internal research project was to conduct a study of the hydrologic and energy budgets, and the water transport characteristics, of Lake Erie. Specific objectives were to review available data on these lake characteristics, to survey possible approaches to more precise determination of the relevant lake properties, and to suggest ways in which new research would most effectively contribute to better knowledge of Lake Erie's physical properties. (CA)

73. Browzin, Boris S. 1962. On classification of rivers in the Great Lakes-St. Lawrence Basin. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:86-92.

A hydrographic description by monthly flow rates of the tributaries of Southern Lake Erie shores is mentioned. Classification by use of the hydrographs as an index can thus describe the rivers, since regional individualities are due to local deviation in climatology.

74. Browzin, Boris S. 1964. Seasonal variations of flow and classification of rivers in the Great Lakes-St. Lawrence Basin. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:179-204.

The seasonal variation of flow is a product of climate as well as the result of local conditions of river basins. The hydrologic type of rivers may be described by the index hydrograph which represents the graph of monthly dimensionless coefficients. The average flow of a particular month for the period of observation divided by the yearly mean flow for the same period represents the monthly dimensionless coefficient. The tributary systems of the Lake Erie Basin are incorporated in this study.

75. Browzin, Boris S. 1966. Annual runoff in the Great Lakes-St. Lawrence Basin. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:203-219.

The annual runoff in the Great Lakes-St. Lawrence Basin, expressed in terms of unit runoff, increases from the southwest to the northeast approximately six times, which is an unusual characteristic of a river basin. The responsible factors, precipitation and its seasonal distribution, as well as mean annual temperature vary considerably but not gradually from the Middle West portion of the basin to the coast of the Atlantic. Frequency analysis based on available data at gaging stations located in various climatic zones of the basin has shown that the frequency distribution of the annual runoff is moderate to low as compared with other basins with similar geographic conditions.

76. Bruce, J. P. 1963. Meteorological factors affecting the freshwater environment. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:140-149.

This paper has reviewed some of the studies concerning the exchanges of matter, heat, and momentum between lakes and the atmosphere. An attempt has also been made to stress the practical importance of a greater knowledge of lake-atmosphere interactions in questions of lake levels, biological environment, ice formation and dissipation, wind set-up and seiches, and so on.

77. Bruce, J. P. 1970. Water pollution and the role of the Canada Centre for Inland Waters. Canadian Geog. J. June. pp. 182-193.

A brief mention of the phosphate in sediment and its relationship to the sediment-water interface is included in this article concerning the Lake Erie Basin.

78. Bruce, J. P., D. V. Anderson and G. K. Rodgers. 1961. Temperature, humidity, and wind profiles over the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7:65-70.

Mean profiles for periods during which winds were steady and the lapse rate in a condition of near neutral stability are given for Lake Erie for two ten-hour periods on September 26 and 27, 1960, and the drag coefficient and shear stress derived from them are also given.

79. Bruce, J. P. and G. K. Rodgers. 1962. Water balance of the Great Lakes system. In: "Great Lakes Basin", Am. Assoc. Adv. Sci. Univ. Toronto. Great Lakes Inst. Tech. Rept. 7. pp. 41-69.

After noting the value of accurate information on the magnitudes of the components of the water balance and their variations in time and space, gross annual water budget figures are presented which indicate that about one-third of the precipitation falling on the whole basin eventually appears as flow in the St. Lawrence River. A short account is given of secular trends in these components on Lake Erie and of the complex interrelationships between these factors through lake water temperatures and the radiation balance. Precipitation falling directly onto the lake surfaces and evaporation from the lakes are considered in more detail. Three methods of estimating amounts of precipitation falling onto the lakes are critically examined. These are water budget determinations, gage networks, and weather radar. Although the last method appears to be potentially most useful, preliminary results with a low-powered, 3-centimeter radar are not encouraging.

80. Brunk, Ivan W. 1961. Changes in the levels of Lakes Michigan and Huron. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7: 71-78.

Ten-year overlapping averages of mean annual levels of the Great Lakes for the period 1860 to 1960 indicate peaks in the levels of most of the lakes in the 1880's and around 1950. The level of Michigan-Huron averaged more than 1.5 ft lower in the 10-year period ending 1955 than in a similar period ending 1887. This study considers the apparent factors associated with this drop in levels, and it is concluded that it is possible that natural and artificial changes in the natural outlet control system of Lake Huron have been responsible for practically all of this observed drop in Michigan-Huron levels in the 68-year period.

A consideration of the water balance of Lake Erie provides a reasonable method of checking the validity of the outflow of Lakes Michigan and Huron, especially since approximately 90 percent of the average net total supply to Lake Erie is provided by their outflow. (RL)

81. Brunk, Ivan W. 1962. Precipitation estimates for the Great Lakes drainage basins. Mon. Wea. Rev. 90(3):79-82.

Precipitation estimates from various sources for the different Great Lakes drainage basins are reviewed. To check the comparative accuracy of the estimates, they are correlated with the net basin supply (runoff) values for each basin. The best correspondence between the net basin supply and precipitation is indicated for the smaller basins, Erie and Ontario, and the poorest for the larger basins, Michigan-Huron and Superior. It appears that reasons for the poorer relationship in the case of the larger basins include the use of calendar-year, rather than water-year, net basin supply and precipitation data, and the use of a varying number instead of a fixed number of stations. (BECPL)

82. Brunk, Ivan W. 1963. Additional evidence of lowering of Lake Michigan-Huron levels. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:191-203.

This is a study of the lake level of Lake Michigan-Huron. References are made to Lake Erie as a comparison.

83. Brunk, Ivan W. 1964. Hydrology of Lakes Erie and Ontario. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:205-216.

A study of the hydrologic characteristics of the Erie and Ontario Basins indicates significant differences. In the Erie Basin only about 1/3 of the precipitation becomes streamflow --apparently the lowest proportion for any of the Great Lakes basins. In the Ontario Basin the streamflow is equivalent to approximately 1/2 of the precipitation. It appears that factors other than climate are responsible for these differences in hydrologic characteristics. There is a large variation among the various river basins which drain into Erie and Ontario, and also in the months of the year, in the percentage of the precipitation which flows into the lakes. The monthly extremes for Erie range from 75% in March to only 8% in September. For Ontario the values are 117% in April and 17% in August. The water area of Lake Erie makes little contribution to the total water supply of the Great Lakes, because the average annual evaporation of approximately 34 inches is about the same as the average annual precipitation on the water surface of the lake. The average monthly evaporation from Lake Erie is largest in October--about 6-1/2 inches.

For Lake Ontario, the apparent average annual evaporation is between 29 and 30 inches.

84. Brunk, Ivan W. 1968. Evaluation of channel changes in St. Clair and Detroit Rivers. Water Resources Res. 4(6):1335-1346.

Extensive improvements for navigation have been made in the St. Clair-Detroit River (SCDR). Channel changes have lowered the level of Lake Michigan-Huron by about 2 feet, bringing about the lowest levels of record in 1964 and 1965. The unrecognized changes in the regimen of the SCDR before 1900 have also resulted in the computation of flows that are much too large. The discharge of Lake Erie and the precipitation in the Erie Basin are used to derive more reasonable estimates of the flow of the SCDR before 1900. The amount of material excavated from channels and the annual differences in reported and computed flow of the SCDR from 1869-1908 are tabulated. Hydrographs show computed flow and Lake Erie flow from 1860-1967. (SE)

Burns, N. M. - See: J. R. Kramer, et al, No. 413.

85. Bryce, J. B. and G. T. Berry. 1968. Lake Erie-Niagara ice boom. Eng. J. 51(2):28-35.

A review and consideration of the Lake Erie ice boom is made. Influence of ice discharge and its effects on the Niagara River shore and power authorities are presented. Construction and engineering aspects of the ice boom are also included as well as the historical account up to the writing of this article. (SE)

86. Buechi, P. J. and R. R. Rumer. 1969. Wind induced circulation pattern in a rotating model of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 406-414.

Experimental studies have been undertaken to determine the effects of a prevailing westerly wind on the circulation patterns in a vertically distorted Froude model of Lake Erie. The studies were performed in a rotating laboratory and a vertical scale of 1:500 and a horizontal scale of 1:200,000 were used in the construction of the model. Wind stresses were simulated using a battery of centrifugal blowers. Preliminary correlation with prototype wind speeds was obtained by measuring water level changes in the eastern end of the model lake and comparing with available prototype field observations for known wind conditions. Motion picture studies, with dyes serving as tracers were used in the collection of data.

87. Burkholder, Paul R. 1960. Distribution of some chemical values in Lake Erie. In: C. J. Fish and Associates (Eds.), Limnological Survey of Eastern and Central Lake Erie 1928-29. U. S. Fish and Wildlife Service. Washington, D. C. Spec. Sci. Rept. Fish. No. 334. pp. 71-109.

Included in this report is a presentation of data concerning nitrogen compounds, dissolved oxygen, carbon dioxide, methyl-orange alkalinity, pH, chloride and turbidity. The relationships are discussed as to sources of discharge and the relationships among the physical parameters that exist.

88. Burns, N. M. and C. Ross. 1972. Oxygen-nutrient relationships within the Central Basin of Lake Erie. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 85-119.

Included in this study were the measured parameters of temperature in the hypolimnion and mesolimnion, their volumes, a study of the heat budget, an example of sequential mesolimnion erosion model, algal sedimentation, and sediment and water interface chemical relationship.

89. Burns, N. M. and C. Ross. 1972. Project Hypo - an introduction. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 1-2.

The introduction gives the reader a topographic description of the Central Basin of Lake Erie and a general breakdown of the sampling stations in the Basin.

90. Burns, N. M. and C. Ross. 1972. Project Hypo - discussion of findings. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 120-126.

Among the major findings of Project Hypo was the volume increase of the hypolimnion due to replenishment of oxygen without causing large changes in observed concentrations in the water and by net movements of water in the hypolimnion. Also, observed temperature increases were determined to be due to the entrainment of warmer surface waters into the hypolimnion.

91. Butler, Gerald W. 1956. Glacial erosion, Kelleys Island and vicinity. Inland Seas. 12(2):125-127.

A brief history of the formation of Kelleys Island in Western Lake Erie. The geology, glacial history, erosion, and topography are included. (CCIW)

92. Caley, J. F. 1940. Geology of the Toronto-Hamilton area, Ontario. Canada Dept. Mines and Resources. Ottawa, Ont. Geol. Surv. Memoir 224. 284 p.

The area of Ontario includes the Grand River. A description of the rocks exposed along its course and a description of the river are presented in a small section. (SM)

93. Caley, J. F. 1946. Paleozoic geology of the Windsor-Sarnia area, Ontario. Canada Dept. Mines and Resources. Ottawa, Ont. Geol. Surv. Memoir 240. 227 p.

The Windsor-Sarnia area comprises all that part of the peninsula of southwestern Ontario between Lakes Huron and Erie. The bedrock geology of the area is studied by means of drill samples as there are few outcrops and the bedrock is concealed by large thicknesses of glacial drift. Topics covered include: stratigraphy, structural geology, economic geology, and the oil and gas wells on Pelee Island. (SM)

94. Callis, C. F. 1968. Analysis of Lake Erie mud samples. Monsanto Co. St. Louis, Mo. 16 p.

Twenty-nine samples of bottom muds from Lake Erie, taken at depths varying from 8 to 72 feet and with mud penetrations ranging from 0 to 36 feet, were analyzed for total phosphorus content. Petrographic examinations were made on a mud surface sample and a sub-surface sample. Apatite was identified as the principal phosphate mineral present. Calculations were made of the concentrations of phosphorus in equilibrium with hydroxylapatite in aqueous medium. Also, estimates were made of the rate of build-up of sediment, assuming the sediment contains the analyzed phosphorus content and 102,000 pounds of phosphorus are inventoried in Lake Erie per day. (CCIW)

95. Canada Centre for Inland Waters. Undated. Annual Report - 1968. Dept. Energy Mines and Resources. Fish. Res. Board. Dept. National Health and Welfare. Burlington, Ont. 30 p.

The Annual Report lists the specified areas of study undertaken during the 1968 research season. Among the studies were the following: physical limnology, water movement, air-lake studies (small and large), mathematical-hydrodynamical modeling, Great Lakes Data Atlas, monitoring programs and descriptive studies, instrument assessment, stratigraphy, palaeoecology, computer and data service, and laboratory methods.

96. Canada Centre for Inland Waters. Undated. Lake Erie cruise 69-101, February 6-27; cruise 69-103, May 29-June 4; cruise 69-104, July 2-6; cruise 69-105, July 28-August 2, 1969. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 101 p.

This report is one of a series listing chemical, bacteriological, and physical data observed by Canadian government agencies.

Physical data was obtained from four cruises. Cruise 101 extended from February 6 through February 27 and covered 16 sampling locations. Cruise 103 extended from May 29 through June 4 and covered 83 sampling locations. Cruise 104 extended from July 2 through July 6 and covered 52 sampling locations. Cruise 105 extended from July 28 through August 2 and covered 53 sampling locations.

97. Canada Centre for Inland Waters. Undated. Lake Erie cruise 69-107, August 25-30; cruise 69-108, September 13-18; cruise 69-110, October 14-20; cruise 69-111, December 7-13, 1969. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 2. 140 p.

This report is one of a series listing chemical, bacteriological and physical data observed by Canadian government agencies.

Physical data is given from four cruises. Cruise 107 extended from August 25 through August 30 and covered 59 sampling locations. Cruise 108 extended from September 13 through September 18 and covered 78 sampling stations. Cruise 110 extended from October 14 through October 20 and covered 85 sampling locations. Cruise 111 extended from December 7 through December 13 and covered 64 sampling locations.

98. Canada Centre for Inland Waters. 1969. Lake Erie cruise 66-11, August 8-14, 1966. Canadian Oceano-

graphic Data Centre. Burlington, Ont. Limnological Data Rept. 8. 105 p.

This report is one of a series listing chemical, bacteriological, and physical data observed by Canadian government agencies.

Physical data was obtained on cruise 66-11 which extended from August 8 through August 14. A total of 105 sampling stations were located throughout the lake with the exception of the western end.

99. Canada Centre for Inland Waters. 1970. Annual Report - 1969. Dept. Energy Mines and Resources. Fish Res. Board. Dept. National Health and Welfare. Burlington, Ont. 40 p.

Included in this report is a summation of the activities carried out during 1969. The fields dealing with the physical aspects of Lake Erie were as follows: Lake Erie Time Series which measured various physical and meteorological parameters in the Western Basin, computer and data services carried programs in reduction and analyzation of the reversing thermometer, current meter data and lake circulation, palaeoecological studies which included chironomid collection in Western Lake Erie, profiling surveys and core sampling for a study of Western Lake Erie stratigraphy.

100. Canada Centre for Inland Waters. 1970. The control of eutrophication. Canada Centre for Inland Waters. Burlington, Ont. Tech. Bull. 26. 10 p.

This report presents its point that carbon is rarely a critical growth-limiting element in lakes, that nitrogen is of more importance, and that phosphorus in most cases is the critical and controlling factor in eutrophication. Furthermore, phosphorus can be controlled by regulating its use whereas nitrogen cannot be controlled to the same extent. Control of carbon from natural sources is virtually impossible.

101. Canada Centre for Inland Waters. 1970. Lake Erie cruise 67-101, May 30-June 7; cruise 67-102, June 12-18; cruise 67-103, June 19-29, 1967. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 230 p.

This report is one of a series listing chemical, bacteriological, and physical data observed by Canadian government agencies.

Physical data was obtained from three cruises. The dates of the cruises were 67-101 from May 30 through June 7, 67-102 from June 12 through June 18, and 67-103 from June 19 through June 29. The number of samples were 153, 123, and 167 respectively.

102. Canada Centre for Inland Waters. 1970. Lake Erie cruise 67-109, August 21-31; cruise 67-111, September 11-21; cruise 67-113, October 2-9; cruise 67-115, October 23-29, 1967. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 3. 226 p.

This report is one of a series listing chemical, bacteriological, and physical data observed by Canadian government agencies.

Physical data was obtained from four lakewide cruises. Cruise 67-109 extended from August 21 through August 31 and covered 100 sampling locations. Cruise 67-111 extended from September 11 through September 21 and covered 123 sampling locations. Cruise 67-113 extended from October 2 through October 9 and covered 98 sampling locations. Cruise 67-115 extended from October 23 through October 29 and covered 77 sampling locations.

103. Canada Centre for Inland Waters. 1970. Lake Erie cruise 68-102, May 17-24; cruise 68-104, June 15-19; cruise 68-108, July 29-August 3, 1968. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 152 p.

This report is one of a series listing chemical, bacteriological, and physical data observed by Canadian government agencies.

Physical data was obtained from three lakewide cruises. Cruise 102 extended from May 17 through May 24 and covered 85 sampling locations. Cruise 104 extended from June 15 through June 19 and covered 57 sampling locations. Cruise 108 extended from July 29 through August 3 and covered 85 sampling locations.

104. Canada Centre for Inland Waters. 1970. Lake Erie cruise 68-109, August 31-September 3; cruise 68-111, September 28-October 4; cruise 68-112, November 4-10, 1968. Canadian Oceanographic Data Centre.

Burlington, Ont. Limnological Data Rept. 2. 140 p.

This report is one of a series listing bacteriological, biological, chemical, and physical data for waters of Lake Erie, observed by Canadian agencies during the period from May 17 to November 10, 1968. Water quality data are presented in this report. Parameters include: Secchi depth, sounding, color, temperature, turbidity, specific conductance, and various chemical forms.

105. Canada Centre for Inland Waters. 1971. Canada Centre for Inland Waters - 1970. Dept. Fish and Forestry. Burlington, Ont. pp. 4-23.

A summary of projects carried out during 1970 on Lake Erie is as follows: monitor data on Lake Erie was carried out, Project Hypolimnion was conceived to study the extent and mechanism for oxygen depletion in the Central Basin, chemical nature of precipitation and design of a new precipitation sampler, development of a mathematical model to compute the Strontium-90 concentration in the five Great Lakes simultaneously, occurrence of extractable phosphate in the surface sediments in Lake Erie, sediment inventory survey was made along the north shore of Lake Erie, erosion and sediment movement at Pt. Pelee was initiated using dyed sand implacements.

106. Canada Centre for Inland Waters. 1972. Canada Centre for Inland Waters - 1971. Dept. Environment. Burlington, Ont. pp. 5-23.

This year's summation of projects undertaken during 1971 includes the following: monitoring efforts and interpretation of 1970 data of Lake Erie studies; winter study of Lake Erie limnology; analysis of melted ice particulates and ice movement; collection of sediment cores in the Central Basin; effects of seasonal variation on the water chemistry; carbon isotope analysis and isotopic sulfur composition in the sediments of Lake Erie were carried out; continuation of the Rain Chemistry Project; regional sediment sampling program of Lake Erie showed high mercury values in the sediment around the mouth of the Detroit River, Western Basin and area adjacent to Erie and Buffalo; nearshore sediment inventory program extending from Mohawk Point to Peacock Point identifying four bottom types: bedrock, till, glaciolacustrine sediments and recent muds, and sediment distribution and transportation in Western Lake Erie along the Canadian Shore. Also included are: mud cores which indicate a three-fold increase in organic matter, nitrogen and phosphorus input into the Lake; study of the forms of phosphorus present in the Lake; channel study in the Detroit River in regard to mercury pollution; discussion on palynological findings in Lake Erie; identification of mercury in its different forms in the sediments; circulation of the hyperlimnion water in the Central Basin of Lake Erie, and data collection of current and temperature in the Eastern Basin of Lake Erie (initiated in the 1970 period).

107. Canada Centre for Inland Waters. 1972. Canada Centre for Inland Waters - 1972. Dept. Environment. Burlington, Ont. pp. 7-37.

Summation of the project activities for 1972 are as follows: work on the past data has shown that sediment distribution in Lake Erie is affected by wind/wave and fetch factors; nearshore inventory program from Nanticoke to Port Burwell shows that bottom sediment consists of 5% bedrock, 40% glacial material, 55% unconsolidated material and Point Bay deposits varied from clean sands inshore to silts and muds offshore; description of the Long Point-Erie morain; pollen analysis collected on the north central nearshore of Lake Erie demonstrates a major hiatus whereas the offshore cores show uniformity; further cores were obtained from the Central Basin, and sedimentation rates or organic carbon, nitrogen, phosphorus and mercury were measured and a maximum of 1.6 cm per year were recorded in the Eastern Basin of Lake Erie (the geochemical concentrations of the above chemicals are increasing due to increased sediment loading in recent years as was shown by the core samples). Chlorophyl pigment studies of recent cores is being undertaken. The fine-grained sediment of Lake Erie contains approximately one-half of the total phosphorus as apatite, equivalent to 300-600 ppm P. (The apatite appears to be entirely of detrital origin.)

108. Canada Centre for Inland Waters. 1973. Summary data atlas of Lake Ontario and Lake Erie, summarization of temperature data and oxygen content by months for Lake Ontario and Lake Erie, 1960-1970. Canada Centre for Inland Waters. Burlington, Ont. Paper 10.

This atlas summarizes temperature and dissolved oxygen data from lake-wide sampling surveys of Lake Ontario and Lake Erie during the years 1960-1970 inclusive. Presented is the surface temperature, near bottom percent saturation of oxygen, depth of the top of the hypolimnion. The values given are a summary of monthly gridded values. (CCIW)

109. Canada Inland Waters Branch. 1972. Surface water data Ontario 1971. Dept. Environment. Water Surv. Canada. Ottawa, Ont. 206 p.

This publication includes data on the discharge rates of the Grand River and other tributaries that empty into Lake Erie for the 1971 year. These are given in daily amounts computed in cubic feet per second at stations located at selected points on the tributary. Also included is the data for the total drainage area, ice conditions, type of guage and location, maximum instantaneous discharge, minimum and maximum daily discharge, total and mean discharge along with the daily recordings.

110. Canada Inland Waters Directorate. 1972. Historical streamflow summary Ontario to 1970. Dept. Environment. Water Surv. Canada. Ottawa, Ont. 258 p.

Data on the annual and monthly mean discharge rates are given for the years up to and including 1970 of some of the tributaries in Ontario that empty into the Erie Basin. The data load will vary from tributary to tributary, depending on the amount of data collected in the past.

111. Canadian Department of Energy, Mines and Resources. 1970. Key to a continent: The Great Lakes. Dept. Energy, Mines and Resources. Ottawa, Ont. 29 p.

A pamphlet containing some of the physical aspects of the Great Lakes including Lake Erie.

Carey, Walter E. - See: Paul L. Zubkoff, No. 925.

112. Carman, J. Ernest. 1927. The Monroe division of rocks in Ohio. J. Geol. 35:481-506.

The Monroe division of rocks around the west end of Lake Erie has long been considered of Silurian age and was especially so interpreted by Grabau (Michigan, 1910). Later Stauffer (1916) and Williams (Ontario, 1919) assigned the Upper Monroe to the Devonian. The present paper, based upon a study of the Monroe of Ohio, presents the several lines of evidence bearing on the age of the Monroe and concludes that, on the bases of geographical distribution of the members, stratigraphical relations, and faunas, the Upper and Middle Monroe are of Devonian age, the systemic contact in Ohio being at the base of the Sylvania (Middle Monroe) sandstone. (BL)

113. Carman, J. Ernest. 1930. Drainage changes in the Toledo region. Ohio J. Sci. 30:187-193.

General characteristics of the drainage around Toledo, its origin, geologic history (including Lake Erie's incursion into the area) and the formation of the Maumee River. Included are the tributaries linking up with the Maumee River and changes in the drainage that have occurred. (SE)

114. Carman, J. Ernest. 1946. The geologic interpretation of scenic features in Ohio. Ohio J. Sci. 46(5): 241-283.

The last five pages of this report are concerned with the Lake Erie Basin and the Islands, the geologic agents of erosion active in the area, maps and discussion of the lithology and resistance of the rock types and the formation of Lake Erie. (SE)

115. Carney, Frank. 1908. Glacial erosion on Kelleys Island, Ohio. Geol. Soc. Am. Bull. 20:640-645.

This paper discusses ice movement across Kelleys Island resulting in grooves, corrasion, and joint planes. (BL)

116. Carney, Frank. 1909. The metamorphism of glacial deposits. J. Geol. 17:473-487.

Regional metamorphism in the Erie Basin is discussed during the Wisconsin ice age. Sediment characteristics as to metamorphic formation and observation are presented. Also the depth of the Wisconsin ice and its influence on the regional geology are mentioned. (BL)

117. Carney, Frank. 1909. The raised beaches of the Berea, Cleveland, and Euclid sheets, Ohio. Denison Univ. Sci. Lab. Bull. 14:262-287.

Discussion of earlier investigations, the tracing of the successive glacial lakes Maumee, Whittlesey and Warren and the level influences they had on the shorelines in the Cleveland area. Included also are the shore processes involved, embayments, growth of lakes, altitude and details of the beaches under discussion. (SE)

118. Carney, Frank. 1910. The abandoned shorelines of the Oberlin quadrangle, Ohio. Denison Univ. Sci. Lab. Bull. 16:101-117.

Historical account of the glacial lakes of Maumee, Whittlesey, and Warren and their effect on the vicinity of the Black River. Drainage cycles discussing the base levels for the glacial lakes and Lake Erie are also presented. (SE)

119. Carney, Frank. 1911. The abandoned shorelines of the Vermilion quadrangle, Ohio. Denison Univ. Sci. Lab. Bull. 16:233-244.

Discussion of the glacial lakes of Maumee, Whittlesey, and Warren and the situation of their shorelines in the vicinity of the Vermilion River. Location, description, and levels are given in relation to the present Lake Erie. (SE)

120. Carney, Frank. 1911. Lake Maumee in Ohio. Geol. Soc. Am. Bull. 22:726.

The reference in this bulletin includes an abstract of the Carney paper and a discussion by Taylor on the Maumee beaches extending eastward of Cleveland. Taylor speculates that Carney's paper is not complete and gives evidence why. (BL)

121. Carney, Frank. 1913. Some pro-glacial lake shorelines of the Bellevue quadrangle, Ohio. Denison Univ. Sci. Lab. Bull. 17:231-246.

Mentioned are the shorelines of the pro-glacial lakes (Warren, Whittlesey, and Maumee), their drainage into the Erie-Huron Basin in the vicinity of Bellevue. Material distribution, shoreline remnants, formation of the Bellevue spit compared to the Cedar Point spit and glacial islands are included. (SE)

122. Carney, Frank. 1916. The abandoned shorelines of the Ashtabula quadrangle, Ohio. Denison Univ. Sci. Lab. Bull. 18:362-369.

Discussed are lakes Maumee, Whittlesey, Arkona, Warren, Wayne, and Lundy in the vicinity of Ashtabula. Their beachlines, location, material characteristics, and shore process interpretation are presented. Map included. (SE)

123. Carney, Frank. 1916. The shorelines of glacial lakes Lundy, Wayne, and Arkona of the Oberlin quadrangle, Ohio. Denison Univ. Sci. Lab. Bull. 18:356-361.

Discussion of the shorelines of the glacial lakes Lundy, Wayne, and Arkona in the vicinity of Lorain, material evidence and shoreline characteristics, relation of altitude as compared to the other glacial lakes and Lake Erie are all presented. Map included. (SE)

124. Carr, John F. 1962. Dissolved oxygen in Lake Erie, past and present. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9:1-14.

Brief mention of the morphmetrical and limnological division of the three basins of Lake Erie is made. Included in the study are temperature data taken in the three basins in their study during the 1961 spring and summer season.

125. Carr, John F., V. C. Applegate and M. Keller. 1964. A recent occurrence of thermal stratification and low dissolved oxygen in Western Lake Erie. Ohio J. Sci. 65(6):219-327.

Instances of thermal stratification have been detected only occasionally in Western Lake Erie during the past 40 years, but when it does occur it is of considerable importance because of associated dissolved oxygen (DO) depletion in the hypolimnion. Data collected in June of 1963 give an indication of the meteorological conditions necessary to produce this thermal stratification. These conditions are: daily wind speed of less than 3.1 m/sec (7 mph); highest wind speed of less than 6.7 m/sec (15 mph); and an average daily temperature of more than 18.5° C for approximately 5 consecutive days. Weather records for Sandusky, Ohio, show these conditions to have occurred on 33 separate occasions between 1953 and 1963. These data suggest stable thermal stratification occurs more frequently than heretofore suspected. The 1963 data also show that in only 5 days of stratification DO in the hypolimnion was reduced to less than 3 ppm, whereas 28 days were required in 1953. This increased rate of DO depletion is probably due to an increase in the oxygen demand of the bottom sediments in recent years.

126. Carroll, Richard and John A. Jones. 1970. Meteorological records for Lakeside 1968-1969. Lake Erie Environmental Studies. N. Y. S. Univ. College at Fredonia. Tech. Data Rept. 6. 28 p.

This report summarizes reduced meteorological data for the latter half of 1968 and all of 1969 near Van Buren Point, Lake Erie. Specific data is given in charts and graphs.

127. Carter, Charles H. 1973. The November 1972 storm on Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Info. Circ. 39. 12 p.

The Lake Erie area was hit by a severe storm on the 13th and 14th of November 1972. A north-northeast wind, which reached a speed of 60 knots, blew 2 days directly down the long axis of the lake. This wind generated high (12 foot) waves and at the west end of the lake piled up water more than 6 feet above the lake's average November level or about 4 feet above the record high lake level set in November 1972. Damage of the areas involved are also discussed. (SM)

128. Chadwick, G. H. 1925. Chagrin formation of Ohio. Geol. Soc. Am. 36:455-464.

The article discusses the geological formations and their stratigraphy in the South Lake Erie Basin. The discussion includes the Venango group, Chagrin formation, Summit unconformity, the Oil Lake group, and the age of the Bradfordian. (BL)

Champion, M. M. - See: G. D. Hubbard, No. 346.

Chandler, David C. - See: Alfred M. Beeton, No. 39.

129. Chandler, David C. 1940. Limnological studies of Western Lake Erie I. Plankton and certain physical-chemical data of the Bass Island region, from September, 1938, to November, 1939. Ohio J. Sci. 40(6):291-336.

This paper is the first of a series dealing with basic fish foods and it is concerned primarily with year-round data derived from weekly plankton collections and certain physical and chemical determinations. (SE)

130. Chandler, David C. 1942. Limnological studies of Western Lake Erie II. Light penetration and its relationship to turbidity. Ecology. 23(1):41-52.

The report is concerned with variations in turbidity of the water of Western Lake Erie and the effect of these variations on the depth to which one percent of the surface light penetrates. In this investigation, year-round observations were made of turbidity, light penetration, amount of organic and inorganic suspended matter, and quantity of phytoplankton. The study extended from September, 1939, through October, 1940. (BU)

131. Chandler, David C. 1942. Limnological studies of Western Lake Erie III. Phytoplankton and physical-chemical data from November, 1939, to November, 1940. Ohio J. Sci. 42(1):24-44.

Year-round limnological data based on weekly observations are presented. Turbidity varied from 5 to 60 ppm, water being most turbid in summer and autumn. (SE)

132. Chandler, David C. 1944. Limnological studies of Western Lake Erie IV. Relation of limnological and climatic factors to the phytoplankton of 1941. Am. Micro. Soc. 63(3):203-236.

Results from the third year-round limnological studies of Western Lake Erie are presented and are concerned with the annual variations in the abundance of phytoplankton and the factors that are responsible for these variations. Discussed are the annual heat budget, ice cover, solar radiation, river discharge, precipitation, turbulence, light penetration, oxygen, and phytoplankton pulses. (BU)

133. Chandler, David C. 1964. The St. Lawrence Great Lakes. Verh. Internat. Verein. Limno. 15:59-75.

General morphymetry and physiographic characteristics are given for Lake Erie. Discussion of the Great Lakes (citing Lake Erie) concerning thermal stratification, seiches and water level changes that are affected by them (graph), lake chemistry (general data), and eutrophication.

134. Chandler, David C. and Owen B. Weeks. 1945. Limnological studies of Western Lake Erie V. Relation of limnological and meteorological conditions to the production of phytoplankton in 1942. Ecol. Mono. 15(4):435-356.

Study performed in Put-in-Bay and various other areas in the Western Basin presents data, physical and chemical, in relation to the effects on the phytoplankton. Data for four and one-half years has been varied as well as the quality and quantity of phytoplankton. Physical topics covered are temperature, lake levels, ice cover, solar radiation, river discharge, turbidity, and transparency. (BU)

135. Changnon, Stanley A. 1971. Atmospheric controls of water exchange in Great Lakes Basin. Water Resources Bull. 7(3):473-483.

Existing meteorological controls of water exchange by precipitation and evaporation on the Great Lakes are almost entirely inadvertent and related to man's urban-industrial complexes and their effect upon precipitation processes. These inadvertent effects have led to 10 to 40% increases in precipitation in localized areas within the Basin. Envisioned growth of urban-industrial complexes within the Great Lakes region should lead to more inadvertent weather modification in the Basin. The only existing planned weather modification efforts are those at Lake Erie which are attempting to eliminate by redistribution the concentration of lake-derived heavy snowfall along the south shore. Practical increases of lake precipitation on the order of 5-20% could be achieved on an operational basis over the Great Lakes in the next 10 years, but the time of accomplishment will depend on national priorities, international cooperation, and economic factors. These activities might produce a sizeable increase in the water quantity of the Great Lakes and should result in an improvement of water quality. Operational methods of evaporation suppression applicable to the lakes are not available. Meteorological controls to ameliorate certain undesirable lake-effect snowstorms are a near reality. (SE)

136. Changnon, Stanley A. and Douglas M. A. Jones. 1972. Review of the influences of the Great Lakes on weather. Water Resources Res. 8(2):360-371.

The considerable influence of the masses of water in the Great Lakes on the weather over and around the Lakes is reviewed and the average lake-related weather alterations are indicated. Particular emphasis is placed on delineating the known facts and those that are adequately known. The lack of extensive continuous weather measurements, particularly over the lakes, makes definitive areal assessments of lake influences on the weather around them difficult. Whether the lakes act as the energy sources or sinks on a daily or seasonal basis depends on the relative temperature of the waters and the overlying air. Over the lakes and their downwind shore area, the lake-caused average changes in cloud and precipitation amounts represents 5-15% reductions in summer and 5-45% increases in winter in comparison with upwind values.

Included in this report is mention of the water temperature effect of Lake Erie water on the winter cold air masses, 36 inches of average annual evaporation from Lake Erie, and generalized discussion covering the Great Lakes as a whole.

Chapman, Carleton A. - See: Robert F. Sitler, No. 661.

137. Chapman, L. J. and D. F. Putman. 1966. The Physiography of Southern Ontario. Univ. Toronto Press. Toronto, Ont. 386 p.

This is a description of the surface of Southern Ontario. It deals with the major features controlled by the underlying rock structures and in particular describes the local land forms composed of unconsolidated materials. It is accompanied by maps upon which the classification and distribution of these land forms is shown. (BU)

Charlesworth, L. J. - See: L. J. Walters, et al, No. 882.

Chau, Y. K. - See: V. K. Chawla, No. 139.

Chawla, V. K. - See: R. R. Weiler, No. 888.

Chawla, V. K. - See: R. R. Weiler, No. 889.

138. Chawla, V. K. 1970. Changes in the water chemistry of Lake Erie. In: R. A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Chemistry of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25(2):31-64.

This paper explains the results of a study on nutrients, major ions, and trace elements in Lakes Erie and Ontario with reference to Lake Erie's topography.

139. Chawla, V. K. and Y. K. Chau. 1969. Trace elements in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 760-765.

The data on trace elements obtained from six cruises during the period June to October 1967 on Lake Erie were examined to study their concentrations and distributions both horizontally and vertically.

Of the 11 elements studied, the concentrations of cadmium, chromium and cobalt were below the detection limits. The annual average values of iron, manganese, strontium and copper of surface waters were comparatively higher than the average of some fresh water lakes of North America. Concentrations of zinc, nickel, lithium and lead were quite comparable.

The horizontal distributions of copper, zinc, nickel, lithium and lead were uniform in the main water body of the Western, Central and Eastern Basins. Iron and manganese were higher in the Western and Central than the Eastern Basins, however, strontium on the contrary was lower in the Western Basin.

140. Chawla, V. K. and W. J. Traversy. 1968. Methods of analyses in Great Lakes waters. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 524-530.

Methods of the Analytical Section, Water Quality Division, were used to analyse Great Lakes waters aboard ship on Lake Erie and at the shore based laboratory, Burlington, Ontario where both Lake Erie and Lake Ontario waters were analysed. Lake Erie samples were analysed aboard ship for pH, turbidity, dissolved oxygen, biochemical oxygen demand, specific conductance, silica, nitrate and orthophosphate. The analyses carried out on shore included sulphate, chloride, alkalinity, calcium, magnesium, sodium, potassium, fluoride and many heavy metals. This paper discusses some techniques and limitations, particularly, for determining orthophosphate aboard ship. It tabulates the methods used for determining each parameter and shows the precision for these methods obtained on shore.

141. Cheng, R. T. and C. Tung. 1970. Wind driven lake circulation by the finite element method. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 891-903.

A simple mathematical model for lake circulation which includes wind stress, bottom friction, Coriolis force and the actual shore line of the lake is presented. Special attention is focused on the geometrical effect of the lake on the circulation patterns. The lake is assumed to be of constant depth but with arbitrary lateral topography. The governing equation of a stream function for the mean velocity components takes the form of Poisson's equation. The resulting boundary value problem has been solved for the case of Lake Erie by the finite element method. The finite element method is simple to use in dealing problems with irregularly shaped boundaries. The circulation in Lake Erie caused by in-flow and out-flow is presented along with the circulation caused by wind shear. Discussions of the main results are given based on the mathematical properties of the governing equation.

142. Chieruzzi, Robert and Robert F. Baker. 1958. A study of Lake Erie bluff recession. Ohio State Univ. Eng. Exp. Station Bull. 27(6): 100 p.

The purpose and scope of this study are restricted to general analysis of shoreline erosion along Lake Erie in Ohio and the associated manifestations which contribute to bluff failures; the development of design concepts for effective and economical corrective measures necessary to reduce bluff failures to tolerable limits in the area of the Perry Township Park in Lake County, Ohio, and a consideration of the applicability of these basic principles to other areas. (SE)

Cho, H. K. - See: J. P. Coakley, No. 153.

Clark, Clarence - See: C. J. D. Brown, et al, No. 71.

143. Clark, Clarence. 1956. Sandusky River Report. Ohio Div. Wildlife. Columbus, Ohio. Pub. 283-F. pp. 3-9.

General discussion on the Sandusky River concerning its physiography and water pollution. This study was planned as a part of the district fisheries activities for the years 1952 through 1954.

144. Clarke, Frank W. 1924. The composition of the river and lake waters of the United States. U. S. Geol. Surv. Prof. Paper 135. pp. 1-99.

This is a systematic investigation of many of the river and lake waters in the United States. On pages 16 through 19 are the statistics of Lake Erie, Maumee, Huron, Sandusky, Vermilion, Black, and several smaller rivers. (BL)

145. Classen, E. 1898. On erratic boulders in the valley of the Rocky River, Cuyahoga County, Ohio. Ohio Acad. Sci. 6:43-44.

Erratics found approximately 3 miles from Lake Erie were found to be composed of the same material (limestone) found on Kelleys Island. Fossils were used to determine the origin of the boulders. (SM)

146. Claypole, E. W. 1878. On the preglacial geography of the region of the Great Lakes. Canadian Nat. 8(4):187-206.

The early Quaternary geology of the Great Lakes is discussed in detail. Existing theories and controversies are argued, fallacies and controversies are pointed out. Much room is devoted to the formation of Lake Frie as it is one of these

controversies--either it existed as a valley or a lake. The author tries to show that the lake beds are not results of glacial erosion during the Ice Age, but antedate the Ice Age and are due to the action of fresh water streams which flowed at an earlier time. (BECPL)

147. Claypole, E. W. 1881. Pre-glacial formation of the beds of the Great American lakes. Canadian Nat. 9(4):213-227.

Further arguments to show that the beds of Lake Erie and the other Great Lakes existed prior to the advance of the glaciers. The excavation of the bed of Lake Erie would have required the removal of nearly 1000 feet of rock by the same glacier which was unable to remove pre-existing glacial grooves from a rock surface. Two different sets of directions belong to the grooves and the striations adjacent to the lake representing the advance and retreat of the ice sheet. The river theory should be considered due to the less explanatory difficulty. Lakes Huron, Erie, and Ontario were formed by widening of areas in a large pre-glacial river. (BECPL)

148. Claypole, E. W. 1882. Evidence from the drift of Ohio, Indiana and Illinois, in support of the preglacial origin of the basins of Lakes Erie and Ontario. Am. Assoc. Adv. Sci. Proc. (1881). 30:147-159.

Formation of the basins, it is argued, is not the result of erosion of modern glaciers. The erosion demanded is far beyond what the drift deposits of Ohio, Indiana and Illinois warrant us in attributing to any local glaciers or even to a continental ice sheet. The material excavated is not found where, on the theory, it should be found. There could have been no local glaciers had the lake beds not previously existed to hold them. The basins should be considered as broad open portions of the course of a preglacial river, whose narrower parts are now filled with drift and concealed. (SM)

149. Claypole, E. W. 1886. Buffalo and Chicago, or "what might have been". Am. Nat. 20:856-862.

This report discusses the sensitive balance and geologic activity that has produced the outflow of waters through Lake Erie and the Niagara River instead of Chicago and into the Mississippi River. The existence of ice sheets, moraines, and flow diversions in the topography for Buffalo and Chicago and how they were formed is explained. (BU)

150. Claypole, E. W. 1888. "Lake Cuyahoga": a study in glacial geology. Am. Assoc. Adv. Sci. (1887). 36:218.

Abstract of a paper read at the meeting concerning the formation of Cuyahoga Lake. Drainage northward to Lake Erie was blocked by the presence of the glacier. It was 370 feet above Lake Erie. Evidence of thick strata of silts indicate a long existence of this glacial lake in the valley of the Cuyahoga. (SM)

151. Claypole, E. W. 1892. An episode in the history of the Cuyahoga River. Am. Assoc. Adv. Sci. Proc. 41:176.

Abstract of paper read at the meeting, dealing with the development of the Cuyahoga River at the end of the Ice Age. North of Akron, a peculiar feature is manifested in the present channel which leaves its preglacial path and passes through a rock, cutting about half a mile in length. The upper channel was filled with sediment from the lake which formerly existed there. Through this sediment, the present river has cut its way, removing a large part of the same. (SM)

152. Coakley, J. P. 1972. Nearshore sediment studies in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 330-343.

Investigations into the distribution and provenance of nearshore sediments deposited along the Canadian shoreline of Western Lake Erie were carried out in 1970 and 1971. The study area extended from Wheatley to the Detroit River and offshore for a distance of approximately 3 km. Data collected included echograms and bottom samples collected along traverse lines perpendicular to the shoreline and spaced at approximately 6 km, although closer coverage was used in the vicinity of Point Pelee and at the Detroit River. In addition to the above data, studies of bed transport using fluorescent tracers were carried out on the shoal south of Point Pelee.

The extremely flat and regular bottom topography of the lake bottom in this area is broken only by the abrupt rise of the Point Pelee platform, and by the occurrence of bedrock outcrops at Colchester and southwest of the tip of Point Pelee. Irregularities in bottom topography, comprising depressions and trenches, occur on the shoal to the south of the Point and reflect the dredging activity there. Bedrock, ranging in age from upper Silurian to middle Devonian, underlie the area and comprise approximately 6% of the nonmud facies. Glacial material, mostly till, with associated lag deposits comprise the bulk of the bottom sediments exposed (55%). Sand and gravel deposits of considerable aerial extent (39%) occur in the western (Detroit River) and eastern (Point Pelee) ends of the area. The thickness of these sand and gravel deposits is not precisely known, although those on the shoal off Point Pelee appear to exceed 10 m. Soft clayey silt muds predominate in the regions further offshore.

The principal sources of the sandy deposits east of Colchester are the eroding shore bluffs along the north shore of the study area and to the east. The extensive areas of lag materials over the glacial deposits indicate that in situ erosion of these glacial deposits on the bottom also represent a major source of nearshore sediments, especially along the eastern side of Point Pelee. West of Colchester, where shore erosion is less intense, the discharge of sandy materials from the Detroit River and Big Creek represents the major source of the sand deposited in this area. Apart from the section west of Colchester, where net westward movement is inferred, the overall direction of sediment movement is toward the east and southeast, although evidence is strong that near the tip of Point Pelee, this pattern becomes complex and frequent reversals in sediment transport direction occur. The results of the tracer work off the tip of the Point support this contention.

153. Coakley, J. P. and H. K. Cho. 1972. Shore erosion in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 344-360.

Erosion along the shoreline of Western Lake Erie from Wheatley to the Detroit River was investigated by measuring strand line positional changes on aerial photographs taken in 1931, 1947, and 1970. With the exception of the portions west to Colchester, around Kingsville, and the northwestern shore of Point Pelee, erosion is progressing at rates of up to 1.5 m/yr, mostly in areas of bluff shoreline. At Point Pelee erosion is confined to the western tip and along the eastern side.

In addition to the aerial photograph evidence, which can be regarded as indicative of general, long-term developments, detailed ground investigations were carried out along the shore from Point Pelee westward to Colchester Point. Data on wind and wave parameters, longshore drift, beach materials and beach profiles were collected over a two-month period at six shore stations. Wave refraction diagrams were also constructed on the basis of the predominant wave regime.

Longshore drift, consistently eastward to southeastward in the area from Colchester to Point Pelee, showed reversals in direction at the tip of Point Pelee. Also on the western side of the tip of the Point, local erosion far exceeded figures obtained by aerial photograph comparison, with recession measuring almost 4 m during the three-month survey period.

Rising water levels since glaciation of the area is believed to be responsible for most of the erosion in the bluff shorelines. In the case of Point Pelee erosion, however, alteration in supply of accretionary material through shoreline construction and dredging appear to be significant factors.

154. Coakley, J. P., W. Haras and N. Freeman. 1973. The effect of storm surge on beach erosion, Point Pelee. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 377-389.

The passage of a severe storm on 14 November 1972 caused considerable damage to properties situated on the east side of Point Pelee. Most of the destruction was due to the primary effects of three-meter high waves operating concurrently with elevated water levels further aggravated by the storm surge. Although water level guages at Point Pelee were inundated by the storm surge, it was possible to interpolate the levels, which during the storm exceeded 60 cm above the mean daily level.

Extensive erosion occurred along the approximately 10 km of shoreline studied, with sand and gravel removed from the lower beach face and deposited up to 100 m inland. An estimated 5.5 cubic meters per meter of beach were eroded from the beach. This westward migration of the beach bar on the east side, with similar buildup on the west side, reflects the overall morphological trend of the Point Pelee landform over the past 200 years.

155. Cole, Alan L. 1969. Wave forces in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 540-542.

Wave forces on the Great Lakes, while obviously important, have received little study so that a field evaluation of existing theories was made at Lorain, Ohio, tenatively and quantitatively confirming Sainflou's theory.

156. Cole, Alan L. 1972. Analysis of Lake Erie wave pressure data. Corps of Engineers District. Detroit, Mich. Northern Illinois Univ. Dept. Geog. Final Rept. pp. 1-54.

Measured wave heights, wave periods, mean water level increases, and depths of water on a breakwater at Lorain, Ohio, were used to compute pressure profiles on the breakwater during non-breaking wave reflections. These computed pressure profiles were evaluated with wave pressure measurements taken concurrently. The pressure profiles computed according to the Sainflou formulation agreed reasonably well with the experimental profiles except near the still water level where the experimental data indicated a marked increase of the wave pressures which was not predicted by the theoretical calculations. A second empirical wave pressure profile formulation due to Minikin did not agree as well with the experimental data although its simplicity and its rough agreement with the measured pressure profiles may encourage its use in design problems.

157. Cole, Alan L. 1973. Experimental evaluation of wave pressure formulations for non-breaking waves. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 508-516.

Experimental data have been used to evaluate theoretical formulations of the pressures produced by non-breaking waves on a vertical breakwater. The data were obtained in the fall of 1969 in Lake Erie at Lorain, Ohio and consist of wave pressures at seven vertical positions on the breakwater plus wave heights and water levels as required for the theoretical formulations. Wind speed, wind direction, lake temperature and air temperature were also recorded.

Wave pressure profiles calculated from the observed data using a theoretical formulation by Sainflou showed general agreement with the measured wave pressure profiles except near the still water level. The observed wave pressure profiles showed a marked increase in wave pressure just below the still water level that was not predicted by the Sainflou formulation.

A wave pressure formulation by Minikin did not verify as well, although the deviations from observed values were not excessive. Because it required only the undisturbed wave height as input data and has very simple calculations, the Minikin formulation may well be used for design purposes.

158. Cole, Charles M., Jr. 1963. How El Paso drills Lake Erie gas wells from a floating vessel. Oil and Gas J. 61(40):134-139.

Rotary drilling from a floating vessel has proven effective in developing shallow gas underlying deep water portions of Canadian Lake Erie. Wells are shallow and pressures are low. Winter ice is a hazard. The gas is produced from the Grimsby and Whirlpool sands at depths of 800 to 1400 feet. A Great Lakes steamer, the Simcoe, was converted to drilling service. (BECPL)

159. Collins, R. P. 1971. A microbiological survey in Lake Erie near Cleveland, Ohio. Univ. Conn. Storrs, Conn. 31 p.

Periodic taste and odor at the Cleveland, Ohio, Crown water treatment plant prompted investigation of the role microorganisms play in the problem. Fungi bacteria and algae collected near the plant intake were studied during June through August 1971. During the three months of sampling, no vertical distribution pattern was noted in quantitative analysis of the phytoplankton. A number of algae reported to induce taste and odor in water, were identified. Whatever the source of these odors, they were not due to benthic or periphyton algae, but could have been associated with the phytoplankton community as the reported 'Lake Erie Odor' coincided with phytoplankton increase. (CA)

160. Conger, Norman B. 1899. Water temperatures of the Great Lakes. Mon. Wea. Rev. 27(8):352.

The study of the distribution of fog on the Great Lakes shows the importance of a knowledge of the temperature of the surface water. The temperature of the water in Lake Erie approaches more closely to the temperature of the air than any of the other lakes. Generally the mean temperatures range between 70° and 75°F. (BECPL)

161. Conger, Norman B. 1908. Ice conditions on the Great Lakes, winter of 1907-8. Mon. Wea. Rev. 36(5): 137-140.

In Lake Erie there appeared to be more ice than during the previous winter, but the fields over the western portion moved out from shore and down to the east end, so that on the average the period of ice fields was shorter than before. The packing of the ice fields at the east end is a yearly feature on this lake because of the prevailing southwesterly winds. (BECPL)

162. Conger, Norman B. 1908. Storms and ice on the Great Lakes. Mon. Wea. Rev. 36(8):236-244.

Containing little technical information, this article discusses the display of storm warnings, location of weather bureau stations and towers, and the dates of the opening and closing of navigation at the ports. (BECPL)

163. Conger, Norman B. 1909. Ice conditions on the Great Lakes, winter of 1908-9. Mon. Wea. Rev. 37(6): 244-246.

There was less ice reported in all of the lakes due to a comparatively mild winter. Ice thickness was also considerably less. (BECPL)

164. Cook, C. W. 1926. The influence of joints in the formation of the islands at the western end of Lake Erie. Mich. Acad. Sci., Arts and Letters. 5:243-251.

Principal joint directions as determined on Pelee Island were found to be N45E and N45W, N15E and N75W, N75E and N15W. Examination shows that many of the larger features of the islands and the basin of Lake Erie surrounding them present a striking parallel with these joint directions. Also, the general trend of many of the contour lines and depressions in the basin floor in relation to the joint directions is noted. Faulting is suggested as the agent responsible for the formation of the islands. The joint patterns are compared to preglacial drainage patterns proposed by Spencer and Grabau and some instances of parallelism are found. (SM)

165. Cooper, D. J. 1969. Hovercraft winter trials and observation program, Lake Erie, February 1969. Canada Centre for Inland Waters. Paper 2. 29 p.

This report is based on equipment trials made in Lake Erie during February 1969. Since winter ice conditions on Lake Erie are not conducive to ship operations, hovercraft trials were undertaken to test the suitability of the vehicle in representative operations, including collection of samples from regular monitoring stations. Processing of the samples in the manner usually practiced on board the major vessels, was also conducted. These trials were conducted by day mainly on solid ice; synoptic runs of the hovercraft over water, water and ice, and ice were also carried out, generally near shore. The results of these studies were summarized. (CCIW)

166. Copeland, Richard. 1970. The mercury threat: questions to consider. Limnos. 3(2):11-13.

This paper discusses the basics of the mercury pollution problem. Mercury is used in industry in two forms, metallic mercury as an electrode in the production of chlorine and alkalis, and organic mercury compounds. The latter are as slimicides used in the pulping industry. Mercury is incorporated and accumulated in fish in two ways. Via the gills as an equilibrium is set up between mercury in fish and water. The secone method is ingestion of mercury contaminated food. The author gives a calculated guess as to how long a mercury polluted environment will stay polluted after stopping mercury input. In the case of the Lake Erie-St. Clair system, an estimate of 10-100 years is given. (BU + CCIW)

167. Cottingham, Kenneth. 1919. The origin of the caves at Put-in-Bay, Ohio. Ohio J. Sci. 20:38-42.

The article maintains the Kraus view that the caves as a class have resulted from the hydration of anhydrite, arching of overlying rock, and subsequent solution of the gypsum filled lenses. In Duff's and Victory caves, faulting was produced. Both are open, thrust faults and entrance is gained by way of the fault space. (SE)

Cowher, R. M. - See: M. L. Kaplan, et al, No. 384.

168. Crawford, L. C. 1953. Hydrology of Lake Erie and tributaries. Ohio Dept. Nat. Resources. Div. Water. Lake Erie Pollution Surv. Columbus, Ohio. Final Rept. pp. 19-28.

Included in this report are the following: physical and related features of Lake Erie Basin, crustal movements around the Lake Erie area, characteristics of tributary discharge including the areas of major drainage basins, evaporation and lake levels. Most of the report is presented with data and locations of the study.

169. Cross, William P. 1967. Drainage areas of Ohio streams,

supplement to the Gazetteer of Ohio streams. Ohio Dept. Nat. Resources. Div. Water. Rept. 12a. 61 p.

The report lists the results of planimetering drainage areas of Ohio streams of more than 10 sq mi on the completed 7.5 minute quadrangle topographic maps. The purpose of the report is to make available the most up-to-date information on drainage areas based on the latest and most accurate maps and to add data on drainage areas above gauging stations. (CA)

Crowley, D. J. - See: R. K. Fahnestock, et al, No. 227.

170. Csanady, G. T. 1964. Turbulence and diffusion in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11: 236-339.

In continuing experimental investigations of turbulent diffusion in the Great Lakes, further data have been collected, particularly on vertical diffusion and diffusion in a current which steadily changes direction ("swinging" current). Also a comparison could be made between diffusion in Lake Huron and Lake Erie, Western Basin. The low values of vertical diffusivity reported before were confirmed, and the extreme influence of thermal stratification on vertical diffusion was demonstrated. Diffusivities measured in the Western Basin of Lake Erie were approximately twice as high as those prevailing in Lake Huron, presumably because of higher turbulent intensity in a shallow basin. Diffusion in a swinging current was found to be considerably more rapid than in a steady one, the effective diffusivity (so far as such a concept is useful in that situation) increasing by a factor of 2-5.

171. Csanady, G. T. 1970. Waste heat disposal in the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 1. p. 388.

The energy equation is applied to a flowing sheet of water, subject to surface cooling. This reduces to a two-dimensional diffusion equation if the excess temperature is multiplied by an exponential-decay factor.

An approximate solution is constructed for the diffusion by arranging Gaussian plumes to begin at elements of a line-source, modelling a power station cooling-water outlet. A comparison of the decay of maximum excess temperature with distance from the source due respectively to surface cooling and mixing shows the latter mechanism to be dominant. Some practical conclusions are then pointed out which follow from the result that heat dissipation is "diffusion controlled".

172. Csanady, G. T. 1971. Turbulent diffusion in the Great Lakes: some fundamental aspects. Internat. Symposium on Stochastic Hydraulics. Pittsburg, Penn. pp. 169-191.

Various statistical distributions are discussed, useful in describing the diffusion of a dynamically passive contaminant in a turbulent field. In a body of turbulent fluid such as one of the North American Great Lakes it is frequently convenient to describe diffusion in a frame of reference attached to the center of gravity of a diffusing cloud ("relative diffusion") in the sense of establishing the statistical properties of the dispersal process at fixed distances from the center of gravity. The field of the expected concentration in this "moving" frame is the only theoretical aspect of relation diffusion treated at all extensively by existing theory; this theory is briefly reviewed and related to other aspects of the problem, notably the field of concentration variance. Experimental data on relative diffusion obtained mainly in Lake Huron are then briefly reviewed and their fundamental significance discussed in particular the validity of the diffusion equation, the peculiar behavior of eddy diffusivity and the importance of considering concentration fluctuations in assessing pollution nuisance or hazard.

173. Culp, L. R., N. A. Rukavina and G. G. LaHaie. 1973. Short settling tube for F. A. S. T. size-analysis. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. p. 1043.

The F. A. S. T. procedure for grain size analysis of sediments makes use of the Emery settling tube and the pipette method. Samples were obtained from Lake Erie nearshore sediments and analyzed by this procedure.

174. Curl, Herbert Charles. 1951. The distribution of phosphorus in western Lake Erie and its utilization by natural phytoplankton populations. M. S. Thesis. Ohio State Univ. 52 p.

The sources of phosphorus in the Western Basin of Lake Erie are the Detroit River (2 $\mu$ grams per liter, average; 312 tons in 1945) and the southern tributaries (25 $\mu$ grams per liter, average; 136 tons in 1945). The effect of the northern water is to dilute the water of southern origin. There is a general relationship between the amount of turbidity and phosphorus present at any one time or place, sometimes to the point where the effects of very high phosphorus levels are mitigated by the reduction of the euphotic zone due to the accompanying high turbidity. The bottom sediments have an average phosphorus content of 50 milligrams of phosphate P per gram of sediment. Solution appears to be very slow and the bottom sediments are resistant to removal but all other forms pass rapidly out of the basin. (CCIW)

175. Curl, Herbert Charles. 1953. A study of distribution of phosphorus in Western Lake Erie and its utilization by natural photoplankton populations. In: Lake Erie Pollution Survey. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. Final Rept. pp. 133-136.

Numerous studies have been made in attempts to elicit the role that phosphorus plays in the production of living matter, especially in aquatic situations. The sources of phosphorus for Lake Erie are three: that which already exists in the water at a given moment, that which is brought in from the tributaries, and that which is derived from resuspended sediment. The water in the basin is a mixture from several sources that have radically different phosphorus contents.

176. Curl, Herbert Charles. 1959. The origin and distribution of phosphorus in Western Lake Erie. Limnology and Oceanography. 4:66-76.

The phosphate phosphorus distribution in Western Lake Erie in May 1951 and the average concentration throughout 1950-51 are shown to be a result of the drift current pattern and discharge of the Maumee and Detroit Rivers. The bedrock in the lake appears to provide negligible quantities. The Detroit River supplies .405 metric tons per year at an average concentration of 2.6 $\mu$ gm $PO_4$-P/1, and the Maumee River 125 tons and 43 $\mu$ gm $PO_4$-P/1. The remaining streams supply 39 tons and 16 $\mu$ gm $PO_4$-P/1. The bottom sediments are considerably enriched in phosphorus. Phosphate phosphorus and turbidity in the lake are positively correlated ($r = +0.65$). Evidence from turbidity data indicates that the lake is enriched by a thin layered tongue of water from the south shore streams which flow over or under the clearer, nutrient-poor water, then mixes vertically with it. (BU)

Curtis, L. W. - See: C. D. Simpson, et al, No. 660.

177. Cushing, H. P., Frank Leverett and Frank R. VanHorn. 1931. Geology and mineralogy of the Cleveland district, Ohio. U. S. Geol. Surv. Bull. 818. pp. 1-138.

Although this paper refers to the land south of Cleveland, it correlates the land to the water mass in terms of the shoreline, drainage, and sedimentary materials. (BL)

178. Cuthbert, F. Leicester. 1937. A geologic study of Cattaraugus Creek and vicinity with special reference to Pleistocene sediments. M. A. Thesis. S. U. N. Y. at Buffalo. Buffalo, N. Y. 35 p.

This study is an attempt to outline a pre-glacial lake at an elevation of 1400 feet in the vicinity of Zoar Valley, Cattaraugus County, New York. This lake came into being as a result of waters being impounded between the north-sloping land south of Cattaraugus Creek and the ice front of the Pleistocene glacier during its gradual retreat to the north. Three different positions of the ice front and the effect of these positions upon the outline of the lake and its outlets have been traced and mapped. The work has been accomplished by research in the field with the aid of topographic maps and a laboratory study of samples collected from the lake deposits found. (BL)

179. Cuthbert, F. Leicester. 1944. Clay minerals in Lake Erie sediments. Am. Mineralogist. 29:378-388.

A clay-mineral and petrographic study has been made of 14 different samples of sediments from the bottom of Lake Erie. Thermal analyses, optical studies, and x-ray diffraction patterns have been used to determine the nature of the clay-mineral composition of these sediments. The data indicate that the predominant clay-mineral is of an illite character.

The analyses of these samples show a good correlation between the depth of water under which the samples were secured, their location with regard to shore line, and the amount and character of residue (particles greater than two microns in diameter) and clay (particles smaller than two microns in diameter). (BL)

Dachille, F. - See: Richard Lowright, et al, No. 461.

180. Dachnowski, A. 1912. Peat deposits of Ohio: their origin, formation, and uses. Ohio Geol. Surv. Columbus, Ohio. Bull. 16. 424 p.

Some of the submerged marl beds and peat deposits described in this report are part of the evidence in support of the fact that the area has undergone subsidence. The glacial history is described in detail. (SM)

181. Dadisman, Quincy. 1972. The pathology of Lake Erie. Nation. 214:492-496.

Although most reports indicate that Lake Erie is 'dead', a recent study shows that the Lake is not dead and could be revived in one generation. One serious problem is the input of phosphorus into the Lake. Scientists believe that if this input were reduced a quick improvement in the condition of the Lake could be expected. Other problems include the large amounts of mercury discharged by chloralkali plants near Detroit and the discharges of sewage all along the coast. One of several factors preventing improvement of the Lake's condition is the lack of an institutional mechanism for cooperation between the United States and Canada. This can be traced to three conditions in America: inferior American technology in sewage and pollution treatment, the U. S. hesitance to eliminate the phosphate content of household detergents, and the political inability of the U. S. to act quickly. As a result, phosphates and other pollutants continue to enter Lake Erie with little hope remaining for the Lake. The U. S. bureaucracy, in particular the Environmental Protection Agency, fails to recognize that stricter pollution control standards are needed in the Great Lakes than for the ocean. (BU)

182. Davis, C. C. 1962. The plankton of the Cleveland harbor area of Lake Erie in 1956-1957. Ecol. Mono. 32(3):209-247.

Weather permitting, trips were taken to three open-lake stations in Lake Erie off Cleveland, Ohio, every two weeks between September 16, 1956 and October 12, 1957. Temperature was measured at the surface, at 6 m below, and at 12 m below.

The maximum temperature occurred in early August and amounted to 24.5° C or slightly above at all depths. Temperature stratification of the water was observed only during the period when temperatures were rising. When the surface water was cooling the water tended to be the same temperature throughout. (BU)

183. Davis, C. C. 1968. Lake Erie's shore and water. In: G. Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. pp. 121-134.

Mr. Davis describes the change in the biological aspects of Lake Erie with reference to several physical parameters.

184. Davis, C. C. 1969. Plants in Lakes Erie and Ontario, and changes of their numbers and kinds. In: R. A. Sweeney (Ed.), Proceedings of Conferences on Changes in Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25(1):19-21.

The author discusses, in part of his article, the contemporary upwarping of Lake Erie resulting from deglaciation. Included in this discussion are the changes in water level, climate and morphology.

185. Davis, C. C. and H. B. Roney. 1953. A preliminary study of industrial pollution in the Cleveland harbor area, Ohio. Ohio J. Sci. 53(1):14-29.

In the Cleveland area, the major portion of the industrial effluents is dumped into the Cuyahoga River. These industrial pollutants are very deleterious to the existence of aquatic life in the river. Beyond the mouth of the river, aside from the unpleasant appearance and odor of the water, there are harmful effects from oil deposits in the bottom muds, the extent of which needs to be determined.

Another harmful result extending over a considerable area accrues from a reduction of photosynthesis caused by high turbidities. (BU)

186. Dawson, G. M. 1875. The fluctuations of the American lakes and the development of sunspots. Canadian Nat. 7(6):310-317. Also Nature, April, 1874.

The observations of secular change (general rise and fall of the level) in Lake Erie from 1788 to 1867 when plotted to scale show a series of well-marked undulations which suggest the possibility of a connection with the 11-year period of sunspot maxima. During a typical maximum period of sunspot activity (1860), the lake depth was 30.6 feet while during the minimum (1867) the depth was 16.56 feet. As it is believed that sunspot activity has an effect on the weather conditions, including precipitation, this may be a true correlation as the amount of precipitation directly influences the lake level. (BECPL)

187. Day, P. C. 1926. Precipitation in the drainage area of the Great Lakes, 1875-1924. Mon. Wea. Rev. 54(3):85-106.

Owing to extensive discussion of lake levels and the causes controlling them, the precipitation data of the Weather Bureau and the Canadian Meteorological Service for the drainage basin of the Great Lakes have been examined with care. From 1875 trustworthy determinations are possible. The precipitation averages about 32 inches per year and in general increases from north to south. Stations considerably above the levels of the lake surface indicate more precipitation than those close to the lake levels due to increased wind effect on the latter.

The water levels seem to be closely related to the quantity of precipitation, delays of a year or more often appearing in the response of the levels since the runoff is not immediate. (BECPL)

188. Deane, R. E. 1963. Limnological and meteorological observation towers in the Great Lakes. Limnology and Oceanography. 8(1):9-15.

Six limnological and meteorological single-shaft towers of 4-in pipe were installed in 3 of the Great Lakes by the Great Lakes Institute, University of Toronto. The towers were of two types, a shallow-water tower for depths of less than 60 ft where the base of the tower rested directly on the lake bottom, and a deep-water tower supported by a buoyancy tank 25 ft below lake level. A platform on the towers, situated 8 to 12 ft above lake level, gave a stable base to house limnological and meteorological instruments and recorders. The platform and upper part of tower were designed for easy removal and reinstallation.

189. Dearborn, H. A. S. 1829. On the variations of level in the Great North American lakes. Am. J. Sci. 16(1):78-94.

This report in the fluctuations of the lake levels is based on observations of various members of the Army stationed along the Great Lakes. Most of the data pertains to Lakes Michigan, Huron, and Superior but a general discussion of the causes of such variations is applicable to Lake Erie. (BECPL)

190. DeCooke, Benjamin G. 1961. Forecasting Great Lakes Levels. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7:79-84.

A comparison of average error under the current method of forecasting of lake levels, with the average change method shows an improvement on all lakes for a six-month period with the exception of Lake Erie. For Lake Erie, there is an improvement for the first three months, however the fourth through the sixth month no improvement over the average error is shown. The forecast method is described in this article. (RL)

191. DeCooke, Benjamin G. 1968. Regulations of the Great Lakes levels and flows. In: Proceedings of Great Lakes Water Resources Conference, June 24-26, 1968. Eng. Inst. Canada. Toronto, Ont. pp. 249-275.

The paper presents a brief description of the physical characteristics as well as the hydraulics and hydrology of the Great Lakes system. Included are tables of average lake levels, outflows, runoff, precipitation and evaporation. The rule-and-limitation approach to regulation plan development (a plan tailored to the past sequence of water supplies) and the probabilistic approach (a plan which gives consideration to the variability of future water supplies) are described and compared. The paper includes a description and samples of the regulation plans presently in operation on Lakes Superior and Ontario. The author concludes that it is extremely difficult to improve on the natural regulation of the system. However, from an engineering standpoint regulation of the entire system is feasible, but has not been economically justified to date.

192. DeCooke, Benjamin G. and Edmond Megerian. 1967. Forecasting the levels of the Great Lakes. Water Resources Res. 3(2):397-403.

A description is given of the U. S. Lake Survey method of forecasting Great Lakes water levels. The method, in general, consists of determining a level for each month of a 6-month forecast period on each of the Great Lakes by routing a predicted volume of water (Net Basin Supply) to each of the Great Lakes basins. The technique employed in prediction of the volume of the water consists of using multiple linear regressions based upon U. S. Weather Bureau precipitation and temperature data as predictors for the first month and trend predictors for the second through the sixth month. This technique results in forecasting of lake levels on the average from 15 to 40% closer to the recorded lake levels, in comparison with the technique that utilizes the long-term average volume of water as the basis of projection.

Delafield, J. - See: J. J. Bigsby, No. 50.

193. Dell, C. I. 1973. Vivianite: an authigenic phosphate mineral in Great Lakes sediment. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 1027-1028.

Nodules, crystal clusters and small irregular masses of vivianite have been found in postglacial sediments from Lakes Superior, Erie and Ontario. It has formed authigenically within the sediment and is thus a component of the phosphorus cycle in these lakes. The exact conditions leading to its formation are unknown.

Demarest, D. F. - See: J. F. Pepper, et al, No. 568.

194. Denison, F. N. 1898. Periodic fluctuations of the Great Lakes. Mon. Wea. Rev. 26(6):261-62.

Using a self-recording device which measured time, amplitude of waves, and a wind barometer, several observations were made concerning the relationship of atmospheric pressure and lake levels. An editorial comment following the article discredits the relationship. (BECPL)

195. Denison, P. J. and F. C. Elder. 1970. Thermal inputs to the Great Lakes 1968-2000. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 811-828.

A survey of expected man-made thermal inputs to the Great Lakes from electric-generating stations, steel mills, and municipal waste treatment plants has been completed for the period 1968-2000. Charts and maps are presented to show the increase in thermal input.

196. Dennis, John V. 1960. Oil pollution survey of the Great Lakes within United States territorial limits. American Petroleum Inst. Washington, D. C. 22 p.

The oil pollution survey made of shore areas along Lake Erie found no oil between Buffalo and Erie, Penn., heavy deposits on Presque Isle (16 lbs of oil along a typical 100 ft stretch of beach), and varying amounts along the Ohio shores of Lake Erie. In Cleveland, the pollution was found to emanate from the Cuyahoga River which drains a large area devoted primarily to industry. (BECPL)

197. Derecki, Jan A. 1964. Variation of Lake Erie evaporation and its causes. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:217-227.

Monthly evaporation from Lake Erie was determined by water budget method for the 1937-1959 period. The component factors of water budget are briefly examined and discussed. Evaporation rates varied from -4 to 24 cm per month and from 53 to 108 cm per year; therefore, the average values are poorly adaptable for hydrological forecasts. The variation of evaporation was analyzed statistically and indexes of air-water temperature difference ($T_W$-$T_A$), heat influx by radiation (sunshine), and humidity were found to be of primary importance, while precipitation and wind speed showed only sporadic effect. The climatic factors gave reasonable account for the variation of the monthly evaporation rates during the months having high evaporation and poor account during the low evaporation period.

198. Derecki, Jan A. 1972. Hydrometeorology: climate and hydrology of the Great Lakes. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4:4-181 to 4-184, 4-277.

The climate and hydrology of the Great Lakes region is discussed in terms of radiation, winds, temperature, humidity, precipitation, evaporation, runoff, etc.

199. Deutsch, Morris. 1972. Earth resources observation systems program research and plans for the Great Lakes Basin. In: Proceedings of the First Federal Conference on the Great Lakes. Interagency Committee on Mar. Sci. and Eng. for the Federal Council for Science and Technology. Washington, D. C. pp. 48-68.

Multispectral photography techniques showing infrared photographs taken over Maumee River and Cuyahoga River describe thermal and sediment discharges into Lake Erie. Technique objectives are discussed.

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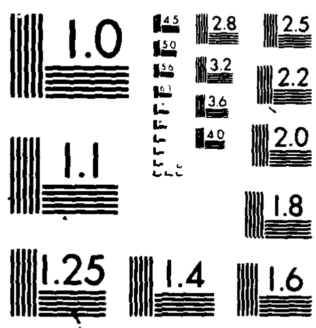


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

200. Dewey, C. 1846. Facts relating to the Great Lakes. Am. J. Sci. and Arts. 2(4):85-87.

General statement of low levels recorded in Lake Erie, due to the drought for half of 1845. (SM)

DeWitt, W. - See: J. F. Pepper, et al, No. 568.

201. Doan, Kenneth H. 1941. Relationship of Sauger catch to turbidity in Lake Erie. Ohio J. Sci. 41(6): 449-452.

There is considerable evidence that lake turbidity during the months of April and May bear a significant relationship to the mean precipitation in the same months at several points along the southwestern shore of Lake Erie. Of the factors relating to the abundance of certain fishes in Western Lake Erie, turbidity of water is important. (BU)

202. Doan, Kenneth H. 1942. Some meteorological and limnological conditions as factors in the abundance of certain fishes in Lake Erie. Ecol. Mono. 12(3):293-314.

By methods of correlation, a survey has been made of the physical factors concerned in the abundance of Lake Erie fishes. It was found that the mean temperatures decrease in order from the southwest to the northeast (same applies to the water temperatures). Mean precipitation varies similarly along Lake Erie, as does turbidity, and the latter decreases in value eastward. Turbidity of the lake water depends in part upon the amount of precipitation along the shore. These parameters are correlated to fish catches and occurrences. (BU)

203. Doan, Kenneth H. 1945. Catch of Stizostedion vitreum in relation to changes in lake level in Western Lake Erie during the winter of 1943. Am. Mid. Nat. 33(2):455-459.

Included in the report is some data on the water level and the responding current change as performed at Put-In-Bay in Lake Erie.

204. Dobson, H. H. and M. Gilbertson. 1972. Oxygen depletion in the hypolimnion of the Central Basin of Lake Erie, 1929-1970. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 3-8.

Included in the report are two maps showing the major bathymetric features and temperature structure in the Lake Erie Basins.

205. Dohler, G. C. and R. J. D. MacKenzie. 1969. A discussion on the interpretation of high and low water datum planes in the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 415-440.

There is a growing and continuing requirement for more precise definitions of the various levels of the Great Lakes. Every sector of the Great Lakes Basin community is affected sooner or later by lake levels. The purpose of High and Low Water Datum planes are examined and defined, and the criteria which could meet these requirements are established. All available water level data are analysed and techniques developed for the selection of appropriate datum planes.

206. Donn, William L. 1959. The Great Lakes storm surge of May 5, 1952. J. Geophys. Res. 64(2):191-198.

A damaging storm surge struck much of the shore zones of Lakes Huron and Erie on the morning of May 5, 1952. The surge, which was associated with a moving atmospheric pressure-jump of average characteristics, is explained on the basis of resonant coupling to both edge waves and gravity waves. The latter in turn created above-normal seiches in lake areas with appropriate dimensions and forms. A pronounced lag occurred between the surge and the generating air disturbance at places where lake parameters did not permit resonant coupling, with the surge arriving from regions where coupling was possible. (BL)

207. Donnan, Bryson C. 1957. Great Lakes leases off new drilling area. Oil and Gas J. 55(41):301, 304-305, 307, 309-310, 312.

The article covers the Ontario side of Lake Erie. Stratigraphy, geologic formations, and oil and gas productivity in these formations are discussed. Potential drilling sites, techniques, and methods are presented. Operations in offshore acreage on the Ontario side are given a summary in seven areas. Water pollution, legislation and economics, and lease sales during 1957 are included. (SE)

208. Donnan, Bryson C. 1959. Tempo quickens on Lake Erie. Oil and Gas J. 57(23):222-227.

Productive stratigraphic units in the Erie Basins and progress in the Central, Western, and Eastern Basins are mentioned in regard to drilling operations, location techniques, and recovery pay, as well as deepwater drilling. (SE)

209. Donnan, Bryson C. 1960. Great Lakes search focuses on eastern end of Lake Erie. Oil and Gas J. 58(23):102-104.

This is an account of the previous year's activities on the eastern end of the lake. Five new gas and one new oil pool were found. Most activity will be off the Ontario side with the objective being the gas in shallow, 700-1000 feet Clinton-Medina sands. (BECPL)

210. Donnan, Bryson C. 1961. Offshore exploration in Great Lakes region. Am. Assoc. Petroleum Geologists. 45(11):1847-1858.

Approximately 35 billion cubic feet of natural gas has so far been produced from beneath the waters of shallow Lake Erie, where offshore activity has been concentrated. Two hundred ninety-three wells have been drilled offshore in Lake Erie and Lake St. Clair to date, with two of these in the United States opposite Pennsylvania.

Offshore development in Lake Erie has been concentrated in the eastern and western sectors. Clinton-Medina gas fields almost surround the east end on land, and underlake extensions of these are being sought. The geological problem has been to trace permeability trends following discovery; a better understanding of the conditions of deposition of these strandline sands is necessary. Modern fracturing techniques have been used successfully in this region.

In the western sector, Guelph gas-bearing reefs and Salina A-2 gas fields have been successfully extended underlake. However, the success ratio in wildcatting for these biostromic structures has been disappointingly low in spite of the use of the various geophysical tools. The geological problem has been in finding a suitable means of location.

The oil discovery in the Trenton Group at Colchester in Essex County, Ontario, near the west end of Lake Erie has resulted in a renewed interest in deeper exploration. It has also resulted in the first commercial oil well in the Great Lakes (in 1959). Subsurface geology must be used to locate areas of suitably porous dolomitized Trenton Limestone.

Some offshore wells have penetrated the Cambrian sands and these beds also have oil and gas possibilities, and are of current interest.

An attempt has been made to correlate the various survey maps, where available, in order to show composite geological maps of the western and eastern Lake Erie regions. This geological information has been projected across Lake Erie and Lake St. Clair, where possible, on the basis of information obtained from offshore wells drilled to date. This has been done with due thought to the implications involved in such projections with limited information, and with the different nomenclatures which are encountered when political boundaries are crossed. (BL)

211. Dorr, J. A. and D. F. Eschman. 1970. Geology of Michigan. Univ. Mich. Press. Ann Arbor, Mich. 476 p.

In general, identification and descriptions of principal geological features of Michigan and an explanation of the origin of those features in terms of chemical, physical, and biological processes. Lake Erie is discussed in a section dealing with the formation of the Great Lakes. (BU)

212. Dow, J. W. 1962. Lower and Middle Devonian limestones in northeastern Ohio and adjacent areas. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 42. 67 p.

The subsurface stratigraphic relations of the Lower and Middle Devonian limestones in northeastern Ohio are studied in detail to establish their regional relationship. The Detroit River group pinches out eastward in southern Ontario allowing the Columbus limestone to lie unconformably on top of the "Onondaga limestone" (Bois Blanc formation). This relationship is also found to occur in northeastern Ohio. (SM)

Dragert, H. - See: T. L. Richards, et al, No. 618.

Dreimanis, Aleksis - See: R. P. Goldthwait, et al, No. 262.

213. Dreimanis, Aleksis. 1957. Stratigraphy of the Wisconsin glacial stage along the northwestern shore of Lake Erie. Science. 126:166-168.

Six-year field investigations and laboratory studies of Pleistocene deposits north of Lake Erie have provided information sufficient for preliminary conclusions on the Wisconsin stratigraphy of this area. Data is given concerning dates and deposits of material. (BL)

214. Dreimanis, Aleksis. 1958. Wisconsin stratigraphy at Port Talbot on the north shore of Lake Erie, Ontario. Ohio J. Sci. 58(2):65-84.

While examining Lake Erie cliffs half a mile southwest of Port Talbot in October 1957, the author discovered an organic layer below the lower till. These two exposures with organic remains have been compared with many others and both combined, were considered as the most complete Wisconsin sections along the north shore section of Lake Erie. Discussed in this paper are the lithologies of the section, ice flow direction, organic remains discovered (paleo), stratigraphic correlations and sequence of Pleistocene events. (BU)

215. Dreimanis, Aleksis. 1964. Lake Warren and the Two Creeks Interval. J. Geol. 72:247-250.

The recently published radiocarbon dates of Lake Iroquois, a new date of early Lake St. Clair, and absence of unconformities between the early and the late Warren deposits in southwestern Ontario suggest that not only the early Lake Warren, but also the late Lake Warren, Lake Wayne, Lake Grassmere, Lake Lundy, early Lake Algonquin, and the initial phase of Early Lake St. Clair are older than the Two Creeks Interval. (BL)

216. Dreimanis, Aleksis. 1969. Late-Pleistocene Lakes in the Ontario and the Erie Basins. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 170-180.

No undisputable information is available for the pre-Illinoian time, and the record from the Illinoian Glacial Stage is too fragmental for concluding on the proglacial lakes in the Ontario and the Erie Basins.

A lake existed in the Ontario Basin during the Sangamon Interglacial, and its level rose above the present lake towards the end of this interglacial, probably because of the isostatic uplift in the St. Lawrence outlet area. It is possible that a contemporaneous lake existed in the Erie Basin, and the St. David's buried gorge was its outlet.

During the Wisconsin Glacial Stage, because of the recurring changes of the lake outlets by the advances and the retreats of the ice margin and the depression of the outlet areas by glacial load, several high- and low-level lakes alternated in the Ontario and the Erie Basins.

In the Ontario Basin high-level lakes (higher than at present) are known from the beginning of the Wisconsin Glaciation, for instance Lake Scarborough, then during the Port Talbot and Plum Point Interstadials and several towards the end of the last ice age. The lake level was below the present one during the St. Pierre Interstadial and for some time after the opening of the post-glacial St. Lawrence outlet.

In the Erie Basin the number of lakes or their phases is greater than in the Ontario Basin, because of more fluctuations of the ice margin and the development of outlets along two rather than one glacial lobe: the Erie-Ontario and Huron lobes. Lake levels lower than now are known from the Port Talbot and Plum Point Interstadials, the Port Huron-Cary Interstadial, and the Late-glacial. Lake levels were higher than at present whenever the Niagara area was blocked by the Ontario lobe.

217. Dreimanis, Aleksis and G. H. Reavely. 1953. Differentiation of the lower and the upper till along the north shore of Lake Erie. J. Sed. Petrol. 23:238-259.

Lower and upper tills along the north shore of Lake Erie were studied by various field and laboratory methods. Some of these methods are color and grain-size, petrographic analyses, heavy mineral investigations, and determination of carbonate content. (BL)

218. Droste, John B. 1956. Clay minerals in calcareous till in Northeastern Ohio. J. Geol. 64:187-190.

The clay-mineral content of 103 samples of calcareous till was determined by X-ray techniques. The difference in clay-mineral content of horizon V, unoxidized, and horizon IV, oxidized, till of the same age is pointed out, and it is suggested that the clay minerals present in tills of different ages may be used as an aid in correlation. (BL)

Duane, D. B. - See: D. W. Berg, No. 46.

Duchene, J. - See: R. M. Pfister, et al, No. 576.

Dugan, Patrick R. - See: D. L. Howard, et al, No. 342.

Dugan, Patrick R. - See: Walter O. Leshniowsky, et al, No. 443.

Dugan, Patrick R. - See: R. M. Pfister, et al, No. 574, 575, 576.

Eadie, William J. - See: G. E. McVehil, et al, No. 478.

219. Eadie, William J. 1970. The experimental modification of lake-effect weather, final report. Calspan. Buffalo, N. Y. CAL Rept. VC-2898-P-1. 70 p.

During November and December of 1968, field experiments were carried out on the southeastern shore of Lake Erie to determine the feasibility of modifying lake-effect weather. The primary objective of the experiments was to test the hypothesis that the snowfall from intense lake-effect storms could be redistributed over a larger area by overseeding with ice nuclei, thereby reducing the heavy natural snowfall near the lee shore. The experiments demonstrated that overseeding can be accomplished for short periods in lake-effect snow bands of moderate intensity. (CA)

220. Eadie, William J., Ronald J. Pilie and Warren C. Kormond. 1971. Modification and modeling of lake-effect weather, final report. Calspan. Buffalo, N. Y. CAL Rept. VC-2898-P-2. 101 p.

Field experiments in the Great Lakes weather modification program were carried out near the southeastern shore of Lake Erie to determine the feasibility of modifying lake-effect cloud systems by seeding with artificial ice nuclei. These experiments provide additional evidence that it is possible to rapidly glaciate lake-effect cloud systems by overseeding. (CA)

221. Edwards, William M. and Lloyd L. Harrold. 1970. Agricultural pollution of water bodies. Ohio J. Sci. 70(1):50-56.

Pollution of Ohio's water bodies is of growing public concern; industrial, urban, and rural sources are becoming the subject of critical examination. Rural sources are soil sediment, plant nutrients, animal waste, and pesticides. Pesticides and phosphorus are absorbed rapidly and strongly to soil particles. Therefore reductions in sediment, phosphorus, and pesticide pollution are achieved by soil-erosion-control farming practices. More acres need to be brought under erosion-control practices. Nitrates dissolve in water and are carried by surface flow to streams and lakes, and by percolating water to underground aquifers. Increases in the use of nitrogen fertilizer, in evidence almost everywhere, could result in serious contamination of water bodies, if soil enrichment greatly exceeds the crop demand. Areas where large-scale livestock and poultry production is concentrated are also potential sources of serious pollution. In Ohio, animal-waste pollution problems are being studied at the Ohio State University, and movement of pollutants in surface and subsurface waters on drainage plots near Castalia are being studied by the Ohio Agricultural Research and Development Center and on agricultural watersheds by U. S. D. A. Agricultural Research Service at Coshocton, Ohio. (SE)

222. Eichenlaub, V. L. 1970. Lake effects of snowfall to the lee of the Great Lakes: its role in Michigan. Am. Meteor. Soc. Bull. 51(5):403-412.

Lake effect snowfalls contribute a significant portion of the total winter snowfall in areas to the lee of the Great Lakes. Evidence suggests that lake effect snowfall has significantly increased during the past several decades. It seems likely that a general cooling of winter temperatures may be partially responsible for this climatic change. (BU)

Elder, F. C. - See: P. J. Denison, No. 195.

223. Emmett, Joel. 1969. The effects of precipitation elements on the point discharge corona current from a multiple-point collector. In: Lake Effect Snow. N. Y. S. Univ. College at Fredonia. Final Rept. pp. 67-80.

Atmospheric conditions are many and varied. The purpose of this paper is to make an approximate correlation between the atmospheric precipitation type and the point discharge corona current occurring during the "lake-effect" season. Correlation has been made between both the current intensity and polarity and various types of precipitation formation, both liquid and solid in degree. (CCIW)

Engel, Ronald - See: N. Wilson Britt, et al, No. 68.

224. Environment Control Technology Corporation. 1974. Huron River: Gedded Dam through Ford Lake - September 12-13, 1973. Mich. Water Resources Comm. Ann Arbor, Mich. 51 p.

A forty-eight hour intensive study of the Huron River from Geddes Dam to Ford Lake Dam was performed during September 1973. The study included analysis of wastewater point sources discharging directly into the river. A river model was constructed using data obtained from the study and compared with mathematical models of dissolved oxygen concentration. Water near lake sediments was found to be low in dissolved oxygen but no significance is attributed to it in this report.

225. Erie-Niagara Basin Regional Water Resources Planning Board. 1969. Erie-Niagara Basin Comprehensive Water Resources Plan. Main Rept. N. Y. Water Resources Comm. Albany, N. Y. pp. III-1 to III-14.

This section of the report contains a summary of the ground and surface water resources in the Basin with emphasis on quantitative potentials for development. Included is information and maps concerning the distribution of unconsolidated deposits and bedrock. The surficial ground water deposits are shown also on a map along with data on the major streams and their drainage, annual precipitation, snowfall, and runoff. The end section of this chapter deals with upland reservoirs.

226. Erie and Niagara Counties Regional Planning Board. 1973. Water quality management study, interim report. Erie and Niagara Counties Regional Planning Board. Utilities Committee. 337 p.

The purpose of this study is to present a plan for the development of a Water Quality Management Program which will restore and maintain the water quality in accordance with the standards set forth by the Stream Classifications. The theme deals with identification of sources of pollution, surveillance and monitoring programs, research towards new disposal and treatment, and a general encouragement of joint cooperation of related agencies and interests. Data and sources of the various tributary systems in Erie County are presented.

Eryuzlu, N. E. - See: R. L. Pentland, No. 567.

Eschman, D. F. - See: J. A. Dorr, No. 211.

227. Fahnestock, R. K., D. J. Crowley, M. Wilson and H. Schneider. 1973. Ice volcanoes of the Lake Erie shore near Dunkirk, New York, U. S. A. J. Glaciology. 12(64):93-99.

Conical mounds of ice form in a few hours during violent winter storms along the edge of shore-fast ice near Dunkirk, New York. They occur in lines which parallel depth contours, and are evenly spaced in the manner of beach cusps. The height and spacing of mounds and number of rows vary from year to year depending on such factors as storm duration and intensity and the position of the edge of the shore-fast ice at the beginning of the storm. The evenly sloping conical mounds have central channels which increase in width lakeward. The ice between the channels forms headlands above the lake surface. Sprayed-formed levees develop along the headlands and slope gently away from the lake margin. Lake marginal walls of ice are usually vertical. Spray, slush and ice blocks are ejected over the cone as each successive wave is focused by the converging channel walls. Ice blocks, interlayered with frozen slush and dirt, form bedding paralleling the sloping surface of cones, headlands and levees. These features are termed 'ice volcanoes' because their origin is in so many ways analogous to that of true volcanoes. (BL)

228. Fairchild, Herman L. 1897. Lake Warren shorelines in Western New York and the Geneva Beach. Geol. Soc. Am. Bull. 8:269-286.

General discussion and reconstruction of Lake Warren's shorelines. Lake Warren was an extensive body of water held at a high level in a portion of the Laurentian Basin by a barrier of glacial ice which blocked the low eastern outlets. Most of the work was covered in the Western New York region where it occupied the Erie-Huron Basin. (BL)

229. Fairchild, Herman L. 1899. Glacial lakes Newberry, Warren, and Dan, in Central New York. Am. J. Sci. (4th Ser.). 7(40):249-263.

Paper deals with the above listed glacial lakes and makes only a brief mention of their extent into the Erie Basin. The paper is chiefly concerned with the geologic series of events and features in Central New York. (SM)

230. Fairchild, Herman L. 1907. Glacial waters in the Lake Erie Basin. N. Y. S. Museum Pub. 106. 86 p.

This is a study of the Erie drainage basin in Western New York including discussion of the topography, location and trend of the glacial front, flow of escaping waters, position and effects of lake waters which followed the retreating ice front, plus descriptions and locations of moraines, drainage channel outlets, local glacial lakes, beaches, deltas, and lake plains. (SM)

231. Fairchild, Herman L. 1928. Geologic story of the Genesee Valley and Western New York. Scrantom's Inc. Rochester, N. Y. 215 p.

The data pertaining to Lake Erie is scattered throughout the book. However, most of it pertains to the Erigan River system, precursor to Lake Erie. (BU)

232. Falconer, R., L. Lansing and R. Sykes. 1964. Studies of weather phenomena to the lee of the Eastern Great Lakes. Weatherwise. 17(6):256-261, 277.

Discussion of the lake effect storms, snow squalls, that the Lakes of Erie and Ontario produce due to the thermal relations of their water bodies to the air. (BU)

Farlow, John S. - See: A. Okubo, No. 531.

233. Farlow, John S. 1965. A field technique used for horizontal diffusion studies in Lakes Michigan and Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 13:299-303.

Locations of 130 plywood floats, each of 120 square inches area and supporting 4- by 8-foot drogues at depths of either 5 or 20 feet, were determined by aerial photography at 5-minute intervals for 2 hours and then at 10-minute intervals for at least one more hour. This technique was used twice at each of three shallow-water locations in 1964: a mile northwest of Indiana Harbor, Indiana; 5 miles west of Colchester, Ontario; and 3 miles west of Cleveland, Ohio.

234. Farnsworth, P. J. 1892. The Great Lakes Basins. Science (Ser. I). 20(496):74-75.

Author maintains that the Great Lakes are pools left by the intrusion of the Azoic Seas. The glacial periods caused the deviation in the outflow of the Great Lakes and he states that Lake Erie is of post-glacial age and a shallow trough that acted as an outflow bridge between Huron and Ontario. (BU)

235. Farwell, Oliver A. 1925. Botanical gleanings in Michigan. Am. Mid. Nat. 9(7):259.

Brief account of author's observation of "tide" change at Monroe Piers on August 27th. A one-foot water change caused a 200-foot beach to be covered with water. No winds were noted in the vicinity for the day. (SM)

236. Fell, G. E. 1910. The currents at the easterly end of Lake Erie and the head of Niagara River. J. Am. Medical Assoc. 55(10):828-834.

The water supply intake for the city of Buffalo was located near the center of the Niagara River, near its head at Lake Erie. The current at this point was 7 to 9 mph and it carried 220,000 cubic feet per second of water. This was considered an important factor in the purity of the water and the prevention of an epidemic of typhoid fever from spreading from the Smoke Creek area and affecting the entire city in 1903. The current was studied by using floats and it was found that no material from Smoke Creek or Buffalo River gains access to the Niagara River intake under normal wind and weather conditions. Instead, it flows into Buffalo harbor through the breakwall. (BECPL)

237. Fish, Charles J. 1929. Preliminary report on the cooperative survey of Lake Erie - Season of 1928. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 14(3):7-15, 195-220.

Preliminary statement on the results of three months survey of Eastern Lake Erie to determine the cause for the decline in the fishery. Included are the sample stations, their locations, their depths, and a statement concerning the field program in regard to the physical observations made. The last section is a summary of the reports in the bulletin and a data listing of each of the cruises, showing the location, time, depth, wind force and direction, seas, weather, transparency, and temperature.

238. Fish, Charles J. 1960. General review and conclusions. In: C. J. Fish and Associates (Eds.), Limnological Survey of Eastern and Central Lake Erie 1928-29. U. S. Fish and Wildlife Service. Washington, D. C. Spec. Sci. Rept.-Fish. No. 334. pp. 173-198.

This section of the report deals with a summation of the articles presented. Also included is a discussion of the topography and physical hydrography of the Central and Eastern Basins. These include a map showing the distribution of clays and mud in the Basins.

239. Foell, Eric J. 1974. The age and growth of Freshwater Drum (Aplodinotus grunniens Rafinesque) from Lake Erie near Cleveland, Ohio. M. A. Thesis. John Carrol Univ. Cleveland, Ohio. pp. 84-85.

Brief discussion of the temperature profile made in Lake Erie in the Central and Western Basin, showing the difference in time annulus formation of the Freshwater Drum.

240. Forel, F. A. 1900. Oscillations of Lake Erie. Mon. Wea. Rev. 28(10):446.

A reply to the article by Henry (28:203-205). The author questions the previous findings concerning the period of seiches, both binodal and ninodal. A difference of 10 to 15 hours in duration had been observed making them the longest oscillations accurately measured up to the present day on any body of water. (BECPL)

Forsyth, Jane L. - See: R. P. Goldthwait, et al, No. 262, 263.

Forsyth, Jane L. - See: E. S. Hamilton, No. 293.

241. Forsyth, Jane L. 1959. The beach ridges of Northern Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Info. Circ. Columbus, Ohio. 10 p.

Low continuous sandy ridges occur throughout wide areas of Northern Ohio. These ridges represent ancient beaches formed during various stages of Lake Erie. Glacial lake history is briefly summarized and an excellent map of ridges and other glacial features is included. (SM)

242. Forsyth, Jane L. 1960. Correlation of tills exposed in Toledo Edison Dam cut, Ohio. Ohio J. Sci. 60(2):94-99.

Two tills separated by a cobble pavement and overlain by lacustrine and alluvial deposits, are exposed in the east bank of the Anglaize River, three miles south of Dyrance, just north of the Toledo Edison Dam. This section is of significance because these tills have mechanical compositions which match those of the two tills described on the north shore side of Lake Erie by Dreimanis and two of the three tills mapped in Northeastern Ohio by White. (SE)

Fortin, J. P. - See: T. L. Richards, No. 619.

Frea, James I. - See: D. L. Howard, et al, No. 342.

Frea, James I. - See: Walter O. Leshniowsky, et al, No. 443.

Frea, James I. - See: Patricia A. McCabe, No. 471.

Frea, James I. - See: Robert M. Pfister, et al, No. 574, 575, 576.

Freeman, N. - See: J. P. Coakley, et al, No. 154.

243. Fuller, M. L. 1904. Evidence of caves of Put-in-Bay, Ohio, on question of land tilting. Science. 20:761.

A discussion of lakes within the caves of Put-in-Bay which fluctuate in level with the waters of Lake Erie. Submerged stalagmites in Daussa's Cave indicate a rise of the lake water relative to land. Stalactites in Paradise Cave indicate surmergence of recent times and thus a change in level of Lake Erie waters and offers no positive evidence of tilting. Occurrence of submerged tree stumps and other accordant evidences testifying to a level change seem to point to the tilting movement as little as half a foot to a hundred miles per century as the cause of the submergence indicated by the stalactites of the caves. (BL)

244. Gahnoog, Abdillahi. 1968. Textural and mineralogical investigation of Iroquois and Warren beaches, in Erie and Niagara Counties, Western New York. M. A. Thesis. S. U. N. Y. at Buffalo. Buffalo, New York. 45 p.

Comparison and contrast of the sedimentological characteristics of the Warren beach complex with those of the Iroquois beach in Western New York is presented. A discussion is also made on the sedimentological differences between the first Warren and second Warren beaches. Mechanical analysis, heavy mineral determinations, and statistical methods were used. (BL)

245. Galloway, F. M., Jr. 1973. The dependence of pollution circulation on the vertical diffusivity in the Western Basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 702-709.

Numerical and graphical results have been obtained from the computer for the spread of a conservative pollutant in the Western Basin of Lake Erie. The Gedney-Lick current model was used to describe the circulation. In each example, the spread of pollution was simulated for up to two days.

A strong dependence on the value of the vertical diffusivity was obtained. Using the typical value of 5 sq cm/sec for the vertical diffusivity, it was found that the variation in pollutant concentration in the vertical direction was slight. A value of 50 sq cm/sec for the vertical diffusivity produced pollution contours that demonstrate virtually no variation in the vertical direction. On the other hand, a value of .5 sq cm/sec for the vertical diffusivity yielded results in which the pollution contours varied sharply from top to bottom, reflecting the vertical dependence of the currents.

The solutions were mildly dependent on changes in the distribution of pollutant concentration at the mouth of the river from which they were introduced. Because of the sensitivity of these results to the vertical diffusivity, it is concluded that more experimental and theoretical work needs to be done to accurately relate the vertical diffusivity to local conditions.

246. Gannon, J. E. and A. M. Beeton. 1969. Studies on the effect of dredged materials from selected Great Lakes harbors on plankton and benthos. Univ. Wisc. Center for Great Lakes Studies. Milwaukee, Wisc. Spec. Rept. 8. pp. 3-20.

Report bears mention as to physical characteristics of sediments collected at Detroit, Toledo, Cleveland, and Buffalo Harbors. Presented in the tables are the particle types, size analysis, gross observations, chemical characteristics, and maps showing the collection sites.

247. Gedney, Richard T. 1971. Numerical calculations of the wind-driven currents in Lake Erie. Ph.D. Dissertation. Case Western Reserve Univ. Cleveland, Ohio. 258 p.

The steady state, wind-driven velocities in Lake Erie have been calculated numerically. A single equation for an integrated stream function based on a shallow lake theory originally developed by P. Welander is solved by finite difference methods. The three-dimensional velocities as a function of depth and horizontal position are displayed for numerous wind cases. The results show that the velocities vary greatly from position to position and depend strongly upon the bottom topography and boundary geometry.

The calculated velocities are compared with continuous current meter measurements at 10 and 15 meters below the surface. Remarkably good quantitative agreement between the meter measurements and calculations was found to exist wherever the wind was fairly steady for 2 or more days. Qualitative agreement with sea bed drifter and surface drift card measurements is also reached. (CA)

248. Gedney, Richard T. and W. Lick. 1970. Numerical calculations of the steady-state, wind-driven currents in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 829-838.

Solutions for the steady-state, wind-driven currents in Lake Erie have been obtained by numerical methods. A shallow lake model, which does not require the friction layers to be small by comparison with the depth of the lake, has been used. In order to obtain some of the observed features of the currents, it was necessary to use a relatively small grid (3.22 km). This grid was variable in size for the mesh points adjacent to the boundaries and this permitted the boundaries to be approximated accurately.

The velocity as a function of depth and horizontal position has been determined. Results are presented for southwesterly and northeasterly winds. In both cases, narrow bands of strong currents were found near the shore. In other areas, large subsurface gyres were evident. The calculated results compare quite well with seabed drifter measurements and other observations.

249. Gedney, Richard T. and W. Lick. 1971. Numerical calculations of the wind-driven currents in Lake Erie and comparison with measurements. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 454-466.

The steady-state, wind-driven velocities in Lake Erie have been calculated numerically using a shallow lake model. The three-dimensional velocities as function of depth and horizontal position are displayed for the prevailing southwest winds. The results show that the velocities vary greatly from position to position and depend strongly on the bottom topography and boundary geometry. For the numerical calculations, a

0.805 km grid size in an island region and a 3.22 km grid size in the rest of the lake had to be incorporated to represent adequately the Lake Erie geometry.

The calculated velocities compare quantitatively very well with the current meter measurements made at mid-depths in the Central and Eastern Basins. The magnitudes of the average eddy viscosity used in the calculations agree with measurements made in the Great Lakes. Steady currents are shown to occur usually after two days to fairly uniform winds.

250. Gedney, Richard T. and W. Lick. 1972. Wind-driven currents in Lake Erie. J. Geophys. Res. 77(15): 2714-2723.

The steady-state wind-driven currents in Lake Erie are investigated. A numerical solution for the mass-transport stream function and the three-dimensional velocities as a function of depth and horizontal position is obtained and compared with measurements. The agreement is good. This report shows that the currents depend strongly on bottom topography and boundary geometry.

251. Gedney, Richard T. and Herman Mark. 1972. The Lewis Research Center's earth observation program for water quality and limnology. In: Proceedings of the First Federal Conference on the Great Lakes. Interagency Committee on Mar. Sci. and Eng. for the Federal Council for Science and Technology. Washington, D. C. pp. 246-263.

Presentation of remote sensing methods for satellites and aircraft and how the spectral characteristics of a water body can be related to many of the water body's parameters. Related topics to Lake Erie are high and low particulate concentration, parameters applying to particulate distributions --causes and effects, current patterns and wind-driven currents which are shown graphically for Lake Erie.

Gehring, P. E. - See: T. Braidech, et al, No. 61.

Gehring, P. E. - See: C. O. Kleveno, et al, No. 398.

252. Gelinas, P. J. and R. M. Quigley. 1973. The influence of geology on erosion rates along the north shore of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 421-430.

Shoreline erosion in the central part of the north shore of Lake Erie, between Rondeau to the west and Long Point to the east, is estimated by comparison of early surveys of the shoreline (circa 1810) with recent air photographs of the same area (1963). The total wave energy reaching the shoreline has been calculated from five-year weather records and appropriate wave forecasting techniques. A nearly linear correlation exists between total wave energy at the breaking point and the long-term average rate of erosion except for two coastal areas, one east of Port Stanley and the other east of Port Burwell, where the erosion is significantly faster.

Erosion rates vary from 0.25 m/yr near Rondeau to about 2 m/yr east of Port Stanley. The two areas of excessive erosion (approximately 3 m/yr) correlate with non-cohesive sand and silt deposits extending to water level.

The morphology of the bluff varies from "flat" during periods of low water level to "steep" during periods of high water level and active erosion. A preliminary erosion model based on the mechanics of slope instability is presented.

253. Gibson, J. 1836. Geology of the lakes and the valley of the Mississippi. Am. J. Sci. (1st Ser.). 29:201-213.

Geologic formations located on the eastern margin of Lake Erie to the lithology of Lake Erie's shoreline are mentioned. Paleontology and the materials that contain the fossil forms is also mentioned. Very broad and general article containing information on Lake Erie. (SM)

Gilbert, B. K. - See: W. E. Harding, No. 297.

254. Gilbert, G. K. 1873. Geology of Lucas County. Ohio Geol. Surv. 1(1):573-587.

Local geology concerning topography, geological structure of the rock units, joints, surface geology, and soils are discussed. Included is the Lake Erie shore and the Maumee River. Economic geology is also presented with a discussion of usable material found in this area. (BL)

255. Gilbert, G. K. 1873. Geology of West Sister Island. Ohio Geol. Surv. 1(1):588-590.

Local geology concerning topography, soil, structure, and rock units is presented. Value and use of gypsum beds is al-

so discussed. (BL)

256. Gilbert, G. K. 1873. The surface geology of the Maumee Valley and on the geology of Williams and Fulton Counties, and West Sister Island. Ohio Geol. Surv. 1(1):535-572.

Discussed in this report are the raised beaches north of the Maumee River, glacial history and its effects on the ancient shores of the local geology, Erie clay, drift, glacial markings, and local rock units. The author discusses the history on the unconsolidated deposits of the region under consideration of the glacial epoch and postglacial epoch with their subdivisions. (BL)

257. Gilbert, G. K. 1891. On certain glacial and postglacial phenomena of the Maumee Valley. Am. J. Sci. 1(5):339-345.

A description of the Maumee Valley is presented with analysis of glacial effects in the region. (BL)

258. Gilbert, G. K. 1897. Modification of the Great Lakes by earth movement. National Geog. Mag. 8(9): 233-247.

Formation of the modern Lake Erie Basin, with a description of the location and extent of its postglacial basin in development following and prior the crustal rising and tilting is discussed. Flow of the Great Lakes water is described in the evolution of the Great Lakes. Included is a discussion regarding Lake Erie wind effect levels, oscillations, seiches, and crustal tilting and movement. Discharge of the lakes is related to land tilting and the effects in 1000 to 3000 years. (BU)

Gilbertson, M. - See: H. H. Dobson, No. 204.

259. Gillies, Donald K. A. 1960. Winds and water levels on Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:35-42. also in Royal Meteor. Soc. (1959). 9(1).

Hourly and daily variations in Niagara River flow cause problems to the scheduling of power production. The problem of variable Lake Erie water levels is discussed, concerning meteorological and morphymetrical factors that produce seiches and noted variations in levels of the water. A presentation

of the parameters involved and a method of forecasting of lake levels is made. (RL & CCIW)

Gleissner, Bruce - See: C. J. D. Brown, et al, No. 71.

260. Glick, D. T. 1960. Breaking king winter's hold on Lake Erie. Inland Seas. 16(4):323.

Brief historical summary of attempted winter navigation of Lake Erie in 1897, by the steamer State of Michigan, from Amherstburg to Cleveland. (BU)

261. Goldthwaith, Richard P. 1958. Wisconsin age forests in Western Ohio I: Age and glacial events. Ohio J. Sci. 58(3):209-219.

Twenty-nine dates have been determined by radiocarbon analysis for buried wood materials in Western Ohio and immediately adjacent areas. This is an attempt to fit known stratigraphic sections to dates. The vicinity of Sandusky and Cleveland are covered. Glacial advances, material deposition, and glacial lake levels are also included. (BU)

262. Goldthwaith, Richard P., A. Dreimanis, J. L. Forsyth, P. F. Karrow and G. W. White. 1965. Pleistocene deposits of the Erie Lobe. The Quaternary of the U. S. Princeton Univ. Press. Princeton, N. J. pp. 85-97.

The Erie Lobe was fed by ice flow from north of Lake Ontario. This paper discusses the glacial history of the area below Lake Erie. Brief mention is made of some glacial deposits on the southern Lake Erie shore. (BL)

263. Goldthwaith, Richard P., G. W. White, and Jane L. Forsyth. 1961. Glacial map of Ohio. U. S. Geol. Surv. Misc. Geol. Invest. Map 1-316. 1 map.

Glacial map of Ohio illustrates lacustrine and alluvium deposits on the Ohio Lake Erie shores, with an outline of glacial lake beaches. Also the glacial deposits and their age in the vicinity of the Erie Basin in Ohio is shown. Major glacial lobes and a key map showing sources of data for each of the areas in Ohio for the compilation of the map is also included. (SM)

264. Gottschall, R. Y. and O. E. Jennings. 1933. Limnological studies at Erie, Pa. Am. Micro. Soc. Trans.

52(3):181-191.

General introduction into physical and chemical studies performed in the vicinity. Emphasis is on biological life forms in an investigation to determine decline in fish life. (BU)

265. Grabau, A. W. 1899. The palaeontology of Eighteen Mile Creek and the lake shore sections of Erie County. Bull. Buffalo Soc. Nat. Sci. 6(2,3,4): 303 p.

Report contains the local palaeontology of the lake shore and drainage in Erie County. Book is illustrated and keyed. Included are general discussion and introduction. (BU)

Graves, Maurice E. - See: W. Gale Biggs, No. 49.

266. Graves, Maurice E. 1962. The prediction of prolonged temperature inversions near the western shore of Lake Erie. Univ. Mich. Great Lakes Res. Div. Spec. Rept. 16. Tech. Rept. 6. 37 p.

Temperature inversions at the site of the Enrico Fermi Atomic Power Plant near the western shore of Lake Erie are studied for the three year period from December 1956 to November 1959. Such inversions in the first 100 feet persisting more than 24 hours are related to certain macroscalar surface synoptic features, to surface wind direction, and to warm air advection. The surface trajectories of air parcels arriving over the plant site during prolonged inversions are classified and discussed. The importance of stagnating anticyclones is then investigated. And lastly, a graphical method is proposed and tested for the prediction of prolonged inversions in this area. (CA)

Gray, C. B. J. - See: A. L. W. Kemp, et al, No. 388.

267. Gray, C. B. J. and A. L. W. Kemp. 1970. A quantitative method for the determination of chlorine pigments in Great Lakes sediments. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 1. pp. 242-249.

A method for the extraction and quantitative measurement of chlorophylls a, b, c; pheophytin a, b; chlorophyllides a, b; pheophorbides a, b; and allomerized a and b chlorin pigments in lake sediments is described. The chlorin pigments are ultrasonically extracted in an acetone-methanol mixture, concentrated, and separated by reverse-phase thin layer chromatography. The chlorins were eluted from each band and determined spectrophotometrically. The method had a precision of ±6%.

Chlorin pigments were determined in six surface sediment samples from the main basins of Lakes Ontario and Erie. Chlorophyll a (0-10 ppm), allomerized chlorophyll a (0-1.3 ppm), pheophytin a (3.6-7.4 ppm) and pheophorbide a (6.7-17.3 ppm) were found in the six samples. The absence of chlorophyll b and its degradation products suggested that the organic material at these stations was autochthonous organic matter.

268. Great Lakes Basic Hydraulic and Hydrologic Data Coordinating Committee. 1965. Lake Erie outflow 1860-1964. U. S. Lake Survey. Corps of Engineers. Washington, D. C. 18 p.

Documentation of the Lake Erie outflow and record of the outflows that were derived for the period 1860-1964. Stage discharge records and mean monthly outflows are included in tables and plates following the report. (CCIW)

269. Great Lakes Basic Hydraulic and Hydrologic Data Coordinating Committee. 1969. History of water level guages, Lake Erie and Niagara River. U. S. Lake Survey. Corps of Engineers. Washington, D. C. 89 p.

Presentation of the history of the operation of water level guages on Lake Erie and the Niagara River. Details as to the location, the type of record, the operating agency, and how the datum was established and maintained are given for each gauging station. (CCIW)

270. Great Lakes Basin Commission. 1972. The future of the Great Lakes - Great Lakes Basin Framework Study. Great Lakes Basin Comm. Ann Arbor, Mich. 60 p.

Broad-scale analyses of resource needs and problems of the Great Lakes are presented. Pages 18-60 deal specifically with the Lake Erie study area. Tributary streams annually contribute nearly 25 million tons of sediment to Lake Erie. The Maumee River alone contributes approximately 1.2 million tons to Maumee Bay and the Western Basin of Lake Erie. (SM)

271. Great Lakes Commission. 1968. Report to the States 1967-1968. Great Lakes Comm. Ann Arbor, Mich. 39 p.

Brief mention of the precipitation for the years 1967-1968 and the average from 1900-1968 are given for each of the Lakes including Lake Erie. Water level in Lake Erie is also mentioned and represented graphically.

272. Great Lakes Commission. 1970. Report to the States 1969-1970. Great Lakes Comm. Ann Arbor, Mich. pp. 8-9.

A brief mention of the precipitation in the Great Lakes Region, giving data for Lake Erie for the 1969-1970 year compared to a 71-year average. Also included is the annual discharge for the Detroit River.

273. Great Lakes Commission. 1972. Report to the States 1971-1972. Great Lakes Comm. Ann Arbor, Mich. pp. 8-11.

A brief mention of the precipitation in the Great Lakes Region, giving data for Lake Erie for the 1971-1972 year as compared to a 73-year average. Monthly mean elevations of water levels is presented graphically and the results of flooding that have produced erosion in the Great Lakes Basin is discussed.

274. Great Lakes Commission. 1973. Precipitation, lake levels and the Lake Superior Reservoir. Great Lakes News Letter. Great Lakes Comm. Ann Arbor, Mich. 17(3):5.

Above normal precipitation is mentioned for Lake Erie and the average amounts are presented in this section of the newsletter.

275. Great Lakes Commission. 1973. A year round record of high water levels for Lake Erie. Great Lakes News Letter. Great Lakes Comm. Ann Arbor, Mich. 17(6):5.

A brief summary of high water levels recorded for Lake Erie during the late 1972 to August 1973 period. Included is a graph showing the monthly means from January 1972 to August 1973.

276. Great Lakes Institute. 1964. Data record 1962 surveys, Part I - Lake Ontario and Lake Erie. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 16. 97 p.

The data presented in this report consist entirely of physical and chemical data on lake waters and the meteorological conditions which accompanied these surveys. Included in this report are maps denoting station locations for each of the studies, synoptic weather observations taken at each of the stations, radiation data, bathythermograph data and many other chemical and physical measurements. Sediment samples and hydrosonde records are mentioned only as to location of sampling but reference is made as to where information can be obtained concerning this aspect of the report.

277. Great Lakes Institute. 1965. Great Lakes Institute data record 1963 surveys, Part I - Lake Ontario, Lake Erie and Lake St. Clair. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 23. 195 p.

The data presented in this report consist entirely of physical and chemical data on lake waters and the meteorological conditions which accompanied these surveys. Included in this report are maps denoting station locations for each of the studies, synoptic weather observations taken at each of the stations, radiation data, bathythermograph data and many other chemical and physical measurements. Sediment samples and hydrosonde records are mentioned only as to location of sampling but reference is made as to where information can be obtained concerning this aspect of the report.

278. Great Lakes Institute. 1971. Great Lakes Institute data record surveys in 1964 of the CCGS Porte Dauphine for Lake Ontario, Lake Erie, Lake St. Clair, Lake Huron, Georgian Bay, Lake Superior. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 42. 238 p.

The data presented in this report consist entirely of physical and chemical data on lake waters and the meteorological conditions which accompanied these surveys. Included in this report are maps denoting station locations for each of the studies, synoptic weather observations taken at each of the stations, radiation data, bathythermograph data and many other chemical and physical measurements. Sediment samples and hydrosonde records are mentioned only as to location of sampling but reference is made as to where information can be obtained concerning this aspect of the report.

279. Great Lakes Laboratory. 1970. Analysis of sediments (in the vicinity of Cleveland, Ohio, Lake Erie).

N. Y. State Univ. College. Great Lakes Lab. Buffalo, N. Y. 11 p.

The major purpose of the investigation was to determine the quality of the sediment in the area off Cleveland, Ohio, in Lake Erie.

280. Great Lakes Laboratory. 1970. Evaluation of the ecological impact of sand dredging on Lake Erie. N. Y. State Univ. College. Great Lakes Lab. Buffalo, N. Y. 11 p.

The effect of sand dredging on the oxygen-temperature profile of the water off Erie, Pennsylvania, was shown to be negligible.

281. Great Lakes Research Institute and the Institute on Man and Science. 1971. The Lake Erie Congress. Great Lakes Res. Inst. Erie, Penn. 42 p.

The proceedings of the Congress, the purpose of which was to clarify concerns and mandates and to examine new institutional and technical interventions which might effectively order resources in the service of Lake Erie. (MS)

282. Great Lakes Research Institute. 1973. Selected analysis and monitoring of Lake Erie water quality. Erie County Health Dept. Erie, Penn. Annual Rept. 60 p.

Analysis of the data from water samples collected in the Pennsylvania region of Lake Erie during the 1973 season shows very little difference in water quality between points east and west of Erie, Penn. The pollutant input level is apparently not sufficient to have any adverse effects on the water quality of Lake Erie. Of the eight heavy metals assayed, the only metals that were present were copper, iron, and aluminum. Coliform and pesticide levels were also tested. Benthic contamination was analyzed with emphasis on its effect on the quality of the overlying water.

283. Great Lakes Research Institute. 1973. Selected analysis and monitoring of Lake Erie water quality. Erie County Health Dept. Erie, Penn. Supplement. 140 p.

The statistical analysis of the Lake Erie Water Quality Study for the Erie, Pennsylvania, area. Twenty-two selected res-

ponses are analyzed.

284. Great Lakes-St. Lawrence Seaway Winter Navigation Board. 1972. Winter Navigation Seminar. Great Lakes-St. Lawrence Seaway Winter Navigation Board. Detroit, Mich. Proc. 238 p.

The proceedings discuss the problems of winter navigation on the Great Lakes-St. Lawrence Seaway and the progress being made toward extension of the navigation season. The information is very general in its application; Lake Erie is rarely mentioned.

285. Great Lakes-St. Lawrence Seaway Winter Navigation Board. 1973. Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program. Great Lakes-St. Lawrence Seaway Winter Navigation Board. Detroit, Mich. First Annual Rept. Appendix C. pp. 89-100.

A complete description of the physiography, economic development, existing traffic, and discussion of winter characteristics of the Great Lakes (including Erie) and the St. Lawrence Seaway system is provided.

286. Green, Charles K. 1960. Physical hydrography and temperature. In: C. J. Fish and Associates (Eds.), Limnological Survey of Eastern and Central Lake Erie 1928-29. U. S. Fish and Wildlife Service. Washington, D. C. Spec. Sci. Rept.-Fish. No. 334. pp. 11-69.

The data included deals with the conditions in Lake Erie during 1928-29. The topics covered include methods, meteorological conditions, temperatures, water movements (currents and subsurface movements of the Deep Hole waters), oscillations, and transparency. General physical properties are covered and the data obtained during the surveys are included in the form of tables and figures.

Gronek, R. J. - See: M. L. Kaplan, et al, No. 384.

287. Gumerman, R. C. 1970. Aqueous phosphate and lake sediment interaction. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 673-682.

Significance of aqueous phosphate interaction with sterile

sediment from Central Lake Erie and Western Lake Superior was investigated in the laboratory. The buffering effects of sediments upon aqueous phosphate is of critical significance in attempts to alter lakewater phosphate concentrations. System equilibrium shifts to yield greater removal at increased aqueous phosphate concentration, oxidation-reduction potential, and acid pH values. However, decreased uptake per unit weight of sediment results from both decreased temperature and depth of sediment greater than 3.5 mm below the interface.

Shifts in chemical equilibrium between aqueous phosphate and sterile sediments allowed sediment phosphate releases in both cases when aqueous phosphate dropped below a minimum value. Cessation or reduction of phosphate inputs to a lake will not reduce aqueous phosphate concentrations as rapidly as believed, but is a necessary first step prior to elimination of available sediment phosphate and thus expurgation of nuisance algal growth.

288. Gutenberg, Beno. 1933. Tilting due to glacial melting. J. Geol. 41:449-467.

To investigate tilting and changes in level in the Great Lakes Region, results from the records of tide gauges of different stations were analyzed. In the Great Lakes Region, all results indicate a tilting of the land upward in the northerly direction by about 10 cm per 100 km per century. The cause of tilt is related by the author to the forces which tend to restore isostatic equilibrium, disturbed by the melting of ice after the Ice Age. Part of this article deals with the Great Lakes and a particular data for Lake Erie is included concerning tilt, gauge readings, and water level. (BL)

289. Gutenberg, Beno. 1941. Changes in sea level, postglacial uplift, and mobility of the earth's interior. Geol. Soc. Am. Bull. 52:721-772.

Record of tide gauges indicate that sea level is rising at an average rate of 10 cm per century. The uplift in North America is investigated, and maps showing the rate of uplift are given. (BL)

290. Gutenberg, Beno. 1954. Postglacial uplift in the Great Lakes Region. Archiv. Fur Meteor. Geophys. und Bioklimatologie. Ser. A. 7:243-251.

New data concerning uplift in northern North America and in

Fennoscandia are combined with earlier findings. The main quantities involved in the hypothesis of postglacial uplift are of the same order of magnitude of Fennoscandia and for the Great Lakes-Hudson Bay regions. Whereas the hypothesis of postglacial uplift is readily accepted for Fennoscandia, it has been rejected in several publications for the present uplift in North America, partly as a consequence of misinterpretation of data. Actually it offers the best explanation by far for the uplift in both areas. Given are data on relative lake level changes for Erie from 1865 to 1952. (SE)

291. Hachey, H. B. 1952. Vertical temperature distribution in the Great Lakes. Canada Fish. Res. Board J. 9(7):325-328.

On the basis of temperature observations made in the Great Lakes in the summer months, it has been shown that:

a) the maximum depth of the thermocline does not exceed 50 feet
b) the temperature gradient within the thermocline may be as much as $26^{\circ}$ F in 10 feet
c) the thickness of the surface layer varies considerably with time and position, and can, under certain circumstances, be entirely removed from an area
d) the temperature of the deeper waters approximates to that of the maximum density of fresh water. (SM)

292. Hamblin, P. F. 1971. Circulation and water movement in Lake Erie. Dept. of Energy, Mines and Resources. Inland Waters Branch. Ottawa, Ont. Sci. Ser. No. 7. 50 p.

This report provides a summary of presently available knowledge of the circulation, water movements, and diffusive processes occurring in Lake Erie. In addition, the residence time, theory of lake circulation and diffusion are discussed. An atlas of monthly averaged currents is provided.

Hamilton, A. L. - See: R. O. Brinkhurst, et al, No. 65.

293. Hamilton, E. S. and J. L. Forsyth. 1972. Forest communities of South Bass Island, Ohio. Ohio J. Sci. 72(4):184-210.

A description of the substrate characteristics of South Bass Island are given, with the local geology of formation, its bedrock and soil types.

294. Han, Gun. 1969. Neutron activation analysis of iodine in snow. In: Lake Effect Snow. N. Y. State Univ. College at Fredonia. Final Rept. pp. 81-90.

The present work was undertaken to test the feasibility of using more effective neutron activation analysis for determining traces of iodine in snow samples. In this method, snow samples were irradated with thermal neutrons and then after the ion exchange process, the gamma rays from activated $I^{128}$ were analyzed with a solid state detector. (CCIW)

295. Hanna, John. 1970. A situation report: Great Lakes water levels. Limnos. 3(1):23-27.

Lake Erie is the most susceptible to seiches, primarily because its long axis is nearly parallel to the prevailing wind direction. This article gives data for the lake levels of the Great Lakes.

296. Hanna, John. 1973. The Great Lakes are overflowing again. Limnos. 5(3):12-18.

This is a brief survey of Erie's lake levels. It tells what's going on, why they're rising, and what can be done about it.

Haras, W. - See: J. P. Coakley, et al, No. 154.

297. Harding, W. E. and B. K. Gilbert. 1968. Surface water in the Erie-Niagara Basin, New York. N. Y. Cons. Dept. Water Resources Comm. Albany, N. Y. Basin Planning Rept. ENB-2. 118 p.

The Erie-Niagara Basin contains about 2,000 square miles in Western New York State. The drainage systems of the area discharge into Lake Erie and the Niagara River at an average rate of about 1,730 mgd (million gallons per day). Annual precipitation ranges from about 32 to 44 inches. Evapotranspiration losses account for about 20 inches of water a year and the streams have an average annual runoff of about 18 inches.

Streamflow is highly variable throughout the year and also from place to place within the area. Extremes range from no flow to a maximum of about 200 cubic feet per second per square mile for the 50-year flood. In general, streams in the uplands region in the southern part of the basin have higher rates of flow per square mile than those in the rest of the area.

The regional distribution of runoff was estimated from studies of more than 100 streams. Mean annual runoff in the area increases as a function of the direct relationship between precipitation and elevation of the land surface; therefore, a map on a topographic base was developed from which mean annual runoff can be estimated for any stream in the area. Other maps in the report present the regional distribution of flow at the 50-, 90-, and 99-percent duration points. Low-flow frequency analyses show the minimum flows expected to recur at various intervals of time for periods of 1, 7, and 30 consecutive days. Studies of high flows provided the basis for a regional analysis of flood frequency for streams with drainage areas larger than 10 square miles.

Overbank flooding in the Erie-Niagara Basin is most extensive in the Tonawanda Creek Basin. Many floods are the result of the formation of ice jams, both in stream channels and at the mouths of streams entering Lake Erie, and are not necessarily caused by unusually high streamflows.

298. Harris, D. L. 1968. Preliminary wave climatology for the Great Lakes. Mariners Weather Log. 12(3): 82-84.

Wave heights on Lake Erie were reported to average 1.5 feet or less during the 1965 and 1966 seasons. Low waves had periods of less than 5 seconds. A close correlation in the frequency of wave heights between the Great Lakes is shown. (BECPL)

299. Harris, D. L. and A. Angelo. 1962. A regression model for the prediction of storm surges on Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9:123-126.

An abstract of predictions of the lake level for operational use by a numerical integration of the hydrodynamic equations are discussed and used in setting up regression models for Buffalo of storm surge observations and predictions.

Harris, T. B. - See: P. A. Allee, et al, No. 6.

Harrold, Lloyd L. - See: William M. Edwards, No. 221.

300. Hartley, Robert P. 1961. Bottom deposits in Ohio waters of Central Lake Erie. Ohio Dept. Nat. Resources. Div. Shore Erosion. Columbus, Ohio. Tech. Rept. 6. 14 p.

The bottom reconnaissance sampling program carried out by the Ohio Division of Shore Erosion has covered all of the Ohio waters of Lake Erie. This report includes that part from the island area eastward to the Ohio-Pennsylvania line. The samples were taken with a two-quart snapper sampler. Sampling density varied from one sample per one square mile to one per four square miles. Some depth sampling was also done by coring and jetting. All samples were mechanically analyzed for grain sizes and sorting.

Central Lake Erie is flat for the most part with a mud bottom. Slopes of any consequence are found only along shore in sand, gravel, and rock areas and in the commercial sand deposit north of Vermilion, Ohio. As a whole, the bottom surface deposits of the Ohio portion of Central Lake Erie are comprised of 22.5% sand and gravel, 76.6% silt and clay (mud), and 0.9% rock. The bottom deposits are derived mainly from glacial deposits with bedrock supplying a lesser but still large amount. Sands, gravels, and muds are probably transported and re-deposited by water currents and waves. Small areas of till and lag deposits of pebbles and cobbles have been found near shore, especially from Cleveland eastward. The coarser materials everywhere reflect the composition of the bedrock nearest at hand. Large quantities of sand and gravel of potential commercial value have been found near shore from Cleveland to Fairport and in mid-lake between Ashtabula and Conneaut. (CCIW)

301. Hartley, Robert P. 1961. Bottom sediments in the island area of Lake Erie. Ohio Dept. Nat. Resources. Div. Shore Erosion. Columbus, Ohio. Tech. Rept. 9. 22 p.

The study area includes the island area in the Ohio waters of Lake Erie. The bottom surface materials of the island area show a predominance of mud with patches of sand and gravel and bedrock. Mud areas are flat while others may be rugged. Subsurface data have been obtained in 99 borings. They have shown a predominance of lake deposited materials and rather scanty till overlying bedrock. The bedrock topography is rough west of the islands and comparatively smooth between the island chains. An attempt is made to correlate the surface and subsurface data with the present and previous lake stages and the processes which created the deposits. Preglacial buried valleys are indicated by bedrock topography. Some borings indicate the possibility of interglacial or postglacial buried valleys and low lake stages. Present bottom topography is an indicator of the character of contemporary wave and current forces and is briefly discussed. (CCIW)

302. Hartley, Robert P. 1962. Relation of shore and near-shore features to rock structure along Lake Erie. Ohio J. Sci. 62:125-131.

Small scale structural forms lead to variety in shoreline configuration. The discussion deals with forms found on Kelleys Island and those found along a two-mile stretch of shore just east of Vermilion, Ohio. Kelleys Island has been affected mainly by jointing of the Columbus limestone while the area east of Vermilion exhibits jointing, thrust, faults, normal faulting, and folds in Ohio shales. Shoreline trends in Lake Erie follow the general strike of the bedrock on a smaller scale, jointing leads to angular or block irregularities. Faulting results in narrow inlets and bays. Flexures lead to gently curving shorelines. (SE)

303. Hartley, Robert P. 1964. Effects of large structures on the Ohio shore of Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 53. 30 p.

Most of the large structures along the Ohio shore have caused build-up of beaches on their updrift sides and accelerated erosion downdrift. The effects are not balancing, in that the length of eroding shore is ordinarily five or more times the length of the shore which is protected by build-up. (SM)

304. Hartley, Robert P. 1968. Bottom currents in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 398-405.

In the summer of 1965, seabed drifters were released in Lake Erie primarily along the south shore and in the Western Basin. Returns have indicated clockwise bottom eddies in the Toledo-Detroit area, in the island area, and in mid-lake in the west half of the Central Basin. They have also indicated eastward bottom flow in the narrow band along the south shore and in a wider band along the north shore of the Central Basin. Centers of eddies may be significant repositories for pollutants. The center of the large clockwise gyre in the Central Basin may accumulate material originating all along the south shore of the Central Basin. The Toledo-Detroit eddy suggests accumulation of materials therein from these cities.

305. Hartley, Robert P., C. E. Herdendorf and M. Keller. 1966. Synoptic water sampling survey in the West-

ern Basin of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:301-322.

A water sampling survey was conducted on 23 June 1963 in Western Lake Erie in an attempt to map separate water masses within the basin. Samples were taken at five feet below the surface and at two feet above the bottom at 300 pre-established stations. All samples were analyzed in the laboratory for turbidity, hydrogen-ion concentration, and conductivity. Bathythermograph recordings were made at 76 stations. The values for each of the parameters were plotted and contoured.

Most of the measured values indicated a movement of the main flow of the Detroit River southward, perhaps as far as the Ohio shore. Water from the west side of the Detroit River apparently moves south and along the Michigan shore, while water from the east side of the river may move eastward along the Canadian shore. Movements from the Maumee River area southeastward along the Ohio shore and northward along the west side of the Bass Islands were also indicated, implying a dominant basin outflow through Pelee Passage. Water appeared to be moving into the southern island area from the Central Basin. Current measurements made during the spring of 1963 and water level data for the period during and preceding the survey lend support to the interpretation. Additional field measurements in 1964 tend to substantiate a consistency of flow patterns in Western Lake Erie.

Conductivity and water temperature are apparently the most useful parameters in mapping water masses. Turbidity and hydrogen-ion concentration are subject to many short-term variables and are probably not as useful in mapping water masses.

306. Hartley, Robert P., C. E. Herdendorf and M. Keller. 1966. Synoptic survey of water properties in the Western Basin of Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 58. 19 p.

Same article as appears under "Synoptic Water Sampling Survey in the Western Basin of Lake Erie", Univ. Mich., Great Lakes Res. Div., Proc. 9th Conf. on Great Lakes Res., Pub. 15: 301-322, No. 305. (CCIW)

307. Hartley, Robert P. and Chris P. Potos. 1971. Algal-temperature-nutrient relationships and distribu-

tion in Lake Erie. U. S. Environmental Protection Agency. Water Quality Office. Washington, D. C. 87 p.

Data gathered in the Lake Erie surveillance program by the Federal Water Quality Administration, Lake Erie Basin Office, provide the basis for discussion of the distribution of algal types and some of the physical and chemical factors which control algal populations in the Western and Central Basins of the lake.

For three seasons of the year, spring, summer, and fall, soluble phosphorus is remarkably uniform at any one place in Lake Erie, with occasional variations. Concentrations generally decrease from shore lakeward and from west to east in the lake (average midlake soluble phosphorus P 30 µg/l; nearshore 50 µg/l for Western Basin; Central Basin nearshore 30 µg/l; Central Basin midlake 15 µg/l). In winter, soluble phosphorus more than doubles in all nearshore areas and in the Western Basin midlake indicating considerable winter tributary input, nearshore sediment resuspension, limited dispersion, and low utilization by algae in winter. Particulate phosphorus exhibits an erratic year-round distribution. Nitrogen distribution is analyzed. The effect of water temperature on nutrient-algal relationships is discussed. (CCIW)

308. Hartman, W. L. 1970. Resource crises in Lake Erie. Explorer. 12(1):6-11.

The introduction of this article contains a brief, general description of the geologic characteristics of Lake Erie. The changes in the lake due to pollution are discussed.

309. Hartman, W. L. 1972. Lake Erie: Effects of exploitation, environmental changes and new species on the fishery resources. J. Fish. Res. Board Canada. 29:889-912.

In the author's study are included general morphometry, climate and environmental changes of Lake Erie. Included in this discussion are changes and effects of the drainage basins, temperature, and nutrient loading.

310. Hassan, J. and Robert A. Sweeney. 1972. Influence of the Upper Niagara River ice boom on the climate of Buffalo, New York. N. Y. S. Univ. College at Buffalo. Great Lakes Laboratory. Buffalo, N. Y. Spec. Rept. 13. 33 p.

This paper was generated from research to determine the possible impact of the Lake Erie ice boom at the head of the Niagara River on the climate and air pollution of the Greater Buffalo area. The study was initiated by statements by Erie County officials to the members of the International Joint Commission on 15 December 1971 in which it was claimed that the boom caused an extension of the winter season (cool temperatures) and increased inversions. The latter were cited as a factor aggravating air pollution problems on the Niagara Frontier.

311. Hayes, F. R. and E. H. Anthony. 1964. Productive capacity of North American lakes as related to the quantity and the trophic level of fish, the lake dimensions, and the water chemistry. Trans. Am. Fish. Soc. 93(1):53-57.

The Productivity Index, which is derived from the angling catch, commercial catch, or standing crop of fish, is given by the expression:

$$\log PI = -0.236 + 1.47 \cdot 10^{-4}x_1 - 0.517x_2 + 0.287x_3$$

where $x_1 = 10^5$/area in sq km, $x_2$ = log depth in m,

and $x_3$ = log methyl orange alkalinity in ppm.

The equation accounts for 67% of the variability in the Productivity Index, of which 20% is due to the area function, 29% to depth, and 18% to alkalinity. Lake Erie exhibited a great deviation; observed PI 1.57, calculated PI 0.51. Perhaps this is due to treating the lake as a single lake rather than as three distinct basins with marked morphometric and limnological differences. (BU)

312. Hayford, J. F. 1922. Effects of winds and of barometric pressures on the Great Lakes. Carnegie Institution. Washington, D. C. Pub. 317. 133 p.

The outcome of the investigation is summarized as follows:

1) Reasonably accurate numerical expressions have been obtained and developed for the effects of barometric pressures on the elevations of the water surface at any location.
2) General expressions for the effect of winds on any body of water have been developed.
3) Four of the prevailing seiches or free oscillations under the influence of inertia (some on Lake Erie)

have been isolated, their periods, and probable methods of oscillation have been determined. (SM)

313. Heath, Ralph C. 1964. Ground water in New York. N. Y. Cons. Dept. Water Resources Comm. Albany, N. Y. Bull. GW-51. 1 map.

The map shows by color overprint the location of the most productive unconsolidated deposits and the type of bedrock underlying each part of the State. A table summarized data on the depth and yield of wells and the chemical quality of the water from the different types of rock. A brief discussion of the occurrence and development of groundwater in New York is contained on the sheet.

314. Helwig, P. A. 1970. Drilling in Lake Erie? The question before us. Explorer. 12(1):12-17.

The geological, historical, technical, and environmental backgrounds of offshore oil and gas drilling in Lake Erie are reviewed in light of the oil and gas industry's request for permission to drill exploratory wells in Lake Erie. According to the geologic cross-section, the Canadians, who are allowed to drill, are draining natural gas from formations that extend under U. S. waters. The effects of oil spills on the ecosystem and U. S. waters and means of treating and preventing them are discussed with emphasis on the need for joint cooperation. (SM)

315. Henry, A. J. 1899. Normal precipitation in the region of the Great Lakes. Mon. Wea. Rev. 27(4): 151-153.

A chart of the normal annual precipitation of rain and snow in the drainage basins of the Great Lakes shows that Lake Erie has a normal annual precipitation of 36 inches. The precipitation is greater on the southern shore than on the northern shore of the lake by 3 inches. (BECPL)

316. Henry, A. J. 1900. Lake levels and wind phenomena. Mon. Wea. Rev. 28(5):203-205.

The mechanical effect of the wind in raising and lowering the level of the lake using lake level, barometric pressure, wind velocity and direction was studied at the mouth of the Detroit River and at Buffalo Harbor. A seich from the Canadian to the U. S. side rather than from west to east is described in detail. The oscillations are found to be stationary rather than progressive; the whole lake oscillates about a pivotal or nodal line. (BECPL)

Herdendorf, Charles E. - See: Robert P. Hartley, et al, No. 305, 306.

Herdendorf, Charles E. - See: G. D. Hobson, et al, No. 329.

Herdendorf, Charles E. - See: A. Brant Russell, No. 638.

Herdendorf, Charles E. - See: L. J. Walters, et al, No. 882, 883.

317. Herdendorf, Charles E. 1966. Geology of the Vermilion West and Berlin Heights quadrangles, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 60. 1 map.

Nearly all the unconsolidated material overlying bedrock of these areas is glacial in origin, deposited either directly by the Wisconsin ice sheet or in glacial lakes that were predecessors of Lake Erie. (SM)

318. Herdendorf, Charles E. 1967. Lake Erie bathythermograph recordings 1952-1966. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Info. Circ. 34. 36 p.

A compilation of bathythermograph data taken over a fifteen year period by the Ohio Geological Survey for the entire Lake Erie Basin with substantial information on the Western Basin. (SM)

319. Herdendorf, Charles E. 1968. Sedimentation studies in the South Shore Reef Area of Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 188-205.

The first year has been completed of a three-year program to study the characteristics of the bedrock reefs and surrounding sediments adjacent to the south shore of Western Lake Erie. The objective of the program is to relate the effect of these factors to the spawning, nursery, and feeding grounds for such species as walleye, white bass, and channel catfish. The physical characteristics of the major reefs and surrounding areas were studied by mapping the reef topography, sampling and analyzing the bedrock and the surface and subsurface sediment, and gauging contemporary sedimentation.

Detailed topographic maps were prepared for several of the reefs from fathometer profiles. Sampling of the bedrock and surface sediment was done with mechanical samplers and by SCUBA divers. A total of 824 samples were taken on a half-mile grid pattern. Subsurface samples were obtained at 44 stations by hydraulic jetting and corer methods. The thickness and character of the lacustrine sediment and glacial till overlying the bedrock, as well as the hidden bedrock topography were determined from these borings. Abundant plant detritus deposits were uncovered in the area west of the Bass Islands, overlain by 6-10 ft of silt and clay. These deposits apparently represent a low water stage in Western Lake Erie. Contemporary sedimentation was studied by the installation of sediment collection devices on four of the reefs. Sediment deposition rates appear to be seasonal, with the highest rates and largest particles in the spring.

320. Herdendorf, Charles E. 1969. Water masses and their movements in Western Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 74. 7 p.

The synoptic water property study has demonstrated that a sampling and analysis program carried out in a short time and in a dense pattern can be valuable in determining the existence, shapes, movements, and velocities of water masses.

Temperature and conductivity values indicate a dominating southward movement of the Detroit River water, some of which reached the Ohio shore near Locust Point. Part of the mid-channel main flow appears to split off and move eastward near the Ontario shore. Water along the sides of the Detroit River has higher temperature and conductivity values and produces sluggish flow that generally clings to the shoreline or forms eddy currents. Measurements indicate an eastward movement of water along the Ohio shore from Maumee Bay to the Bass Island area and thence northward along the west side of the islands. A northwestward flow of Central Lake Erie water into the southern islands area and south of Pelee Point is also recognized. Most of the flow from Western Lake Erie into the Central Basin appears to be through Pelee Passage.

Variations in water levels, when correlated with podlike masses of water which have entered the lake from the Detroit River, provide data for determining the velocity of their movements. The average velocity of Detroit River water flow in Western Lake Erie is approximately 0.5 ft/sec.

321. Herdendorf, Charles E. 1970. Lake Erie physical limnology cruise - midsummer 1967. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 79.

In July and August 1967 a cruise was undertaken to provide new information on the physical limnology of Lake Erie, with particular attention to circulation patterns and to changes that occur in the quality of the water as it passes through the lake. The objective of the field survey was to measure several physico-chemical properties of Lake Erie water from its major inflow at the Detroit River to outflow in the Niagara River. This was done by making thirteen transects across Lake Erie and its connecting waterways. Observations of water properties and movements were made at 110 stations, and in most cases consisted of profile measurements with readings and samples taken at various depths from surface to bottom from aboard the Ohio Division of Geological Survey research vessel, GS-1. The properties and conditions investigated on the cruise were: 1) water temperature, 2) specific conductance, 3) water color, 4) transparency, 5) hydrogen-ion concentration (pH), 6) dissolved-oxygen content, &) chloride-ion concentration, 8) turbidity, 9) currents, 10) waves, 11) water level, 12) meteorological conditions, 13) water depth, and 14) bottom deposits. The study was completed within a two-week period to give the data collected some degree of synopticity.

322. Herdendorf, Charles E. 1970. Sand and gravel resources of the Maumee River estuary, Toledo to Perrysburg, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Rept. Invest. 76. 19 p.

Geologic and hydrologic studies of the lower Maumee River have shown that this reach is an estuary of Lake Erie. This study reports on the distribution and quantities of sand and gravel deposits in the river bed. Analysis shows that recently deposited material (toward the mouth of the river) is much finer than the subsurface deposits. Apparently high stream velocities occurred in the Maumee River during a low water level stage in Western Lake Erie about 12,000 years ago and resulted in the deposition of much of the coarser material found at depth. (SM)

323. Herdendorf, Charles E. 1972. Sedimentology of Lake Erie. In: Limnology of Lakes and Embayments.

Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Framework Study. 2(Draft 2)Appendix 4: 4-972 to 4-991.

This paper describes the basin morphology, basin geology, and bottom sediment distribution of Lake Erie. An historical essay as well as recent charts and research are presented.

324. Herdendorf, Charles E. and L. L. Braidech. 1972. Physical characteristics of the Reef Area of Western Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Rept. Invest. 82. 90 p.

Thirteen major reefs, which occupy about 8 square miles, and 12 major islands are present in the Reef Area of Western Lake Erie. The reefs and islands are composed of Silurian and Devonian dolomite and limestone, allochthonous rubble, and glacial gravel, and are elongated northeast-southwest because of the structure and relative resistance of the bedrock, orientation of glacial scour, and dominant current directions.

Surface sediment samples at 1,383 stations indicated that the bottom was composed of mud (58.5 percent), sand (26.2 percent), gravel (9.4 percent), and exposed bedrock (5.9 percent). Cores at 280 stations revealed the following sequence of subsurface sediments above the bedrock: (1) glacial till clay, (2) compacted lake clay, (3) softer lake clay containing abundant plant detritus, and (4) recent mud and sand. Lag sand and gravel deposits form a thin veneer over the glacial till in the Locust Point Reef area. East and west of the Bass Islands accumulations of plant detritus represent a low-water stage (radiocarbon dates 11,300 to 4,300 years B.P.). Contemporary sedimentation studies on six reefs and in two deep areas revealed that sediment deposition rates are seasonal, with the highest rates and deposition of the largest particles in the spring. No permanent sedimentation appears to be occurring on the reefs.

Wind, bottom topography, and shoreline configuration are the major factors controlling current patterns. Surface currents are normally driven downwind while bottom currents are often opposed to the wind in the form of a compensating return flow. Repetitive measurements at 68 stations revealed average velocities of 0.28 knot for surface currents and 0.15 knot for bottom currents. Because of the shallowness, currents and associated water-level fluctuations stir the entire water column, producing nearly isothermal conditions throughout the year.

Herrington, H. B. - See: R. O. Brinkhurst, et al, No. 65.

Hewson, E. Wendell - See: Eugene W. Bierly, No. 48.

325. Heymsfield, Andrew J. 1969. Snow crystal analysis of the effectiveness of seeding a Lake Erie snow squall on December 14, 1968. In: Lake Effect Snow. N. Y. S. Univ. College at Fredonia. Final Rept. pp. 1-66.

Four continuously operating snow crystal replicators were built and used to determine the effectiveness of seeding lake effect snow squalls. A snow crystal analysis of silver iodide seeding effects on December 14 indicates two significant results. First, there was a tremendous increase in the number of tiny crystals, especially plates. Second, the full objective of the seeding was not realized because the tiny crystals attached onto aggregates of crystals which have a high terminal velocity, reducing advection further inland. (CCIW)

Hill, R. - See: J. Van Oosten, No. 859.

326. Hiney, R. A. 1969. Optimum regulation of the levels of the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 449-468.

In 1964 the Canadian and American governments authorized a massive international study to determine what measures could be taken to further regulate the levels of the Great Lakes. A regulation subcommittee is currently devising and testing regulation plans in an endeavor to find one plan that will best serve all Great Lakes interests.

This paper investigates the feasibility of using a dynamic programming algorithm to find this optimum regulation plan given objective functions relating dollar losses of each interest to monthly mean lake levels and outflows. The optimum plan will be that which minimizes these objective functions for a given set of inflows and flow constraints. Inflow sequences will consist of both the recorded-adjusted net basin supplies and 390 years of artificial monthly net basin supplies simulated to preserve as nearly as possible the serial and interlake correlations observed during the period of record.

The regulation rules will be derived from a multiple regression analysis. The resulting empirical formulas will relate the monthly regulated outflow from each lake to significant hydrological parameters such as antecedent inflows and current lake levels. Comparison of losses incurred with the derived plan to those which would occur for the same inflows and existing conditions will indicate the benefits attributable to the plan.

Hiltunen, J. K. - See: David R. Wolfert, No. 913.

327. Ho, Diana Yunn. 1967. Heavy mineral size distribution in some Erie and Warren beach sands, Western New York. M. A. Thesis. S. U. N. Y. at Buffalo. Buffalo, New York. 73 p.

The principal objective of the study was to investigate textural characteristics of individual heavy minerals across beach zones of varying energy, Lake Erie, Western New York. A linear series of samples was collected from plunge point to dune. A similar series was also collected for comparison purposes from Lake Warren, a pre-Erie strandline. (BL)

328. Hobbs, G. D. 1899. The diamond field of the Great Lakes. J. Geol. 7:375-388.

Diamonds have been found in glacial till south of the Great Lakes. Hobbs gives a description of the diamonds and a theory on how they arrived in the region. (BL)

329. Hobson, G. D., C. E. Herdendorf and C. F. M. Lewis. 1969. High resolution reflective seismic survey in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 210-224.

The Geological Survey of Canada, in cooperation with the Ohio Geological Survey, undertook a continuous marine seismic profiling survey in the western part of Lake Erie during August-September 1968. Seismic coverage, totalling 818 mi, was obtained approximately every 5 minutes of latitude and longitude west of Point Pelee in both Canadian and United States waters. Record quality varies considerably over the survey area. East of Pelee and Kelleys Islands, data are good and provide a reliable interpretation of thickness of bottom sediments and stratification within them. The westernmost portion of the basin yields poor data; this is probably due to gaseous organic material, sand bodies, or buried peat deposits.

Drift thickness from drill holes and from the survey correlate well and range from zero up to 120 ft. A major reflector within the drift indicates the surface of glacial deposits and the general pattern of late glacial and postglacial drainage during low-level phases of Lake Erie.

Offshore bedrock elevation varies between 390 and 571 ft above sea level. Bedrock highs underlie Point Pelee and the islands whereas bedrock lows in inter-island areas and the Central Basin are readily outlined. An interpretation of preglacial drainage is presented.

330. Hohn, M. H. 1969. Qualitative and quantitative analysis of plankton diatoms: Bass Island, Lake Erie, 1938-1965 including synoptic surveys of 1960-1963. Ohio Biol. Surv. Bull. Ohio State Univ. Columbus, Ohio. 3(1):1-211.

Quantitative and qualitative analysis of the plankton diatom flora from collections in the Bass Islands Area of Western Lake Erie show a definite pattern in regard to major species and occurrence and volume of total population. Boundaries of water masses in the Central and Western Basins can be charted using diatom species, percent occurrence, and total occurrence.

Hole, T. J. F. - See: C. E. Redmond, et al, No. 610.

331. Holleyman, J. B. 1966. Some results of the program conducted by Great Lakes-Illinois River Basin Project on the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:323-331.

A study of water pollution in the Great Lakes is being conducted by the Federal Water Pollution Control Administration. To gain an understanding of the motion of pollutants in the lakes, networks consisting of instrumentation to record lake current and surface wind data were established in Lakes Michigan, Erie, and Ontario. These networks and instrumentation are described, tabulations of available data are presented, and the collection and reduction of data are briefly discussed.

Winds recorded by the network instruments and winds observed aboard ships navigating the Great Lakes are compared with geostrophic winds determined from synoptic weather maps. The results are presented in terms of ratios of actual wind speeds to geostrophic wind speeds and deviation in direction of actual winds from the direction of geostrophic winds.

332. Hollmer, Alvin. 1967. The effect of sill-type channel modifications in the Niagara River on Lake Erie water levels. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. Great Lakes Res. pp. 208-213.

The effects of a sill-type structure in the upper Niagara River on Lake Erie water levels are determined. Various heights, lengths and locations of sills are considered. It is found that for some sills, the low levels could be raised significantly with a corresponding minimum increase in high levels. During years of high lake levels, it is shown that it is hydraulically feasible to use the Black Rock Canal to augment the discharge capacity of the Niagara River to the extent that the lake levels can be lowered more than they are raised by the sill.

Holroyd, Edmond W. - See: James E. Jiusto, No. 377.

333. Holroyd, Edmond W. 1971. Lake-effect cloud bands as seen from weather satellites. J. Atmospheric Sci. 28(7):1165-1170.

Satellite photographs of the TIROS and ESSA series were examined for the presence and dimensions of lake-effect clouds over the Great Lakes and Gulf of St. Lawrence. It was found that nearly all lake-effect clouds occurred when the 850-mb temperature was more than 13°C colder than the lake surface temperature. The clouds were organized into parallel bands resembling but having larger dimensions than cloud streets. Enlarged cloud bands were found which were 2.5 times larger than normal lake-effect bands. These enlarged lake storms had preferred origins and appear to be generated by frictional differences between land and water, by the geometry of the body of warm water with respect to the prevailing wind, and by certain urban influences.

334. Holroyd, Edmond W. and J. E. Jiusto. 1971. Snowfall from a heavily seeded cloud. Applied Meteor. 10(2):266-269.

Few documented cases exist to demonstrate that highly convective supercooled clouds can be completely glaciated or overseeded. By "overseeding" we imply a sufficient concentration of ice nuclei to accommodate all the water generated in the updraft and to consume rapidly the existing cloud liquid water. One such case is herein presented that describes the ground variations in snow crystal type, size and concentration as a seeded cloud passed by. During this period, snow crystal concentrations increased by approximately two orders of magnitude, and, within the limits of accuracy of the experiment, showed a one-to-one correspondence with the concentration of silver iodide released. Snowflake aggregates were dominant and individual crystals comprising the aggregates averaged only 200 $\mu$, in general agreement with model predictions. Riming of crystals was significantly reduced, with thick plates and solid columns indicative of a "dry" environment replacing the original rimed dendrites. It was evident that heavy seeding, while limiting the riming and size of individual crystals, amplified the snowflake aggregation mechanism. The study was done in Eastern Lake Erie.

335. Holt, W. P. 1911. The islands of Lake Erie. J. Geog. 9(7):186-188.

The islands of Lake Erie situated in the western end of the lake are described as to size, formation, stratigraphy, glaciation, caves, and soil composition. (BU)

336. Horberg, L. and R. C. Anderson. 1956. Bedrock topography and Pleistocene glacial lobes in Central United States. J. Geol. 64:101-116.

Pleistocene glacial lobes were closely controlled by bedrock lowlands. The study of glacial centers and possible flow units within the glacial lobes are considered, and an interpretation of preglacial drainage, based on the bedrock-surface map, is proposed. One of the study areas concerns the Lake Erie region indicating the glacial lobes and related bedrock-surface features, physiographic division, time relations of glacial lobes, sublakes and the Ontario-Erie glacier. (BL)

337. Hough, J. L. 1958. Geology of the Great Lakes. Univ. Illinois Press. Urbana, Ill. 313 p.

Part I of the book contains material which forms a frame of reference for the history of the lakes. It includes descriptions of the present lakes, summaries of the events in the region which led up to the formation of the earliest lakes, and a review of the methods which are used to date the events of lake history. Part II is the history of the lakes' stages including a detailed review of the literature and a re-evaluation of the extensive literature on the Great Lakes. The history of the Great Lakes is summarized in a correlation chart with an absolute time scale in years and major events are shown on a series of lake stage maps. (SM)

338. Hough, J. L. 1962. Geologic framework of the Great Lakes. In: H. J. Pincus (Ed.), Great Lakes Basin, a Symposium. Am. Assoc. Adv. Sci. Pub. 71. pp. 3-27.

The Great Lakes Basin is located in zones of weaker sedimentary rocks which apparently were excavated as major valleys by normal processes of stream erosion and then were deepened and reshaped by glacial ice during the Pleistocene. The lakes, in so far as it is known, began in the Late Pleistocene when the margin of the wasting continental ice sheet retreated northward into the lake basins. The forms and levels of the lakes have undergone large variations. Continued uplift of the land to the north and continued erosion of shores and of outlet channel floors are the cause of slow but still continuing changes in the lakes. (SM)

339. Hough, J. L. 1963. The prehistoric Great Lakes of North America. Am. Scientist. 51:84-109.

Geologic history of the formation, characteristics, glacial advances of the glacial Great Lakes, and the formation of today's Great Lakes is presented. Lake Erie is described in the formation of the Great Lakes and with chronological maps, showing the extent and the stages of development. (SE)

340. Hough, J. L. 1967. Correlation of glacial lake stages in the Huron-Erie and Michigan Basins. Univ. Mich. Great Lakes Res. Div. Collected Reprints. 1:824-839. Also in J. Geol. 74(1):62-77.

The writer's interpretations of Great Lakes history, which have been seriously questioned by J. Harlen Bretz in this Journal (1959, 1964), are explained in detail in a review of the field facts, and a new alternative hypothesis of the lakes history is presented. The principal points of disagreement involve the acceptance or rejection of recent studies in the Lake Ontario Basin and St. Lawrence Valley, which require a revision of the correlation of events in the Huron and Michigan Basins. A distinction is made between field facts and Bretz's interpretations of field facts.

341. Houghton, Frederick. 1914. The geology of Erie County. Bull. Buffalo Soc. Nat. Sci. 11(1): 101 p.

The geology of Erie County, New York, is presented, showing the lithologies, location, and formations. Geologic history is discussed as well as glacial deposition, erosion, the glacial lakes, and their geologic effect on the area. Fossil information and illustrations are also included. (SM)

342. Howard, D. L., J. I. Frea, R. M. Pfister and P. R. Dugan. 1970. Biological nitrogen-fixation in Lake Erie. Science. 169(3940):61-62.

Samples were taken at various locations in the vicinity of the Bass Islands which lie at the eastern edge of the shallow, rapidly eutrophying Western Basin of Lake Erie. The sample sites included shorelines, bay areas, and open lake waters. Nitrogen-fixing activity in the bottom sediments was estimated in the undisturbed sediments. The activity in the sediments was attributed to bacterial action. Nitrogen-fixing activity occurred from June through November suggesting that it is significant over the extremes of seasonal variation in light, temperature, and nutrients. (BU)

343. Howell, J. A., K. M. Kiser and R. R. Rumer. 1970. Circulation patterns and a predictive model for pollutant distribution in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. I. pp. 434-443.

A transition probability matrix method is developed to represent, in a compact and useable form, the flows measured in a rotating model of Lake Erie. The matrix was determined for the case of zero wind stress and restricted to the Western Basin. The resulting representation was in good conformity with the model and also showed some similarities with average bulk flows in the prototype. The model was used to predict the steady state concentration distribution of a nonconservative pollutant in the Western Basin under conditions of zero wind stress.

344. Hoyt, William G. and Walter B. Langbein. 1955. Floods. Princeton Univ. Press. Princeton, N. J. pp. 249-256.

General discussion of hydrological parameters involved in high water levels in the Great Lakes and the major drainage basins. Problems of flooding due to the fluctuations in lake levels is presented. (RL)

345. Hubbard, George D. 1938. Ohio pro-glacial lakes.

Science. 88:617-618.

Brief discussion of the glacial lakes of Ohio and their tilting. These lake beds are 200 feet or more above Maumee Beach of the pro-glacial lake in the Erie Basin and are in no way related to that lake. But their tilting carries the Continental uplift thirty to forty miles further south than the Maumee Beach and that much beyond a known tilt of the Great Lakes area. (BL)

346. Hubbard, George D. and M. M. Champion. 1925. Physiographic history of five river valleys in Northern Ohio. Ohio J. Sci. 25:51-84.

This study deals with the five valleys of Sandusky, Huron, Vermilion, Black, and Rocky Rivers, with their main tributaries. Each is discussed concerning their geologic history, formation, direction of flow and how it was geologically determined, the geology of the region and the effects that glaciation had on the region, the effect of the retreat of the pro-glacial Lake Erie, aging of the rivers in valley formation, physiography, disection, denudation, and drainage. (SE)

347. Hubshman, J. H. 1971. Lake Erie: Pollution abatement, then what? Science (February). 171:536-540.

Included in this report are the effects of siltation on Lake Erie along with a graphic display of a longitudinal cross-section and a map of the bottom sediments in Lake Erie.

Humphris, Curtis C. - See: H. J. Pincus, et al, No. 584.

348. Humphris, Curtis C. 1953. Sedimentary processes along Lake Erie shore, from Marblehead Lighthouse to Bay Bridge. In: H. J. Pincus (Ed.), 1951 Investigations of Lake Erie shore erosion. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 18. pp. 47-81.

Investigations of the sedimentary processes in the shore area from Marblehead Lighthouse to Bay Bridge, covering the source of the sediment, its composition and grain size, inferred direction and method of sediment transport, nature of the shoreline, including bedrock geology, topography of the offshore areas, the effects of erosion on the different types of shore materials, and the influence of existing protective measures. (SM)

349. Hunt, George S. 1962. Water pollution and the ecology of some aquatic invertebrates in the lower Detroit River. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9:29-49.

This paper reports the findings, in the vicinity of Grosse Ile, Michigan, during 1948-1956, made on water quality, underwater soils, and macroscopic invertebrates. Particular effort was made to determine the relationship of snails and fingernail clams to the intensity of water pollution, to other conditions, and to the soils. Physical characteristics for the soils and the water of each sample site were determined. It concluded that the area studied had attained the benthic climax for large rivers.

350. Hunt, George S. 1963. Wild celery in the lower Detroit River. Ecology. 44(2):360-370.

Water quality and characteristics, soils and submerged aquatic plants in the lower Detroit River were studied to determine the relationship of wild celery to the intensity of pollution, other water conditions, and underwater soils. The soils tend to run fairly fertile to very fertile. Physical and chemical parameters encountered had little effect on the celery. Excessive turbidity and general pollution reduced vegetation in the upper part of the study area. The number of species and their abundance are reliable indicators of water quality.

351. Hutchinson, G. Evelyn. 1957. A treatise on limnology. John Wiley & Sons. New York, N. Y. Vol. 1. 1015 p.

General references and examples of Lake Erie are cited in the text principally in regard to origin, morphology, and hydromechanics. Among the topics discussed are depositional islands, recurved spits, Ekman spiral, wind stress and drift velocity and its effect on the water surface form, seiches, tides (damping effect), internal oscillations (in regard to lake stratification), discharge, and wind drift.

352. Hutchinson, G. Evelyn. 1967. A treatise on limnology. John Wiley & Sons. New York, N. Y. Vol. II. 1115 p.

This volume is concerned with lake biology and limnoplankton. A brief mention is made of Chandler's study on turbidity and lake illumination in regard to phytoplankton. This is con-

tained on pages 437 to 439. For a detailed summary, see: David C. Chandler, No. 130.

353. Hutter, Harry K. 1952. Eighty years of weather and climate at Toledo, Ohio. Ohio J. Sci. 52(2): 62-75.

Toledo's location at the western end of Lake Erie places it in a position so that marine influences are felt. Along the edge of the Lake, a semi-marine type of climate prevails. (SE)

Hyche, C. M. - See: K. K. S. Pillay, et al, No. 578.

354. Hydroscience, Inc. 1973. Limnological Systems Analysis of the Great Lakes, Phase I - Preliminary Model Design. Prepared for the Great Lakes Basin Comm. Westwood, N. J. 474 p.

Among the many parameters and their application to a model analysis included in this report were general monthly lake water levels and flows, erosion, sediment, and ice. Their available models considered were hydrological balance, ice and lakewide temperature, thermal, lake circulation and mixing, erosion, sediment, and chemical. Also included are a listing of data on agencies of the various data sources. Application of the model systems can be made to Lake Erie itself and reference to the Lake is made throughout the report as well as to the Great Lakes in whole and in part.

355. Institute of Environmental Sciences and Engineering. 1973. Annual Report - 1972. Univ. Toronto. Inst. Env. Sci. and Eng. Toronto, Ont. Rept. EG-9. 122 p.

A brief mention is made of the projects that were being undertaken at the time with a progress report. The programs that pertain to Lake Erie and the physical aspects were: Monitor Program - Lake Erie Special (study on the atypical summer stratifical and oxygen depletion rates in the hypolimnion); Heat Content Program and surface eutrophication studies; and IFYGL and Lake Erie Monitor Program (temperature surveys to determine heat content change in the Lake).

356. International Joint Commission. 1968. Interim report to the International Joint Commission, regulation of Great Lakes Levels. Internat. Joint Comm. Internat. Great Lakes Levels Board. Washington, D. C. 20 p.

This Interim Report describes features of the lakes which relate to their levels; indicates the interests which make direct use of the lakes and are affected by lake level variations; discusses the problem of regulating the levels by controlling lake outflows; sets forth the nature, scope and progress to date of the Commission's study; and indicates how it is oriented toward a comprehensive consideration, within the terms of reference of the many facets of the lake-regulation problem. It treats the problem to the lakes as a whole. The specific mention of Lake Erie is in regard to its level range, a series of plates describing graphically water levels from 1964 to 1967, drainage systems, and lake profiles in comparison to the other Great Lakes.

357. International Joint Commission. 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Internat. Joint Comm. Internat. Lake Erie Water Pollution Board. Washington, D. C. Summary. Vol. 1. 120 p.

In this extensive report on the pollution of the Lakes in the lower basin, discussion and reference are made to load discharge, both chemical and solid, and their distribution in the lake in regard to circulation and source of input. A further discussion on the relationship of the sediments and its physical relationship in the lake environment is made. The article has substantial data on the topic of discharge and physical aspects in regard to the pollution topic.

358. International Joint Commission. 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Internat. Joint Comm. Internat. Lake Erie Water Pollution Board. Washington, D. C. Lake Erie. Vol. 2. 316 p.

This second volume goes into an extensive examination of Lake Erie with a balance of data and graphics with the discussion presented in this report. As far as the physical aspects of Lake Erie are concerned, the following is the area covered: Physical Characteristics - hydrology, climate, geology; Lake Characteristics Present Trends - thermal, circulation, diffusion, discharge, sedimentation, morphology, turbidity, and chemistry. In the sections that follow, the physical parameters are tied in with the topic of discussion - pollution. At the conclusion is a summary of methods used in the data collection. The account itself is well organized, utilizing information from present and past publications extensively.

359. International Joint Commission. 1969. Potential oil pollution incidents from oil and gas well activities in Lake Erie: Their prevention and control. Internat. Joint Comm. Internat. Lake Erie Water Pollution Board. Washington, D. C. 163 p.

A report on the potential hazards of oil and gas spills on Lake Erie written after the incident at Santa Barbara, California. As earlier reports on the subject concluded that there was minimal risk, this report is more realistic in its attitude. The past and current drilling activity is outlined as are regulations and controls. (BECPL)

360. International Joint Commission. 1970. Pollution of Lake Erie, Lake Ontario and the Internation Section of the St. Lawrence River. Internat. Joint Comm. Washington, D. C. pp. 56, 62-63.

This report on pollution of Lake Erie, Lake Ontario, and the St. Lawrence River contains a description of the transboundary movement of lake water and the geology of Lake Erie.

361. International Joint Commission. 1972. Report on the Great Lakes water quality. Internat. Joint Comm. Washington, D. C. 30 p.

On the basis of available information it appears that further degradation of water quality in the Great Lakes may now have slowed down in some respects. However, there is not yet available a scientific basis to indicate in precise terms the extent of improvement except for some parameters and for some areas. Lake Erie remains the most polluted of all the Great Lakes.

362. International Joint Commission. 1973. Great Lakes water quality annual report to the International Joint Commission. Internat. Joint Comm. Internat. Great Lakes Water Quality Board. Washington, D. C. pp. 71-90.

Included is a report on the waste loading of varied pollutants, phosphorus, chlorophyll a, dissolved oxygen, dissolved solids, suspended solids, and the loading in relation to flow (cfs) of the Detroit River, other tributaries, and industrial and municipal sources.

363. International Joint Commission. 1973. Regulation of Great Lakes water levels, report to the Inter-

national Joint Commission. Internat. Joint Comm. Internat. Great Lakes Levels Board. Washington, D. C. 294 p.

This report deals with a review of the various factors affecting the fluctuations of the water levels of the Great Lakes, a determination of the feasibility of regulating further water levels in the Great Lakes and connecting channels so as to bring about a more beneficial range of stage and other improvements, and the effects, both beneficial and adverse, of regulation plans. (CE)

364. International Joint Commission. 1973. Regulation of the Great Lakes - hydrology and hydraulics. Internat. Joint Comm. Internat. Great Lakes Levels Board. Washington, D. C. Draft 3. Appendix A. 87 p.

This report deals with a description of the hydrologic system of the Great Lakes, inclusive of Lake Erie, and discusses the various factors which govern its water supply and affect the response of the system to this supply. With a knowledge of the response and the physical limitations of the system, then can an application of modern water management be applied. The scope of this report is broad and deals in part with an analysis of man's influences and an application of hydrologic knowledge towards forecasting of lake levels. (CE)

365. International Joint Commission. 1973. Report to the International Joint Commission on the operation of the Lake Erie-Niagara River ice boom 1972-1973 winter season. Internat. Joint Comm. Internat. Niagara Board of Control. Washington, D. C. 12 p.

This report covers the operation of the Lake Erie-Niagara River ice boom and makes mention to the extent of ice cover and water temperatures in Lake Erie for 1972-1973. A brief history of implications of not having an ice boom as was the case in the past and the effects of free, unregulated ice movement, as well as the value of the ice boom are also discussed. The end of the report focuses on future studies dealing with ice accumulations, thicknesses, and the effects on climatic and other environmental conditions.

366. International Joint Commission. 1973. Semi-annual

report. Internat. Joint Comm. Res. Advisory Board. Washington, D. C. Unnumbered.

The Research Advisory Board and seven of its standing committees briefly summarize activities, objectives, and future plans. Of special interest is the section on the Committee on Lake Dynamics. A list of sources of information on research activities and available literature is included.

367. International Joint Commission. 1974. Detailed study plan to assess Great Lakes pollution from land use activities. Internat. Joint Comm. Great Lakes Water Quality Board. Internat. Reference Group on Great Lakes Pollution from Land Use. Washington, D. C. 81 p.

A small number of representative watersheds including the Maumee River Basin are intensively studied to relate contamination of water quality which may be found at river mouths on the Great Lakes to specific land uses and practices. Proposed activities include assessment of concentrations of contaminants in sediments though the exact role of land-derived sediments in water pollution is not clear.

368. International Joint Commission. 1974. Great Lakes water quality, 1973, annual report. Internat. Joint Comm. Great Lakes Water Quality Board. Washington, D. C. 115 p.

The water quality of Lakes Erie and Ontario has not changed significantly from 1970 to 1973. There are, however, some definite signs of improvements in certain previously defined problem areas. Lake Erie phosphorus loading increased because the reported phosphorus load from the city of Detroit increased. A summary of sampling programs carried out in each lake by various agencies is given in table form. Emphasis of the programs has been placed on Lake Erie and the Detroit River area. No major significant areas of noncompliance are found on Lake Erie; however, there are two soda ash plants on the Detroit River which discharge large quantities of inorganic dissolved solids.

369. International Waterways Commission. 1910. Regulation of Lake Erie. 61st Congress, 2nd Session. House Document No. 779. 158 p.

This report deals with the proposal submitted for the regulation of Lake Erie (see U. S. Army Corps of Engineers, 1899, Regulation of the level of Lake Erie). Discussed are the regulations of each of the Great Lakes and the effects that such regulation would have on the Great Lakes as a whole. This in-depth study analyzes all aspects of the hydrologic budget and the bulk of the report has data presented in 42 tables and 29 plates. This study was represented by representatives of Canada and the United States. (CE)

Irbe, J. G. - See: T. L. Richards, No. 620.

Irbe, J. G. - See: T. L. Richards, et al, No. 621.

370. Irbe, J. G. 1969. Some unusual surface water temperature patterns in the Great Lakes, as detected by airborne radiation thermometer surveys. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 583-607.

Since 1966 the Meteorological Service of Canada has undertaken a program of monthly surface water temperature surveys of the Great Lakes bordering on Canada using an airborne infra-red temperature sensing instrument. During the three year period that the program has been in progress, many interesting features of the distribution of surface water temperature have been found. Maps showing some of the more unusual isotherm patterns deduced from these surveys are presented and discussed with reference to lake circulation and meteorological conditions.

371. Ireland, H. Andrew. 1946. Cause and age of Pleistocene entrenchment in the Ohio and Lake Erie Basins. Geol. Soc. Am. Bull. 57:1206-1207.

The age of the major entrenchment, called the Deep Stage, has been previously assigned to the Yarmouth interglacial epoch. The author maintains that the Deep Stage was a result of several epochs of entrenchment culminating in the early Illinoian and was not exclusively Yarmouth. (BU)

372. Irish, S. M. and G. W. Platzman. 1962. An investigation of the meteorological conditions associated with extreme wind tides on Lake Erie. Mon. Wea. Rev. 90(2):39-47.

The dates of incidence of extreme wind tide in Lake Erie have been determined for the 20 year period 1940-1959, for all cases in which the difference in lake level between Buffalo and Toledo exceeded 6 feet. A frequency-intensity analysis shows that a set-up in excess of 10 feet may be expected once every 2 years. Extreme wind tides occur mainly in the 6-month period October through March; more than 70 percent of the cases fall in the three months of November, December, and January. November is the month of most frequent incidence, having more than one-third of the total number of cases in the period studied. The observed seasonal variation of extreme set-up frequency is interpreted as a reflection of the seasonal variation of storm frequency and of storm-track location. Secondary, but important factors are: seasonal variation of storm intensity and seasonal variation of thermal stability of the atmospheric boundary layer. The tendency for marked temperature stratification to be present in the lake during the summer probably inhibits set-up to a significant degree during that season. (BECPL)

Izatt, J. B. - See: M. D. Palmer, No. 552, 553, 554, 555, 556, 557.

Jackson, W. B. - See: L. J. Walters, et al, No. 882.

Janson, Elsie - See: Paul B. Sears, No. 653.

373. Janssens, A. 1968. Stratigraphy of Silurian and Pre-Olentangy Devonian rocks of the South Birmingham pool area, Erie and Lorain Counties, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 70. 20 p.

This report describes the stratigraphy of the Silurian and Devonian carbonate rocks in the South Birmingham pool area. The rocks formerly placed in the undifferentiated Lockport group (Silurian) in the report area can be subdivided and correlated with the Middle Silurian section of Southwestern Ontario. Three potentially productive gas or oil zones occur in structural highs within the described section. (SM)

Jennings, O. E. - See: R. Y. Gottschall, No. 264.

374. Jennings, O. E. 1930. Peregrinating Presque Isle. Carnegie Mag. 4(6):171-175.

Brief discussion of material erosion of Presque Isle, Penn. Graphic illustration of the change of the recurved spit since 1790 from government surveys is shown. Vegetation of the Isle is discussed and the retardation of erosion from wind and waves also. The peninsula at present is moving eastward at about a mile every 200 years. (SM)

375. Jirberg, R. J. 1972. An automatic underwater camera system. In: Project Hypo. U. S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 127-132.

This report discusses some of the interdisciplinary findings of the study together with a few concerns as to future possible changes in the lake. The entire project gives rise to only one recommendation--phosphorus loadings to Lake Erie must be drastically reduced--the immediate implementation of this recommendation is considered to be vital.

Jiusto, James E. - See: E. W. Holroyd, No. 334.

Jiusto, James E. - See: G. E. McVehil, et al, No. 475.

376. Jiusto, James E. 1972. Weather modification technology assessment, 1985 projection. Prepared for the Am. Meteor. Soc. p. 10.

A brief mention as to the feasibility to redistribute heavy snowfall to the lee of the Great Lakes and the results that NOAA obtained in experiments over Lake Erie could support future endeavors in this line.

377. Jiusto, James E. and Edmond W. Holroyd. 1970. Great Lakes snowstorms, Part 1 - cloud physics aspects. S. U. N. Y. at Albany. Atmospheric Sci. Res. Center. Albany, N. Y. 142 p.

This report covers the field stations and instrumentation in regard to the ESSA Seeding Program from 1968 to 1970. Topics of discussion in this part deal with cloud microphysics model, studies of storm band structure, aerosol concentrations, and snowstorm electrification, all related to the lake-effect storms. (CCIW)

378. Jiusto, James E. and M. L. Kaplan. 1971. Snowfall properties of Lake Erie and Ontario storms. Proc. Eastern Snow Conf. New Brunswick, N. S. pp. 17-24.

See: J. E. Jiusto and M. L. Kaplan, 1972, No. 379. Snowfall from lake-effect storms. Basically the same article.

379. Jiusto, James E. and M. L. Kaplan. 1972. Snowfall from lake-effect storms. Mon. Wea. Rev. 100(1): 62-66.

Three years of winter lake-storm data were analyzed to determine snowfall distribution patterns downwind of Lake Erie and Lake Ontario. The total amount of snowfall and the area of ground cover in each of 23 lake-effect storms were determined for both lakes. Total snowfall mass was highly dependent on time of year; November and early December storms were two to five times more productive than January storms. A considerable variation in snow density (snowfall depth to melt water ratio) could be attributed mainly to differences in snow crystal type.

380. Jiusto, James E., Douglas A. Paine and Michael L. Kaplan. 1970. Great Lakes snowstorms, Part 2 - synoptic and climatological aspects. S. U. N. Y. at Albany. Atmospheric Sci. Res. Center. Albany, N. Y. 58 p.

This study concerns itself with a synoptic scale feature often overlooked as a possible catalyst for the more severe lake-effect storms and to determine which parameters are of importance in describing varying synoptic conditions overlying the mesoscale system. A microphysical climatological analysis of the Great Lakes snowstorms covering methodology, ratios of snow depth to meltwater equivalent, crystal density, prediction of crystal type and statistical studies and data on total precipitation over land from lake storms are also included. (CCIW)

Johnson, M. G. - See: H. R. MacCrimmon, No. 464.

Jones, D. L. - See: C. F. Powers, et al, No. 596.

Jones, Douglas M. A. - See: Stanley A. Changnon, No. 136.

381. Jones, Douglas M. A. and D. D. Meredith. 1972. Great Lakes hydrology by months, 1946-1965. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 477-506.

Monthly estimates of precipitation on each lake, evaporation from each lake surface and runoff into each lake from surrounding land areas are developed for the Great Lakes for calendar years 1946-1965. Overlake precipitation is estimated by extrapolation of the land isohyetal patterns multiplied by lake-land ratios as established from island-shore stations. Evaporation by months is calculated using the mass transfer method. An isopleth mapping technique is used to estimate the runoff. The net basin supply for a lake is equal to the total runoff plus the precipitation on the lake surface minus the evaporation from the lake surface. The monthly and annual net basin supplies for each lake are determined from the estimated values of runoff, precipitation and evaporation and are compared with the monthly and annual net basin supplies as reported by the U. S. Army Corps of Engineers. The estimated 20-year mean annual net basin supply for all lakes is about 6% less than the value reported by the U. S. Army Corps of Engineers.

Jones, John A. - See: S. Abram, et al, No. 4.

Jones, John A. - See: E. Ruth Braun, No. 62.

Jones, John A. - See: Richard Carroll, No. 126.

382. Jones, John A. 1969. Lake Erie environmental studies annual report 1968-1969. N. Y. S. Univ. College at Fredonia. Lake Erie Environmental Studies. Fredonia, N. Y. 39 p.

The State University College at Fredonia, New York has developed a studies program on Lake Erie. In this report they discuss the development of the program, list the parameters that they measure, and record their cruises and field trips. No specific data is given.

383. Jones, John A. 1970. Freshwater and esturine specific gravity diagrams. N. Y. S. Univ. College at Fredonia. Tech. Data Rept. 3. 10 p.

If pollutant concentrations cannot be measured by conductivity methods as in the case of organic pollutants, effluent densities may be readily obtained using a hydrometer. The wide-range diagrams provided may be used in connection with an inexpensive hydrometer in estuarine studies for a rough approximation of salinity at the sampling location. Three first approximation diagrams have been constructed within the ranges of total dissolved substances normally found in fresh waters, saline inland waters, and coastal estuaries. The total dissolved substances in solution may be obtained from the specific conductance of the water sample by the method suggested if conductivity determinations are corrected to 25°C. To use the specific gravity diagrams provided, the total dissolved substances are plotted against the water sample temperature for each depth sampled. Four examples have been plotted to illustrate the use of the profiles with data from lakes showing strong gradients in temperature and total dissolved substances. However, with these data a minor error in the determination of temperature or total dissolved substances probably exists. (CCIW)

Kammerer, J. C. - See: R. J. Archer, et al, No. 20.

Kaplan, Michael L. - See: James E. Jiusto, No. 378. 379, 380.

384. Kaplan, Michael L., R. M. Cowher, R. J. Gronek and D. A. Paine. 1974. The proposed A. F. G. W. C. operational mesoscale primitive equation forecast model. 5th Conf. on Weather Forecasting and Analysis. Amer. Meteor. Soc. pp. 113-117.

A ten-level moist PE model utilizing a 42 km grid interval has exhibited skill in forecasting excessive snowfall and rainfall rates documented to be spatially and temporally correct based on surface observations. Regions of observed low-level wind maxima and critical Richardson number have also been simulated by the model. Part of the data was based on data collected on the north and south shore of Lake Erie.

385. Kaplan, Michael L. and Douglas A. Paine. 1972. A macroscale-mesoscale numerical model of intense baroclinic development. J. Applied Meteor. 11(8):1224-1235.

A numerical model has been developed to link quasi-geostrophic and mesoscale forcing functions. This model has shown an ability to simulate the evolution in space and time of the appropriate geophysical fields in an intense lake-effect development. The model is capable of producing vertical motions of greater than 50 cm $sec^{-1}$ within 8 hr and still maintain numerical stability. The initial quasi-geostrophic feature maintains its identity in time while the release of energy stored at smaller scales rearranges the geopotential field. The forecast bulk radiation of energy in the form of long gravitational waves has been supported by upper air observations discussed by Paine and Kaplan (1971).

Karrow, P. F. - See: R. P. Goldthwaith, et al, No. 262.

Keller, Myrl - See: J. F. Carr, et al, No. 125.

Keller, Myrl - See: Robert P. Hartley, No. 305.

Keller, Myrl - See: Robert P. Hartley, et al, No. 306.

Kemp, A. L. W. - See: C. B. J. Gray, No. 267.

386. Kemp, A. L. W. 1969. Organic matter in the sediments of Lakes Ontario and Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 237-249.

Organic carbon and carbonate carbon were determined in six piston cores from Lake Ontario and four piston cores from Lake Erie. The changes in organic carbon with depth of burial are related to sediment type and Eh. Nitrogen, bitumens, humic acids, fulvic acids and kerogen were measured in three surface sediment samples from each Lake.

The basin sediments of Lake Ontario consisted of black laminated grey silty clay muds overlying grey glacial clay, with mud thicknesses ranging from 4.6 to 13.8 m in the cores. Organic carbon content decreased 50% in the top 20 cm of sediment and then gradually decreased to 1% at the glacial clay contact. A complex organic carbon horizon was found two-thirds of the way down the post glacial mud column at each core station and was attributed to a warmer climate between 4000 and 7500 years BP. Lake Erie main basin sediments consisted of a uniform grey silty clay mud with a similar decrease in organic carbon as in Lake Ontario. Penetration was less than two-thirds of the post glacial mud column except in the Sandusky Basin, where a higher organic carbon value obtained at the bottom of the core suggested an organic horizon in Lake Erie similar to that found in Lake Ontario. A core from the Western Basin was typical of a small lake core with a high organic carbon content and plant detritus in the post glacial mud. Eh remained at about zero volts in the post glacial muds of both Lakes and increased to about 0.150 volt in the glacial clay. Carbonates generally showed an inverse relationship to the organic carbon, increasing to about 2% carbonate carbon in the post glacial muds.

Bitumens accounted for 3 to 6% of the organic matter, humic and fulvic acids for 19 to 27% and kerogen for 35 to 48% in the surface centimeter of sediment, in the main basins of the two Lakes. The lower organic carbon content and the greater percent kerogen in the Lake Erie surface sediment were, in part, attributed to greater decomposition of the organic matter by bottom dwelling organisms.

387. Kemp, A. L. W. 1971. Organic carbon and nitrogen in the surface sediments of Lakes Ontario, Erie and Huron. J. Sed. Petrol. 41(2):537-548.

Analyses of 355 surface sediment samples (top cm) from Lakes Ontario, Erie and Huron were carried out for organic carbon, carbonate carbon, Eh, pH, nitrogen and sediment texture. Similar analyses were carried out on a representative core from each lake at close intervals down to 20 cm. The distribution of organic matter in the sediments of each lake was related to the topographic features of the lakes. Organic carbon content was found to be directly proportional to the clay content of the sediment, ranging from less than 1% in the coarse nearshore sands to over 4% in the fine clay muds within the individual lake sub-basins. The organic carbon content of Lake Erie sediments was generally lower than that of Lakes Huron and Ontario, and is attributed to dilution of the sediments with coarser non-clay particles. Nitrogen was directly proportional to organic carbon with carbon-nitrogen ratios ranging from 7 to 13 in the surface sediment. Organic carbon and nitrogen decreased sharply from the surface down to about 10 cm in each core. The decrease is due partly to mineralization of organic matter by bottom organisms and partly to an increasing input of organic matter to the lakes in the last 30 years.

388. Kemp, A. L. W., C. B. J. Gray and Alena Mudrochova. 1972. Changes in C, N, P, and S in the last 140 years in three cores from Lakes Ontario, Erie, and Huron. In: H. E. Allen and J. R. Kramer (Eds.), Nutrients in Natural Waters. John Wiley & Sons. New York, N. Y. pp. 251-279.

This study reports the changes in total organic carbon, carbonate carbon, nitrogen, phosphorus, sulfur, pH, Eh, water content, and sediment texture in the top 50 cm of sediment in a single core from each of the lakes. Investigation of changes in C, N, P, and S near the sediment-water interface in Great Lakes fine-grained muds is made. Measurement of the increase in C, N, P, and S loading to the sediments in the last 140 years by relating the measurements to a time scale based on estimated sedimentation rates is also made. A comparison is made of the cores, of which Lakes Ontario and Erie represent regions close to industrial and urban source inputs and Lake Huron representing a far-removed input from those sources. It is concluded that cultural eutrophication of Lakes Ontario and Erie has resulted in a threefold increase in sediment organic matter, nitrogen, and phosphorus above the natural sediment levels. (SE)

389. Kemp, A. L. W. and C. F. M. Lewis. 1968. A preliminary investigation of chlorophyll degradation

products in the sediments of Lakes Erie and Ontario. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 206-229.

Thirty seven surface sediment samples from Lakes Erie and Ontario have been examined for acetone-soluble chlorophyll degradation products, from stations generally distributed along the axes of the two Lakes. Determinations were made for chlorophylls, pheophytins, organic carbon, carbonate carbon, Eh, pH and particle size distribution.

Sub-environments within each Lake were recognized on the basis of bathymetry, sediment particle size distribution, clay mineral content and mud thickness. Total chlorophylls (chlorophylls a and b) ranged in concentration from 0 to 30 ppm dry weight of sediment in the two Lakes. Total pheophytin (pheophytins a and b) concentrations of 0 to 192 ppm dry weight of sediment were found, with the pheophytin concentrations along the axis of Lake Erie being generally greater than along the axis of Lake Ontario. Calculations showed that the phytoplankton chlorophylls are 93 to 100 per cent decomposed before settling on the bottom. The pheophytins decomposed an average of 70 per cent with burial in the sediment to a depth of 5 cm, whereas the organic carbon decomposed an average of 33 per cent under the same conditions. Percent organic carbon ranged from 0.23 to 3.60 in Lake Erie sediments and 1.90 to 5.00 in Lake Ontario sediments. The pheophytin concentration paralleled the organic carbon content and both varied with the clay content of the sediments. The generally lower values of organic carbon in Lake Erie are attributed to dilution of the sediments with coarser nonclay particles.

Kennedy, R. - See: R. M. Pfister, et al, No. 576.

390. Kennedy, W. E. 1969. Lake Erie Independence Day storm, 1969. Mariners Weather Log. 13(5):212-214.

Lightning was almost continuous along the Ohio shore of Lake Erie. Torrential rains and winds close to 100 mph accompanied the initial outburst of the storm. Winds of 87 knots were reported on the lake, a new record. (BECPL)

391. Kettaneh, A. (Ed.). 1971. Troubled waters, Lake Erie 1971. Social Technology Systems, Inc. Prepared for The Lake Erie Congress '71. Great Lakes Res. Inst. Erie, Penn. pp. 1-121.

This volume has been prepared as an introduction to the subject of pollution and pollution abatement in Lake Erie. Much of the subject material is drawn from conversations with experts in their field. A number of the physical parameters effecting Lake Erie on this topic were brought out.

392. Kick, J. F. 1962. An analysis of the bottom sediments of Lake Erie. M. A. Thesis. Univ. Toronto. Toronto, Ont. 174 p.

Samples of Lake Erie sediment were analyzed to learn the nature and distribution of bottom sediments, to make inferences about bottom environments and the history of the lake possible, and to evaluate certain methods of analysis as applied to Lake Erie sediment studies. Dredge and core samples were given a preliminary examination and then analyzed to determine grain size distribution, carbonate content, organic content, and water content. Sample collection was combined with observations by a diver. Surficial sediments of the Lake Erie bottom have been transported from land areas and from offshore exposures of Pleistocene drift. (CCIW)

Kindle, E. M. - See: F. B. Taylor, No. 720.

393. Kindle, E. M. 1933. Erosion and sedimentation at Point Pelee. Ont. Dept. Mines. 42nd Annual Rept. 42(2):1-22.

Point Pelee offers many opportunities for the study of sediment distribution by currents in the Western Basin of Lake Erie. The Point began with the building of two sand bars, one on the east and one on the west side of an extensive wedge-shaped area of marsh and low land. Other bars have been added to these by waves and currents with most accretion on the west. During the recent history of the Point, erosion has more than kept pace with accretion on the east side. Old maps are examined to show a shift in the trend of the southern half of the Point for the last three centuries: it was southeast; it is now due south. (BECPL)

394. Kindle, E. M. 1937. Geology of Pelee and adjacent islands. Ont. Dept. Mines. Annual Rept. 45(7):75-116.

The gravel and sand deposits and other geological features of the Canadian islands in Western Lake Erie are described. The unconsolidated sediments which constitute a considerable part of the Pelee Island shore line make erosion one of the most important geological problems of the Island. The ancient Dundas and Buffalo Rivers appear to have done the chief work in carving out the basin of Lake Erie and its islands. Included is a lake bottom map showing information as to the strength and persistence of lake currents which are the chief agents in the distribution of the sediments. (BECPL)

395. Kirshner, Louis D. 1968. Effects of diversions on the Great Lakes. In: Proceedings of Great Lakes Water Resources Conference, June 24-26, 1968. Engineers Inst. Canada. Toronto, Ont. pp. 279-310.

Effects of diversions on the levels and outflows of lakes connected by channels affected by backwater, such as Lakes Michigan, Huron, and Erie in the Great Lakes system are discussed. The diversions considered consist of diversions into and out of the drainage basin of the lakes and of diversions between the lakes. The histories and features of the five existing diversions in the Great Lakes Basin that meet these conditions are outlined. It is pointed out that the full effects of such diversions are not immediate upon initiation of the diversion but are progressive over a period of time, depending upon the surface areas and the lake level-lake outflow relationships of the lakes involved.

The methods used by the U. S. Lake Survey to determine the progressive and ultimate effects of diversions in connection with studies of the International Joint Commission of the United States and Canada are described. The equations employed and the results in graphical form are shown. The ultimate effects of the Great Lakes diversions upon their levels and outflows, which have already been reached, are listed.

Kiser, K. M. - See: J. A. Howell, et al, No. 343.

396. Kite, G. W. 1972. An engineering study of crustal movement around the Great Lakes. Dept. Environment. Inland Waters Branch. Tech. Bull. 63. pp. 28-37.

The Great Lakes Region is tilting at a very slow rate with the northwestern area rising relative to the southeastern area. With the use of gauging stations, charts are presented to give evidence of this movement.

397. Kleinhampl, Frank J. 1953. Sedimentary processes

along Lake Erie shore four miles east of Lorain
to Huntington Beach Park. In: H. J. Pincus (Ed.),
1951 Investigations of Lake Erie Shore Erosion.
Ohio Div. Geol. Surv. Columbus, Ohio.
Rept. Invest. 18. pp. 82-118.

On sedimentary processes, especially applied to shore erosion along the Lake Erie shore, four miles east of Lorain to Huntington Beach Park. Work entailed are reconnaissance surveys. Analysis of literature and sediment and bedrock collected and studied in light of theoretical considerations.
(SM)

Kleveno, C. O. - See: Thomas Braidech, et al, No. 61.

398. Kleveno, C. O., Thomas Braidech and P. E. Gehring.
1971. Hypothesis for dissolved oxygen depletion
in the Central Basin hypolimnion of Lake Erie.
Internat. Assoc. Great Lakes Res. Proc. 14th
Conf. Great Lakes Res. pp. 252-255.

Dissolved oxygen in the Central Basin hypolimnion declines gradually during early summer but in August the rate of depletion increases rapidly. The explanation of this relatively sudden decline may lie in the death and decomposition of benthic algae, Tribonema utriculosum and Oedogonium sp. These algae were found growing in profusion at the bottom during the summer of 1969. It is postulated that these algae are killed by a reduction in light caused by an increase of plankton in overlying waters. The increased plankton is caused by an increased vertical circulation of nutrients when the lake begins to cool. The death of the benthic algae results in a tremendous increase in biochemical oxygen demand in hypolimnion waters, thus the rapid depletion of dissolved oxygen.

399. Klippart, J. H. 1870. The Maumee Valley. Ohio. Geol.
Surv. Columbus, Ohio. Rept. Prog. pp. 320-400.

A general review of the geology, topography, and glacial geology of the northwestern counties of Ohio. Mention is made of characteristics of the Portage, Maumee, and Sandusky Rivers: erosion, current, drainage, and effect on agriculture.
(SM)

400. Knister, Raymond. 1933. Pelee Island. Canadian Geog.
J. 6(6):295-302.

General geography and history of the Island, its development, crops, and social implications. No physical aspects are presented. (BU)

401. Koepke, W. E. 1964. Supplement to Geological Circular No. 7. Ont. Dept. Mines. Toronto, Ont. Geol. Circ. 7. pp. 31-39.

This supplement to Geological Circular No. 7 (Newton, A. C., 1958, No. 515) is primarily intended to summarize activities centered in Lake Erie during the period of 1958-1963, inclusive. It includes a summary of gas production from under Lake Erie, a resume of exploration and developmental drilling, a brief description of reservoir rocks, a review of offshore drilling methods, a list of active exploration companies, and a brief statement on Crown leasings. (CCIW)

402. Kohli, B. S. and M. D. Palmer. 1972. Lake water quality predictions. J. Water Pollution Control Federation. 44(8):1575-1580.

A water quality sampling network was established in the nearshore areas of Lakes Ontario and Erie by the Ontario Water Resources Commission in 1966. Monitoring consisted of the collection of grab samples by a survey vessel at designated locations of interest. The samples were then analyzed for various biological, chemical, and physical characteristics.

403. Kopec, Richard J. 1965. Continentality around the Great Lakes. Am. Meteor. Soc. Bull. 46(2): 54-57.

In regard to Lake Erie, it was found that the western end is unique in that there appears to be little effect by the Lake on surrounding temperature regimes. Possibly, this results from the shallowness of the Lake in this area. Included is an isoplethic patterns of continentality coefficient of 1% intervals map for the Great Lakes and a general discussion of the Lake waters on the climatology of the surrounding area. (BU)

404. Kopec, Richard J. 1967. Areal patterns of seasonal temperature anomalies in the vicinity of the Great Lakes. Am. Meteor. Soc. Bull. 48(12):884-889.

An attempt is made in this paper to identify the areal patterns of significant thermal influence exerted by the Great Lakes by use of the methods of anomalies and isanomal mapping.

Empirical temperature models for the seasonal months of January, April, July, and October were constructed and the mean monthly temperatures of some 500 stations within the Great Lakes Region were compared to these models. The same procedure was used for average annual temperature ranges. The resultant deviations were mapped and their patterns described and analyzed. Based on these patterns of mean deviations, the areal extent and seasonal variation of the Great Lakes effect on the vicinal temperature regimes is graphically shown, and the method of isanomal mapping is further substantiated as an effective climatological technique. (BU)

405. Korkigian, I. M. 1970. Physical factors of Lake Erie. John Carroll Univ. Cleveland, Ohio. Carroll Business Bull. 10(1):7-9.

A general discussion of Lake Erie concerning its general description, water surface fluctuations, seiches, aging process, and the fact of shale base use of lake oxygen and the disadvantage of having a large surface area.

Kormond, Warren C. - See: William J. Eadie, et al, No. 220.

406. Kormondy, Edward J. 1962. Recent evolution along Lake Erie. Explorer. 4(2):12-16.

Geologic history, its formation and shore processes of Presque Isle. The formation of ponds on the Isle are discussed relative to the formation of the recurved spit. The progression of age of the ponds can be established by a time computation by using the Eastern Cottonwood as a clock. Further discussion of sand binding and vegetation are presented. (SM)

407. Kormondy, Edward J. 1969. Comparative ecology of sandspit ponds. Am. Mid. Nat. 82(1):23-61.

Limnology, productivity, and community metabolism of a series of beach and lagoon ponds, located on a sandspit in Presque Isle, Pennsylvania, were investigated by using chemical, biological and geological techniques. Organic matter which has accumulated to a maximum of 0.8 m in one pond, results in reduction of size approximately 60% and 95% in 50 and 75 years, respectively. Significant macrovegetational characteristics include the replacement of initial colonizers and the appearance of floating-leaved species in 30 or 40 years. The ponds are all moderately to well buffered alkaline systems with medium to high levels of carbonates. Phytoplankton density is greatest in late July to early August with the species diversity greatest in midsummer. Annual net productivity is lower in older beach ponds, and standing crop of chlorophyll a showed considerable variation annually and by stage of succession. Colonization by invertebrates is via secondary invasion subsequent to the establishment of the ponds. Community metabolism showed a change in the ratio of photosynthesis to respiration from 1.0 in the youngest pond to 0.33 in the oldest pond. The geological discussion includes the morphology of the ponds on the compound sandspit showing changes with time due to changing lake levels and erosion of shoreline. (BU)

Kovacik, Thomas L. - See: Lester J. Walters, et al, No. 882, 883.

408. Kovacik, Thomas L. 1972. Information on the velocity and flow pattern of Detroit River water in Western Lake Erie revealed by an accidental salt spill. Ohio J. Sci. 72(3):81-86.

On 2 December 1970, a dock of the Detroit Bulk Dock Inc., in Detroit, Michigan, gave way, spilling 20,000 tons of rock salt into the Rouge River, a tributary of the Detroit River. The rate and pattern of flow of the salt into the southern end of the Western Basin of Lake Erie were measured by monitoring the chloride content of Lake Erie water received at the Toledo Water Treatment Plant.

On 10 December 1970, a salt-rich (35 ppm NaCl) water mass, having chloride concentrations twice the normal background, was detected at the Toledo Water Intake. This demonstrated clearly that Detroit River water does indeed move far into the Southwestern Basin of Lake Erie, a fact for which previous scientific support has been limited, and permitted a determination of the rate at which the water moves across the lake, at least at this time of year. After correcting for the time during which the salt mass was in the Rouge River and Detroit River, and the time required for the water to travel from the Intake to the Toledo treatment plant, the velocity of this salt-rich water mass across Western Lake Erie, i.e. from the mouth of the Detroit River to the Toledo Water Intake, was calculated to be approximately 0.3 ft/sec.

409. Kovacik, Thomas L. and L. J. Walters, Jr. 1973. Mercury distribution in sediment cores from Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 252-259.

Mercury analyses of 63 sediment cores located on a five-minute latitude-longitude grid from Western Lake Erie indicate that two general sources, background and pollution, contribute to the mercury content of sediments in Lake Erie. A background mercury concentration of 0.04-0.09 ppm was observed below about 15 cm for most cores. A constant background level was observed throughout nine of the cores. This background level of mercury, which is similar to that in the Canadian source areas, results from erosion and transport of sediment to Lake Erie. Data indicate that no change has occurred in the background mercury levels until modern time.

Modern sediments at most of the sampling stations exhibit a surface enrichment zone of 1-4 ppm, which decreases exponentially with depth to the background level. The authors believe that this surface enrichment zone is the result of mercury pollution from chloralkali plants and coal fly ash during the time of man's influence. The highest level of surface mercury enrichment (4 ppm) in the Western Basin is southwest of the mouth of the Detroit River, while the lowest level is around the Bass Islands. The distribution of mercury throughout the Western Basin is directly related to the flow patterns of Detroit River water into the Basin. In some areas, resuspension and redeposition of sediment from the surface enriched zone due to current action results in abnormally high mercury levels that are homogenous in the top 20 cm of sediment. Approximately 25% of the sediment cores showed evidence of this resuspension and redeposition process.

410. Kramer, James R. 1961. Chemistry of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7:27-56.

A comprehensive lakewide study on the chemistry of Lake Erie. Included in the report is a discussion on the bottom sediments and their geochemistry. A report on the chemistry of the clays and its relationship to the waters is also made. Temperature data of the waters and chemical concentrations are made lakewide.

411. Kramer, James R. 1968. Mineral water chemistry, Great Lakes. Univ. Mich. Great Lakes Res. Div. Spec. Rept. 38. 59 p.

A computer program uses major and minor ion concentration to determine the degree of saturation of lake water with respect to $CaCO_3$, $CaMg(CO_3)_2$, $Ca_{10}(PO_4)_6(OH)_2$, air and oxygen and carbon dioxide, and various alumino-silicates. Factor analysis of combined chemical and biological data for Lake Erie shows it to be fundamentally an oxygen deficient $CO_2$ excess body of water suggesting major pollution reactions are of the type

$$\text{carbon wastes} + O_2 \text{ -- } CO_2 \ .$$

Water is saturated with respect to hydroxyapatite during summer months but phosphate is removed after the lake overturns in the fall. Data were collected for Lakes Erie and Ontario on a lake-wide basis in spring, summer, and fall 1967.

412. Kramer, James R. 1968. Mineral-water equilibria in silicate weathering. Univ. Mich. Great Lakes Res. Div. Collected Reprints. 2:177-188.

(1) The silicate weathering process is quite different for a limestone terrane compared to a silicate rock terrane. In a silicate terrane, a simple dissolution process forming kaolinite (and eventually gibbsite) appears to take place. If there are excess cations and alkalinity as represented by carbonate rock terranes, clay minerals intermediate to feldspars and kaolinite will form.

(2) Amorphous silica should form in the interstitial waters in many sedimentary environments during weathering.

(3) Low pH, high P-$CO_2$, low alkalinity, and low cation concentrations tend to form only dissolution products and kaolinite.

(4) High pH, high alkalinity, low P-$CO_2$, and low $H_4SiO_4$ concentrations tend to form chlorite, kaolinite, and montmorillonites. This is the typical reaction.

(5) High pH, high alkalinity, low P-$CO_2$, and high $H_4SiO_4$ concentrations would favor the formation of illite.

It is probable that montmorillonites are metastable in a geological sense, and they may alter to feldspars, kaolinite, or chlorite. No doubt the cation content of montmorillonites is a marked function of the cation concentration of the water which in turn may reflect the composition of the surrounding rock. Therefore similar studies in iron, magnesium, and calcium rich silicate rocks is desirable.

413. Kramer, James R., H. E. Allen, G. W. Baulne and N. M. Burns. 1970. Lake Erie Time Study (LETS). Canadian Centre for Inland Waters. Burlington, Ont. Paper 4.

The Lake Erie Time Study (LETS) was initiated to ascertain the extent and time period of major chemical variables in a highly productive area of Western Lake Erie. Temperature, dissolved oxygen, chlorophyll a, pH, Eh, sulfide, total $CO_2$, particulate carbon, mineral matter, total iron, reactive orthophosphate, silica, nitrite, nitrate, and ammonia were measured along with wind direction and velocity, current direction and velocity. The lake stations were located 3 miles east of Little Bass Island. (CCIW)

414. Kramer, James R. and G. Keith Rodgers. 1968. Natural processes and water quality control. In: Proceedings of Great Lakes Water Resources Conference, June 24-26. Eng. Inst. Canada. pp. 419-432.

Each Great Lake expresses its own characteristics with regard to assimilation of constituents, expressed in regard to its size (especially depth), bottom sediment, current pattern, and emptying rate. Examples are cited in regard to Lake Erie as well as the Great Lakes.

Kramer, Jack W. - See: David B. Baker, No. 28.

415. Kraus, Edward H. 1905. On the origin of the caves of the island of Put-in-Bay, Lake Erie. Am. Geologist. 35(3):167-171.

The hydration of anhydrite to gypsum with its accompanying increase in volume exerting enormous pressure directed upward, disturbing the overlying strata followed by solution of the gypsum, is theorized to be the cause of the formation of the caves. (BECPL)

416. Krecker, Frederick H. 1919. The fauna of rock bottom ponds. Ohio J. Sci. 19(8):427-474.

This investigation was undertaken to study both the fauna and physical changes in a series of rock bottom ponds successively greater in age. Within a radius of fifteen miles of the Sandusky Bay area is a series of five ponds, which at the time of the investigation, were one, five, ten, fifteen and thirty years old. Each pond with its component fauna is discussed. The distribution of the various species through the five ponds is then summarized. (BU)

417. Krecker, Frederick H. 1924. Conditions under which *Goniobasis livescens* occurs in the island region of Lake Erie. Ohio J. Sci. 24(6):299-310.

A discussion of the various habitats and distribution of Goniobasis livescens in both the Put-in-Bay area and the island region is presented. With reference to distribution, wave action was found to be the controlling factor either indirectly by moving the substratum or directly by moving the snails themselves. (BU)

418. Krecker, Frederick H. 1928. Periodic oscillations in Lake Erie. Ohio State Univ. F. T. Stone Laboratory. Put-in-Bay, Ohio. Contrib. 1. 22 p.

In the Bass Island Region of Lake Erie there are several channels in which reversing currents occur. The channels connect with ponds, and in these ponds the conditions are distinctly influenced by the currents. The relation of the currents to seiches or other phenomena in the lake are investigated by studying the factors influencing the conditions of life in the inlets. It was found that the oscillations in lake level due to winds, etc., delayed the reversal of the currents and did not negate them. Oscillations at harbors on the island were aligned along the longitudinal axis of the lake. A close correlation existed between wind velocity and the character (height and periodicity) of the oscillations. The periodicity of the currents is correlated with the size of the body of water. (CCIW)

419. Krecker, Frederick H. 1931. Vertical oscillations of seiches in lakes as a factor in the aquatic environment. Ecology. 12(1):156-163.

Vertical fixed oscillations, known as seiches, which occur in bodies of freshwater, create currents in favorable situations, and maintain channels which connect lagoons and other semi-detached areas of water with the main body. The currents entering the lagoons influence the distribution of both plants and animals. They also affect such conditions as temperature, pH, and transparency. The connecting channels serve to make the lagoons available to the fish of the region as a feeding and breeding ground. In addition to these results, the seiches maintain a tension zone along the entire shore line of waters in which they occur. The importance of this is greatest in shoal areas. (BU)

420. Krecker, Frederick H. and L. Y. Lancaster. 1933. Bottom shore fauna of Western Lake Erie: a population study to a depth of six feet. Ecology. 14(2):79-93.

Population studies were conducted on the following shore types: rock cliff with submerged boulders and rubble, shelving rock, rubble beach, rubble bar, pebble beach, bare sand beach, hard clay, sand beach and shoal. Samples of the material was retrieved in shallow water. Temperature and pH studies were also made at each of the sampling sites. (SM)

421. Ku, L. F. 1970. Spectra of monthly mean water level in the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 844-861.

The annual variation <u>Sa</u> and its harmonics appear significantly in the spectra of monthly mean water level in the Great Lakes. The energy of the spectra is concentrated in low frequencies and the plots of background in the spectra at all stations are similar. The coherent energy between Lake Superior and each of the other Lakes is relatively lower than that of other pairs. The phase of <u>Sa</u> increases from east to west. In Lake Superior it lags about 2 months behind that of Lake Ontario. The amplitude of <u>Sa</u> computed by least squares decreases as the number of points increases. For Lakes Superior, Huron and Erie the amplitudes approach 6 cm when 48 years of data are used. The amplitude of Lake Superior is the same as that in Lake Erie, and its value in Lake Ontario is 12 cm larger than that in Lake Huron. Owing to the relatively small contribution towards the variance by the annual term and its harmonics, it is not practical to predict the monthly mean water level using only the periodic components.

422. Kunkle, G. R. 1963. Lake Ypsilanti: A probable Late Pleistocene low-lake stage in the Erie Basin. J. Geol. 71:72-75.

Coarse channel deposits underlying the bed of the Huron River in the vicinity of Ann Arbor and Ypsilanti, Michigan, represent a period of degradation and aggradation which can be dated as post-Cary but pre-Lake Whittlesey and Warren. This period includes the Cary-Port Huron interval, a time of known ice retreat. The river was most probably graded to a low-lake stage in the Erie Basin, Lake Ypsilanti, created by ice retreat from the depressed Niagara Falls area. The exact elevation of the Lake Ypsilanti is not known but was within the limits $\leq 543 \geq 373$ feet. (BL)

Kupiec, Albert R. - See: Daniel G. Bardarik, et al, No. 30.

LaHaie, G. G. - See: L. R. Culp, et al, No. 173.

423. Laidly, W. T. 1962. Regimen of the Great Lakes and fluctuations of lake levels. In: H. J. Pincus (Ed.), Great Lakes Basin, a Symposium. Am. Assoc. Adv. Sci. Washington, D. C. Pub. 71:91-98.

The significant aspects of the regimen of the system are the vast natural reservoirs of the lakes, the small difference in elevation among the middle three lakes, and the generally wide and deep outflow rivers of all the lakes.

Lake level fluctuations are classified as seasonal, long period, and short period. Seasonal fluctuations are caused principally by changes in precipitation, evaporation, ground water and runoff. Long-period fluctuations are caused primarily by long-range changes in the factors affecting seasonal variations, especially precipitation. Short-period fluctuations result from wind, differences in barometric pressure, and seiches caused by these two factors. Artificial factors such as dredging and construction in the outflow rivers and diversions of water into, out of, and within the basin have caused variations. Artificial factors affect the levels of all the lakes except Superior, which is regulated by a control structure in the St. Marys River.

The current Lake Survey six months forecast was developed from a mathematical correlation of runoff records with the important variables affecting the runoff to Lake Ontario. It is applied to the other lakes by establishing a point-weight system based on the statistical coefficients derived from the multiple correlation, establishing above and below normal point ranges, and selecting monthly supplies from the net basin supplies of record. This process is used for the first month only; the second through sixth month forecasts are obtained from average net basin supplies. By routing all supplies through the lakes, present level and outflow conditions are considered. (SM)

424. Lamar, W. 1953. Chemical and physical quality examination. Lake Erie Pollution Survey, Final Report. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. pp. 81-123.

This report includes the chemical and some physical presentation of data taken of the major tributary systems in the Ohio Lake Erie Basin. Temperature, oxygen consumption, color, pH, specific conductance, suspended sediment, and the chemical characteristics are the parameters that are discussed.

Lamb, G. F. - See: W. Stout, et al, No. 70.

425. Lamb, James C. 1969. A plan for ending Lake Erie Pollution. Public Works. 100(6):79-82.

Sources and effects of pollutants in Lake Erie are described along with plans and recommendations for the elimination of pollution from the Lake. Urban runoff and combined sewer overflows are major sources of pollution contributing BOD, bacteria, and nutrients--especially phosphorus. Detroit, Cleveland, and Toledo are the largest offenders in the area of storm water runoff. Suggested state water quality programs are outlined in addition to areas requiring research and development such as: tertiary treatment, nutrient removal, sediment evaluation, pesticide pollution, radioactive and thermal pollution, industrial sludge disposal, oxygen deficient zones, and eutrophication. Expensive separate sewerage systems are recommended only where feasible, such as in redevelopment projects. However, where combined sewers exist, overflows should be disinfected before being discharged to a body of water, and future plans for storage and treatment should be made. (SE)

Lancaster, L. Y. - See: Frederick H. Krecker, No. 420.

Langbein, Walter B. - See: William G. Hoyt, No. 344.

Langlois, Marina H. - See: Thomas H. Langlois, No. 433.

426. Langlois, Thomas H. 1951. Caves on South Bass Island. Inland Seas. 7(2):113-117.

The history of the Island's caves including their probable origin is related. It is believed that Commodore Perry at one time made use of one of the caves. Exploration of some of the caves resulted in the discovery of stalactites. (BU)

427. Langlois, Thomas H. 1954. The western end of Lake Erie and its ecology. J. W. Edwards, Inc. Ann Arbor, Mich. 479 p.

This report, summarizing a series of studies which have been made during a span of sixty years, aims to supply the basis for a fish management program for Ohio's part of Lake Erie. The physical and chemical characteristics of the lake water and sediments and the climate are considered in addition to the flora and fauna. (SM)

428. Langlois, Thomas H. 1964. Ecological processes at a section of shoreline of South Bass Island, Lake Erie. Ohio J. Sci. 65(6):343-352.

The tombolo at the northeastern end of South Bass Island, and a contiguous till bank on the southeastern shore were studied between 1936 and 1963. The bar of the tombolo represents the line of convergence of waves from the east which had passed on both sides of the dolomitic outcrop at the outer end of the bar. Waves from the west, approaching the bar at right angles, brought to it materials from both sides. Changing levels of Lake Erie alternately submerged and exposed the bar for prolonged periods. During periods of exposure, many plants appeared, which were subjected to overriding sheet-ice and then were eliminated by subsequent prolonged submergence. The adjacent till bank receded by a combination of the effects of shoving ice, frost, rain, waves, and winds (dehydration and sand-blasting). Boulders which washed out of the till bank were moved by waves and ice and accumulated near the landward end of the bar. These changes are illustrated by a set of dated photographs.

429. Langlois, Thomas H. 1964. Lake Erie: Progress towards disaster. Longman's Canada Limited. pp. 3-9.

This report contains a discussion of the geological forces that are changing Lake Erie. Included is a historical description of the Lake discussing the inflow and outflow of water, depositional, and erosional processes. In summary, proposals for rejuvenation of Lake Erie are made.

430. Langlois, Thomas H. 1965. Portage River watershed and fishery. Ohio Dept. Nat. Resources. Div. Wildlife. Columbus, Ohio. Pub. W-130. 22 p.

A geologic history up to the present of the Portage River and its tributaries is given. The River is characterized by three zones and its discharge and relationship to Lake Erie are discussed along with data on suspended sediments.

431. Langlois, Thomas H. 1965. The waves of Lake Erie at South Bass Island. Ohio J. Sci. 65(6):335-342.

South Bass is an island with a two-lobed outline near the southwest end of Lake Erie. It is composed of eastward-dipping dolomite rock. Wave erosion has produced high cliffs, characterized by spurs alternating with coves, which often have small pebble beaches, on the west shore, while low rock ridges separated by banks and beaches occur on the east. Locally on the west, large fallen blocks of dolomite partly protect the cliffs from the waves. On the east shore, flotsam is one of the major factors affecting the nature of the shoreline. Waves are locally dampened by masses of tape grass and, in winter, by water heavy with snow-curds and slush-balls. Cusps and cones of ice and splash-ice structures are also formed on shoals by winter waves.

432. Langlois, Thomas H. 1967. Lake Erie despoiled. Echoes. 6(9):1.

This article discusses the "key area" (Western Basin of Lake Erie) and the general ecology with emphasis on sedimentation, tributary discharge, enrichment, and shallowness of this basin.

433. Langlois, Thomas H. and Marina H. Langlois. 1948. Air and water. In: South Bass Island and Islanders. F. Stone Laboratory. Put-in-Bay, Ohio. Contrib. 10. pp. 7-14.

General climatology and ice cover of the South Bass Islands. Weather conditions of the winter is chiefly covered and the characteristics of the ice. Use of the ice for crossing to the mainland is also discussed.

Lanighan, M. C. - See: J. Puleo, et al, No. 601.

Lansing, L. - See: R. Falconer, et al, No. 232.

434. Lapham, I. A. 1847. On the existence of certain lacustrine deposits in the vicinity of the Great Lakes, usually confounded with the drift. Am. J. Sci. 3:90-94.

Much of what passes for drift in the region of the Great Lakes must be attributed to a lacustrine origin of more recent date. These beds, sometimes as much as 15 to 20 feet thick, were deposited in an environment of calm water. They consist of nearly uniform layers of fine clay resting upon irregular beds of sand, gravel, boulders, and hard pan (true drift). Lake deposits may be distinguished from the true drift by the uniformity and regularity of the layers, the fine uniform texture of the material, and the absence of bo.lders and irregular beds of gravel and sand. (BECPL)

LaSala, A. M. - See: R. J. Archer, No. 19.

LaSala, A. M. - See: R. J. Archer, et al, No. 20.

435. LaSala, A. M. 1968. Groundwater resources of the Erie-Niagara Basin, New York. N. Y. S. Water Resources. Erie-Niagara Basin Regional Water Resources Planning Board. Rept. ENB-3. 114 p.

This report presents the results of an investigation by the U. S. Geological Survey to provide the Planning Board with an evaluation of the groundwater resources of the Erie-Niagara Basin and a description of the geology to the extent required for broad planning of water resources development. Evaluation of the groundwater resources included appraising the quantity and quality of water available for development, its areal distribution, and seasonal variations. Existing and potential pollution and their effect on the availability of the groundwater were also included in this work. (SE)

Lawhead, Harley F. - See: Thomas M. Patterson, No. 560.

436. League of Women Voters. 1966. Lake Erie: Requiem or reprieve? League of Women Voters. Lake Erie Basin Committee. Erie, Penn. 50 p.

Basically concerned with presenting a report on the problems of Lake Erie, this pamphlet contains excellent sections on the geologic history, formation, and natural characteristics of the Lake and the fluctuations of lake levels. (SM)

437. League of Women Voters. 1969. Thermal pollution--another threat to Lake Erie. League of Women Voters. Lake Erie Basin Committee. Lake Erie Letter (November). 4 p.

This newsletter reports the effect of heated effluents on the Lake and methods of dissipating heat from power plants.

438. League of Women Voters. 1970. Interim report on thermal and radiological effects being introduced to Lake Erie from electric power plants. League of Women Voters. Lake Erie Basin Committee. 21 p.

A description of the flow, mix, heat loads and temperature of

Lake Erie is presented. The effect of waste from power plants on these parameters is considered and recommendations are given for environmental control.

439. League of Women Voters. 1970. Soil erosion: Spoiler of land and water. League of Women Voters. Lake Erie Basin Committee. Lake Erie Letter (November). 4 p.

Contained in this newsletter is a description of sediments and erosion in Lake Erie and how they affect the environment.

440. Lee, T. R. Water use in the Great Lakes Basin. Canadian Geog. J. 82(6):200-205.

There is a brief mention of the Lake Erie mean water level from 1939 to 1970 and a comparative profile of Lake Erie as compared to the other Great Lakes.

441. Leighly, John. 1942. Effects of the Great Lakes on the annual march of air temperatures in their vicinity. Mich. Acad. Sci., Arts and Letters Papers (1941). 27:377-414.

Using a series of climatological maps of the Great Lakes area, the author reports on the investigation of the thermal influences of the Laurentian Great Lakes on the annual cycle of air temperatures over the lands about them. Lake Erie is cited in the report, but the main report deals with the Great Lakes as a whole. (SM)

442. Leopold, Luna B. 1970. Discussion and summary. John Carroll Univ. Carroll Business Bull. 10(1): 24-28.

This section deals with a discussion about some of the physical aspects of Lake Erie. Included is a discussion of the three basins of Lake Erie, the effects of Lake Erie's clay bottom on nutrient build-up, Toledo's Black Swamp's natural screening function, the effect of silt build-up on water turbidity, the rural runoff factor, and a summary of silt effects.

443. Leshniowsky, Walter O., Patrick R. Duggan, Robert M. Pfister, James I. Frea and Chester I. Randles. 1970. Adsorption of chlorinated hydrocarbon pesticides by microbial floc and lake sediment and its ecological implications. Internat. Assoc.

Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 611-618.

Contemporary sediment collected from Lake Erie was examined microscopically, analyzed for pesticide content and ability to adsorb aldrin. Bacterial flocs adsorbed aldrin from solution giving a 625X concentration factor within 20 min after which there was no further increase. The collected sediment behaved similarly. Floc forming microbes settling from a water column remove pesticides and represent a natural purification process. The pesticides may then accumulate in bottom sediments and exert a toxic effect on susceptible fauna.

Lesley, J. P. - See: J. S. Newberry, No. 514.

Leverett, Frank - See: H. P. Cushing, et al, No. 177.

444. Leverett, Frank. 1892. On the correlation of moraines with raised beaches of Lake Erie. Am. J. Sci. (Ser. 3). 43(256):281-301.

The author follows and describes three beaches and their correlative moraines of Van Wert, Leipsic, and Belmore. Described is the physical evidence, the structure, morphology and deposits, and the glacial retreat and formation of the modern Erie Basin with the shorelines reformed after each successive glacial retreat to its present form. (SM)

445. Leverett, Frank. 1895. Correlation of New York moraines with raised beaches of Lake Erie. Am. J. Sci. (Ser. 3). 50(295):1-20.

The position of the moraines on the south border of the Lake Erie Basin and their relation to beach lines which terminate in Northern Ohio is such to indicate that the eastern portion of the Lake Erie Basin was still occupied by the ice sheet while the western part was occupied by the lake which formed these beaches. The paper deals with the completion of Gilbert's work on the raised beaches, ridges, moraines, and glacial deposits on the south and eastern shores of Lake Erie. Features are noted and interpreted as to the geologic events that have taken place. (SM)

446. Leverett, Frank. 1898. Correlation of moraines with beaches on the border of Lake Erie. Am. Geologist. 21(3):195-199.

A supplement to previous articles (Leverett, 1892, No. 444, and 1895, No. 445) in light of new evidence found by field observations. It had been believed that moraines on the south and east borders of Lake Erie correlated with beaches which encircled the western end of the Lake. This interpretation meant that while a lake was occupying the area enclosed by the beaches, the ice sheet occupied the area to the east. The beaches are now found to continue further to the east to the Genesee region. (BECPL)

447. Leverett, Frank. 1902. Glacial formation and drainage features of the Erie and Ohio Basins. U. S. Geol. Surv. Mono. 41:802.

Study area considered covers area from Genesee Valley westward across Northwestern Pennsylvania and Ohio to Central and Southern Indiana and southward from Lakes Erie and Ontario. Discussed are the physical features, geology, drainage systems, drifts, glacial boundaries, the glacial lakes, and soils of the region. Historical origins and formations are presented, pertinent to the Erie Basin and its evolution as well as the present river systems that drain into Lake Erie and their geologic history. (BL)

448. Leverett, Frank. 1904. Review of the glacial geology of the southern peninsula of Michigan. Mich. Acad. Sci. 6th Annual Rept. pp. 100-110.

Essentially a short review of the glacial history of the Great Lakes; little mention is made of Lake Erie. (SM)

449. Leverett, Frank. 1910. Outline of the history of the Great Lakes. Mich. Acad. Sci. 12th Annual Report. 12:19-42.

General discussion of the glacial history and formation of the Great Lakes, including the Erie Basin. Rise in water and uplift are discussed concerning the Western Basin of modern Lake Erie and the evidences that indicate its formation. (SM)

450. Leverett, Frank. 1912. Surface geology and agricultural conditions of the southern peninsula of Michigan. Mich. Geol. and Biol. Surv. Pub. 9. Geol. Ser. 7. 144 p.

Included in this study is the drainage, surface geology, and brief discussion of glacial geology and the beginnings of Lake Erie in the vicinity of the Michigan peninsula on the

Lake Erie shore. The formation of the Western Basin and the discharge flow into the basin are covered. (SM)

451. Leverett, Frank. 1939. Correlation of beaches with moraines in the Huron and Erie Basins. Am. J. Sci. 237(7):456-475.

This paper attempts to bring down to date the knowledge concerning the beaches and correlative moraines of the Huron and Erie Basins in Ontario as well as in Michigan, Ohio, Pennsylvania and New York. It also calls attention to errors that appear in earlier papers and reports on this subject. It covers the entire series of beaches from the Maumee down to the Algonquin. The latter is not included since Lake Algonquin extended over the Lake Superior and Lake Michigan Basins as well as the Lake Huron Basin. (BL)

452. Leverett, Frank and D. C. MacLachlan. 1934. Variations in tilt lines in the Huron-Erie district. Science. 80(2085):550.

The shores of glacial lakes in the Huron-Erie district show a notable difference in the trend of tilt lines in lakes of different ages and also in different parts of the shore of a given lake. (BL)

453. Leverett, Frank and F. B. Taylor. 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. U. S. Geol. Surv. Mono. 53:529.

Glacial history, formation, and geology are discussed. Included are mention of Lake Erie's separation from the glacial lakes, uplift, tectonic activity, old shorelines at Fort Erie, beach ridges, drainage, Detroit River flow, and its tributaries. (BL)

Lewis, C. F. M. - See: G. D. Hobson, et al, No. 329.

Lewis, C. F. M. - See: A. L. W. Kemp, No. 389.

454. Lewis, C. F. M. 1963. Reconnaissance geology of the Lake Erie Basin. M. A. Thesis. Univ. Toronto. Toronto, Ont. 132 p.

Reflection characteristics of echograms from a navigational echo sounder installed in the research vessel Porte Dauphine enabled the distinction of soft, fine-grained sediments from sand, gravel, or compact clay in Lake Erie. Samples from piston cores, gravity cores, bottom grabs, and SCUBA diving identified the bottom and sub-bottom reflections as Recent sand, silt, and clay, clay and till, or bedrock.

An elongated bedrock basin at a maximum depth of 500 feet below lake level trends N 71°E across the eastern part of Lake Erie. Variations in relief of this basin suggest that the north side is sculptured in Lower Devonian limestones whereas the south side is composed of a limestone-shale sequence similar to the Middle Devonian Hamilton Formation. Unconsolidated drift, probably all Pleistocene and Recent material, has accumulated in this basin to a thickness of 320 feet or more. Although much of the Pleistocene material is composed of deep water lacustrine clay, three moraine-like ridges between Port Rowan-Erie, Erie-Cleveland, and Pelee-Lorain were found under Lake Erie. An extensive erosion interval followed the Pleistocene sedimentation in which wave action attacked the elevated shore and bottom deposits, left a granular lag concentrate and carried the fines into the deeper parts of the lake. A warming climate encouraged production of aquatic organisms whose remains were deposited contemporaneously with the silt and clay. Today the Central Basin is nearly filled, but the deep hole east of Long Point continues to receive the fine-grained sediments resulting from wave erosion of shore and lake bed. (CCIW)

455. Lewis, C. F. M. 1968. Quaternary geology of the Great Lakes. Geol. Surv. Canada. Paper 69-1. Pt. A. pp. 63-64.

Piston cores, recovered from Western Lake Erie, confirmed the presence of buried organic Early Lake Erie sediments and provide material for ecological and radiocarbon analyses. Although buried peat deposits are extensive they were found to be more variable in thickness than previously believed. In addition, long mud cores were collected from each basin of the lake.

Late in August the writer participated in a joint Ohio Geological Survey-Geological Survey of Canada seismic reflection survey of bedrock topography and overburden thickness in the Western Basin of Lake Erie. The survey is described elsewhere in this publication by G. D. Hobson.

456. Lewis, C. F. M. 1969. Late quaternary history of lake levels in the Huron and Erie Basins. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 250-270.

Piston core and echogram data revealed a series of small basins within Western Lake Erie beneath post-glacial clayey silt mud. Each basin contained an extensive bed of plant detritus suggesting the previous existence of a marsh environment. The marsh deposits ranged in age from 12,600 to 5000 years BP. These data with information on differential warping of the Erie Basin yielded a revised history of post-glacial lake levels. Early Lake Erie, following an episode of glacial lake drainage, came into existence 12,600 years BP, at 40 m below present lake level. This low level phase was short-lived as rapid post-glacial rebound raised the outlet at Buffalo. Levels were maintained near 15-10 m from 10,000-6000 BP. A sharp rise between 5000 and 3800 years BP is correlated with the transfer of Nipissing drainage through Lake Erie. A slow but progressive rise is inferred to the present day.

457. Lewis, C. F. M., T. W. Anderson and A. A. Berti. 1966. Geological and palynological studies of Early Lake Erie deposits. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15: 176-191.

Coring and echo sounding of Lake Erie bottom sediments have indicated a thin lag concentrate of sand, in places with plant detritus, pelecypods, gastropods and other fossils, underlying clay till or late-glacial lacustrine clays. Buried shallow pond organic sediments in the Western Basin and relict beach deposits, wave-cut terraces and intrabasinal discharge channels in the Central Basin, some of which are buried, all indicate former low water levels in Central and Western Lake Erie much below those at present. This evidence, combined with radiocarbon dates of 10,200 and 11,300 years BP on the organic material and information from nearby regions, suggests that Early Lake Erie came into existence about 12,400 years ago, with water levels, 100 ft (30 m) lower than at present, at approximately 470 ft above sea level. From this stage lake levels rose rapidly as the outlet area at Buffalo, N. Y., was uplifted isostatically following deglaciation, and probably reached their present elevation 9,000 to 10,000 years ago.

Examination of the cores indicated that pollen is sufficiently abundant and well preserved in the sediments for palynological studies. Pollen diagrams can be correlated with one another, and with those outside of the Lake Erie Basin. The presence of a legible pollen record indicates that sedimentation has been probably continuous and undisturbed at the sites investigated since low-level Early Lake Erie. Palynological studies support the geological evidence of a low lake stage and provide a means for dating and correlating sediment sequences which do not contain enough organic matter for radiocarbon analysis.

458. Li, Ting Y. 1970. Formation of thermocline in Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 1. pp. 453-467.

In the present study the thermal structure and dynamic conditions in the lake are analyzed, based on conservation equations of turbulent mean motion. Under windy conditions, vertical convection and mixing become important for the thermocline problem. While the horizontal motion of the lake water is described by the general Ekman type equations, the vertical mode motion is governed by equations of the form of Burgers' model equation of turbulence. Solutions are obtained which provide theoretical estimates of the formation of thermocline in Great Lakes.

Lick, W. - See: R. T. Gedney, No. 248, 249, 250.

Lick, W. - See: Y. P. Sheng, No. 656.

459. Liu, Paul C. 1970. Statistics of Great Lakes levels. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 1. pp. 360-368.

Records of monthly mean water levels are available for the Great Lakes from 1860 to the present. Spectral analysis of monthly water-level data in the frequency range between zero and six cycles per year reveals that significant peaks of annual cycles exist in all the Lakes. Spectra obtained by taking differences between the monthly data and the long-term average for the same months, on the other hand, do not contain any prominent peaks. Spectral analysis of annual water-level data in the frequency range between zero and one-half cycles per year suggests the existence of a long-term periodic cycle of eight years.

460. Liu, Paul C. 1972. Surface motion. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4:4-79 to 4-118.

This report contains a description of the different types of surface motion on the Great Lakes. Data on ranges of tides and seiches are given for Lake Erie.

Loewen, P. - See: T. L. Richards, No. 622.

461. Lowright, Richard, E. G. Williams and F. Dachille. 1972. An analysis of factors controlling deviations in hydraulic equivalence in some modern sands. J. Sed. Petrol. 42(3):635-645.

Heavy and light minerals in beach, dune and offshore sands from Lake Erie exhibit a systematic divergence from hydraulic equilibrium. As grain size increases, the settling velocity ratio of heavy to light grains decreases, a condition which can be predicted from pickup equations, and is therefore a hydrodynamic rather than a source phenomenon. Also, the concentration of heavies is positively correlated with the velocity ratio. This relationship is explained by a rolling and saltation model, in which larger, lighter grains are most easily removed, leaving behind smaller heavy and light minerals of about the same size but different settling velocities. Paleozoic sandstones exhibit greater divergence from a hydraulic equilibrium than modern sands and have lower heavy mineral concentration, a phenomenon attributed to extensive reworking and recycling. (BL)

462. Lucas, A. M. and N. A. Thomas. 1971. Sediment oxygen demand in Lake Erie's Central Basin 1970. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 781-787.

Sediment oxygen demand rates were measured at five locations in the Central Basin in June, August, and September, 1970. Lake stratification and sediment resuspension are discussed and data of temperatures taken in the hypolimnion are presented in this study.

463. Luck, Alan D. 1967. Lake Erie--a study in resource geography. Ph.D. Dissertation. Univ. Oklahoma. Norman, Okla. pp. 10-45.

This section of the report deals with the physical characteristics of Lake Erie, including physical geology, topography, and hydrology dealing with the water level characteristics. Following is a discussion of pollution discharge into Lake Erie, discussing the water quality and the load discharge into the lake.

Lundahl, A. C. - See: F. J. Pettijohn, No. 571.

464. MacCrimmon, H. R. and M. G. Johnson. 1971. Limnology of the lower Grand River. Canada Centre for Inland Waters. Burlington, Ont. 117 p.

The Grand River, Ontario, was examined between Brantford and Lake Erie. Total dissolved solids varied between 232 and 621 mg/l with the highest values occurring in the spring. Turbidity was low except during the early spring runoff when it attained values of 40 to 70 mg/l. Particulate organic nitrogen concentration was positively correlated and the dissolved organic nitrogen was negatively correlated to discharge. Particulate organic carbon concentration was correlated to discharge; no significant correlation was found between dissolved fraction and discharge. River discharge affected the concentration of particulate organic matter. Suspended solids in the estuary, much of it algae, restricted the photic zone to 1-2 m throughout the study period, suggesting that light rather than nutrients may limit productivity in the estuary. Suspended solids and total phosphorus were collected offshore in Lake Erie in sedimentation traps. Both declined by 90% between the river mouth and points 3.5 km offshore. The limnology of parts of Lake Erie adjacent to the mouth of the Grand River were studied to observe mixing patterns and to compare water quality. (CCIW)

MacDonald, H. C. - See: R. H. Benson, No. 43.

Macer, R. - See: S. Abram, et al, No. 4.

MacKenzie, R. J. D. - See: G. C. Dohler, No. 205.

MacLachlan, D. C. - See: Frank Leverett, No. 452.

465. MacLean, William F. 1963. Modern pseudo-upwarping around Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:158-168.

Previous rates of modern crustal movement have been calculated by comparing gage differences of pairs of water-level gages over a number of years despite the fact that Lake Erie is southwest of the zero isobase of the Nipissing shoreline; thus Lake Erie is in an area where postglacial rebound ceased by Nipissing time (3500-4200 years BP).

An analysis of errors and factors influencing water-level gages and a correlation study of Lake Erie effective winds versus gage differences demonstrated that the quantities which were measured as rates of crustal movement from gage difference-time curves were actually slopes of the lake surface measured from best-fit curves of net summer season set-up.

466. Mangan, John W., Donald W. Van Tuyl and Walter F. White, Jr. 1952. Water resources of Lake Erie shore region in Pennsylvania. U. S. Geol. Surv. Washington, D. C. Geol. Surv. Circ. 174. 36 p.

The purpose of the report is to summarize and interpret all available water resources information for the Lake Erie shore region of Pennsylvania. General characteristics of the region are given. Data and graphs dealing with chemical quality and discharge into the lake are given for major tributaries of Pennsylvania. Also discussed are groundwater, the geology and hydrology, and wells sampled for water resources. (SM)

Mark, Herman - See: Richard T. Gedney, No. 251.

467. Marshall, Ernest W. 1966. Air photo interpretation of Great Lakes ice features. Univ. Mich. Great Lakes Res. Div. Spec. Rept. 25. 92 p.

The report collects visual imagery of ice features and patterns common to the Great Lakes and gives interpretations of it. The study is based on USAF aerial photography flown over the Great Lakes on March 23, 1963 together with observations and photographs taken on U. S. Coast Guard ice reconnaissance flights during January and February 1965. Ice features are included from all Great Lakes with the majority from Lake Erie.

The photographs and interpretations are arranged according to features found in open water areas during freeze-up, in the newly formed ice, in winter ice and in patterns resulting from snow and wind.

The report brings out the role of snow and water turbulence in determining the types of ice sheet formed. Recommendations are made for future research.

468. Marshall, Ernest W. 1968. Investigating the Great Lakes ice cover. Limnos. 1(1):1-11.

An analysis of the ice cover on the Great Lakes in maps, cross sections, aerial photography, and graphs. Also included is the effect of ice on intralake and interlake navigation.

469. Marshall, Ernest W. 1970. Ice on the Great Lakes: More than a canopy. Water Spectrum. 2(1):24-27.

The ice canopy spreads over the Great Lakes much like a heavy cloud cover over land. It restricts sunlight, changes the flow of currents and subtly alters the total water environment. Further research needs are outlined, relating ice cover studies of the Great Lakes to those in the Polar latitudes. (BECPL)

Massey, D. G. - See: T. L. Richards, et al, No. 621.

Masteller, E. C. - See: W. A. O'Kelly, No. 530.

Masters, C. O. - See: J. Puleo, et al, No. 601.

470. Mather, W. W. 1838. Rise and fall of Lake Erie. In: Second Annual Report on the Geological Survey of the State of Ohio. Samuel Medary, Printer to the State. Columbus, Ohio. pp. 23-24.

Report on the increasing level of Lake Erie. Damage due to flooding and erosion are related. Forest tracts are reported to be underwater and dying, showing a long term increase in water level. The author states the reasons for the level change as blockage of the outflow of Black Rock, temperature, evaporation, drainage into the lake and inflow. Change in ground level itself is briefly discussed as the cause and change in the lake level. (SM)

Mayer, Tatiana - See: J. D. H. Williams, No. 905.

471. McCabe, Patricia A. and James I. Frea. 1971. Effects of mineral particulates on microbial degradation of solid organic materials. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 44-51.

In an aqueous medium, strong interactions occur between mineral particulates and (1) the mycelium of a streptomycete, (2) solid proteinaceous substrates and (3) the extracellular enzyme of the streptomycete. We have demonstrated adherence of kaolin to cell and substrate surfaces. We assayed kaolin-adsorbed enzyme by its ability to release azo dye conjugated to collagen, and to degrade collagen structure. In a cell free system, kaolin-enzyme and kaolin-substrate interaction effects two enhancements of enzyme activity. Addition of kaolin to dilute enzyme solutions is a rapid method of concentrating active enzyme. Adherence of enzyme-coated kaolin to degradable material places the enzyme in immediate contact with substrate.

McCrimmon, H. R. - See: A. H. Berst, No. 47.

McIntyre, D. R. - See: T. L. Richards, et al, No. 618.

472. McLean, E. O. 1970. Agricultural pollution of Lake Erie. Ohio Rept. (July and August). Columbus, Ohio. 55(4):94.

Information on the modes by which phosphorus moves from the soil to the streams and lakes is brought out in this particular article with an introduction to the studies that are being carried out during the writing of the article.

473. McMillan, Gladys L. and Jacob Verduin. 1953. Photosynthesis of natural communities dominated by Cladophora glomerata and Ulothrix zonata. Ohio J. Sci. 53(6):373-377.

The littoral zone in Western Lake Erie is populated by attached filamentous algal communities dominated in summer by Cladophora glomerata (L.) Kutz, and in winter by Ulothrix zonata (Weber & Mohr) Kutz. During 1950-51 these communities were studied to determine their photosynthetic activity under near natural conditions. Graphs showing the relationship between photosynthesis and light intensity are reproduced and discussed. (BU)

474. McMullin, D. N. 1962. Comments on "An investigation of the meteorological conditions associated with extreme wind tides on Lake Erie" (Irish and Platzman, 1962, No. 372). Mon. Wea. Rev. 90(6):216.

Because Lake Erie is frequently frozen over in late winter, this might account for the very low frequency of high set-ups. Broken ice packs early in the year have a damping effect on wave motion. (BECPL)

McNair, T. - See: R. M. Pfister, et al, No. 576.

McVehil, George E. - See: R. A. Brown, et al, No. 72.

475. McVehil, George E., J. E. Jiusto, R. L. Peace and R. A.

Brown. 1967. Project Lake Effect: A study of lake effect snowstorms, interim report. Calspan. Buffalo, N. Y. CAL Rept. VC-2355-P-1. 55 p.

Two studies of lake-effect snowfall in Western New York are presented. The first study is an analysis, from radar and radiosonde data, of snowband movement and wind structure in a lake-effect storm that occurred on 3-4 November 1966. The second study deals with the cloud physics and modification potential of lake-effect snowstorms. (CA)

476. McVehil, George E. and Robert L. Peace. 1965. Project Lake Effect: A study of interactions between the Great Lakes and the atmosphere. Calspan. Buffalo, N. Y. CAL Rept. VC-1967-P-2. 54 p.

Analyses have been made of a number of recent cases of lake-effect snowfall along the southern and eastern shores of Lake Erie. Synoptic analyses are presented to show the large-scale weather situations in which severe lake-effect snowstorms occur, and also some of the mesoscale characteristics of the snow squall bands. Examples are included which show typical characteristics as they appeared in several different storms. Meso-analysis of a Lake Ontario storm reveals distinctive pressure, wind, and convergence patterns that are associated with lake-effect storms. (CA)

477. McVehil, George E. and Robert L. Peace. 1965. Some studies of lake effect snowfall from Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:262-272.

Analyses have been made of a number of recent cases of lake-induced snowfall along the southern and eastern shores of Lake Erie. Synoptic analyses are presented which show the large-scale weather situations in which severe lake-effec snowstorms occur, and also some of the mesoscale features of the snow squall bands.

Radar photographs taken from the U. S. Weather Bureau radar at Buffalo have been analyzed to show the frequency of occurrence of the banded convective precipitation from the lake and the characteristics of the precipitation patterns. The results indicate that lake-effect snow occurred on over 21% of all days during November, December, and January of the past three years and that there are several characteristic snowfall patterns.

Rates of heat transfer and evaporation from Lake Erie to the cold polar air masses in which lake-effect storms occur have been estimated from synoptic radiosonde data. Results of the calculations are presented along with comparisons with other estimates.

478. McVehil, George E., C. W. C. Rogers and W. J. Eadie. 1968. The structure and dynamics of lake effect snowstorms, final report. Calspan. Buffalo, N. Y. CAL Rept. VC-2559-P-1. 49 p.

Observational and modeling studies of lake-effect snowstorms on Lake Erie are reported. Data on snowflake characteristics and distribution, vertical velocity in convective snow clouds, and cloud structure were collected in two mid-winter storms. Numerical modeling experiments with several variations of a single layer dynamical model originated by Lavoie were conducted to analyze the dynamical factors that lead to lake-effect snow. (CA)

Megerian, Edmond - See: B. G. Decooke, No. 192.

479. Megerian, Edmond. 1968. Simulation of Great Lakes Basin water supplies. Water Resources Res. 4(1):11-17.

The basic concept utilized in the simulation study is to evaluate statistically the recorded supplies to isolate the two components assumed to constitute the basin water supply: (1) that portion of the supply that is considered random, owing to chance interaction of unpredictable meteorological elements, and (2) that portion of the supply that is the result of the persistence due to natural storage in the lakes, soil, bedrock, and snow over the drainage basin. In this study, consideration was also given to the relationship between supplies in neighboring basins. These factors were used to formulate mathematical models for simulation of supplies to all of the Great Lakes simultaneously. Extensive statistical tests have been used to ensure that the statistical parameters and the time series characteristics of the simulated data resemble those of the recorded data.

Meredith, D. D. - See: D. M. A. Jones, No. 381.

Merkel, H. K. - See: C. D. Simpson, et al, No. 660.

480. Metter, Raymond E. 1953. Sedimentary processes along Lake Erie shore from Cedar Point to Huron.

In: H. J. Pincus (Ed.), 1951 Investigations of Lake Erie shore erosion. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 18. pp. 5-46.

This paper covers a limited analysis of sedimentary processes along the Lake Erie shoreline from Cedar Point to Huron, in Erie County, Ohio. The investigatio s involved a survey of the geologic setting of the area, the collection and analysis of sediment along the shore and the adjacent lake floor, the mapping of profiles, and the observations of effects of physiographical, hydrological and meteorological factors on the movement of sediment. Statistical information obtained from analysis was plotted in order to discover possible simple relationships between features of sediments and their environments. (SM)

481. Michalski, M. F. P. 1972. Phytoplankton conditions in the Nanticoke area of Lake Erie, 1969-1971. Ont. Ministry of the Environment. Ottawa, Ont. 10 p.

Water clarity, as recorded by Secchi disk readings, was higher at offshore stations, although chlorophyll a concentrations were homogeneous throughout the study area. The chlorophyll a and Secchi disk data were described by a near hyperbolic relation. Values for the nearshore stations formed a group of points somewhat removed from the established relationships indicating that higher turbidity levels were reducing water clarity conditions in these coastal waters. It was suggested that future changes in water clarity will result in shifts in the positions of the chlorophyll-Secchi disk relationships for each station. It appeared that high turbidity at nearshore stations limited light penetration and therefore reduced algal densities. This would account for the consistent differences in mean areal standard unit values between coastal and offshore stations.

482. Michigan Department of Natural Resources. 1965. Water resources conditions and uses in the Raisin River Basin. Mich. Dept. Nat. Resources. Mich. Water Resources Comm. Lansing, Mich. 105 p.

Comprehensive report on the Raisin River Basin encompassing the geology, soils, climatology, streamflow, groundwater, and water quality. Special attention is given to water use and management, floods and flood control, and water resource development. Data is given for precipitation, discharge, runoff, and water quality. (RL)

483. Michigan Department of Natural Resources. 1972. Erosion of the Michigan Great Lakes coastal lands. Mich. Dept. Nat. Resources. Mich. Water Resources Comm. Lansing, Mich. 18 p.

Erosion in Michigan shore areas of the Great Lakes is discussed in terms of causes (winds, lake level fluctuations, etc.) and solutions. (CCIW)

484. Michigan Department of Natural Resources. 1973. Flooding problems associated with current high levels of the Great Lakes. Mich. Dept. Nat. Resources. Water Dev. Services Div. Lansing, Mich. 47 p.

This report contains a summary of a survey of flood problems in Michigan associated with high levels of the Great Lakes, including Lake Erie, during 1973, following abnormally high precipitation for the previous three years. Possible alternative courses of action under future and existing local, state, and federal programs are discussed.

485. Millar, F. G. 1952. Surface temperatures of the Great Lakes. Canada Fish. Res. Board J. 9(7):329-376.

Thermographs were installed in the condenser intakes of several steamships on the Great Lakes, with which the water temperature was recorded for five to ten years. Averages for Lake Erie ranged from 35.3°F to 74.2°F and indicate that it is the warmest lake during the summer. The temperature varies considerably over a lake surface in a manner determined by the depths and currents. (SM)

486. Miller, Gerald S. 1968. Currents at Toledo Harbor. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 437-453.

An investigation of currents at Toledo Harbor, Ohio, was conducted from May through November 1966 using Eulerian and Lagranian techniques. The driving forces producing currents in the harbor are wind tides, seiches, and river discharge. The current is a reversing type except during periods of high river outflow. Speed histograms indicate that about 10% of the time the current speed is greater than 15 cm/sec. Spectral analysis of current speed shows that the peaks correspond to the modes of the seiche. Drogue tracks indicate that the mid-channel current is up to 2.5 times greater than that recorded near the channel edge. Opposing currents are occasionally observed because of wind induced surface currents.

487. Miller, Gerald S. 1972. Water movements in harbors. In: Limnology of Lakes and Embayments. Great Lakes Basin. Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4: 4-149 to 4-180.

This is a report on the effects of water movements on harbors. Specific attention is given to Fairport Harbor at the Grand River on Lake Erie.

Moffett, J. W. - See: A. M. Beeton, et al, No. 40.

488. Moore, Sherman. 1922. Tilt of the earth in Great Lakes region. Military Eng. 14(75):153-155, 181-183.

During the winter of 1919-1920, in comparing the water surface elevations of Lake Erie at Port Colborne with the elevations at Cleveland, it was discovered that those at Port Colborne were between .2 and .3 foot lower than the corresponding levels at Cleveland. A comparison of the elevations of the lake surface at Cleveland with those at Buffalo found Buffalo elevations nearly .1 foot below Cleveland while in 1903 they had had the same readings. It was found by studying gage records compiled by the Lake Survey, that the earth's crust was moving, causing a relative rise of the land to the north and east. The rate of tilt for Lake Erie was computed to be .46 feet per 100 miles per 100 years with an axis 31°N of W. This rate is not uniform over the entire Great Lakes region. (BECPL)

489. Moore, Sherman. 1948. Crustal movements in the Great Lakes. Geol. Soc. Am. Bull. 59:697-710.

The crustal movement is determined at 106 points in the Great Lakes area. The entire area, except for North Lake Superior, is subsiding with respect to sea level. Methods and results are discussed but no conclusion as to the cause of the movement is reached. (BL)

490. Morgan, Nabil A. 1969. Physical properties of marine sediments as related to seismic velocities. Geophysics. 34(4):529-545.

An investigation of the dependence of seismic velocities on different physical properties of naturally occurring fresh-

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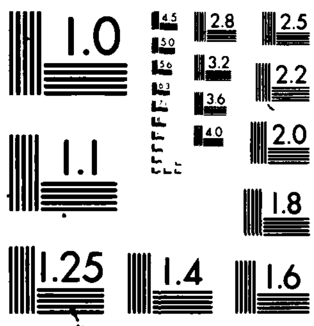


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

water sediments in Lake Erie has been conducted. Cores from one lake bottom were collected and the longitudinal seismic wave velocities as well as the physical properties (grain density, bulk density, porosity, median diameter, and phi deviation) were measured. The data were fitted with a second-order polynomial in all the physical properties to the seismic velocity. Independent variables were ranked according to their individual effect upon the sum of the squares of the regression residuals. A variance-analysis table was set up, and the coefficients were tested by a series of F ratios at certain probabilities. As porosity and bulk density are linearly related, these were not included together in the same model. There are strong indications that the porosity and its square together with the median diameter play a significant role in determining the seismic velocity at the probability of 0.90. At the higher probability of 0.99, the median diameter proved insignificant. The cubic term of porosity is insignificant at the 0.50 level. (BL)

491. Mosely, Edwin L. 1897. The climatic influences of Lake Erie on vegetation. Am. Nat. 31(361): 60-63.

Discussed are the climatic effects on the Sandusky vicinity and the Islands. Comparisons are made to Buffalo and differences in frost days, temperature, and exposures are noted. Plant distribution and types are listed. Plants expected to grow only in the Western States are seen to grow here this far East. (BU)

492. Mosely, Edwin L. 1899. Sandusky flora. Ohio State Acad. Sci. Spec. Papers 1. pp. 1-30.

Basically a report on the flora, and includes discussion of climatic influence of Lake Erie on the vegetation, local geology, physiography and a discussion of the islands in the area (3), their origin, tilting, local geology, and their relation to the change in lake levels. Submerged forests as well as the submerged stalagmites in the caves of Put-in-Bay indicate level change. River channels below present lake levels are traced and evidence of Lake Erie's water deepening in the present century are discussed. (SM)

493. Mosely, Edwin L. 1902. Submerged valleys in Sandusky Bay. National Geog. Mag. 13(11):398-403.

Valleys of streams submerged due to the rebound of the region were traced along the bottom of Sandusky Bay. It was found that off the mouth of each stream, the sediment, composed of soft mud containing organic matter, was readily distinguished from the glacial drift on either side. The agitation of the water by waves has filled in the original valleys, causing the bottom of the Bay to be nearly level. (SM)

494. Mosely, Edwin L. 1903. The currents in Sandusky Bay. Ohio Acad. Sci. Eleventh Annual Rept. (1902). pp. 21-26.

Study performed using drift bottles to determine the currents of Sandusky Bay. Distribution carried the bottles into Lake Erie proper. Discussed are methods, currents, surface and subsurface differential current movement, wind factors, and a map showing the beginning and recovery points of the bottles. (SM)

495. Mosely, Edwin L. 1903. Rainfall and the level of Lake Erie. National Geog. Mag. 14:327-328.

A comparison of the level of Lake Erie at Cleveland with the record of rainfall along the Great Lakes shows a direct correlation. (SM)

496. Mosely, Edwin L. 1905. Formation of Sandusky Bay and Cedar Point. Ohio State Acad. Sci. Thirteenth Annual Rept. (1904). 4(5):179-238.

Discussion of the physiography and morphology of Sandusky Bay and Cedar Point. Included are the geologic history, climate, shore processes active in the area, lake level effects, sediments, Sandusky River and tributaries, and the formation of the area of the past, present, and the future. (SM)

497. Mosely, Edwin L. 1930. Fluctuation of bird life with change in water level. Wilson Bull. 42(3): 191-193.

In the late spring of 1929, the waters in Lake Erie became higher than it had been previously for nearly half a century. In the Sandusky Region and farther west, the water was probably never so high. High precipitation and subsidence are briefly discussed as the cause. (SM)

498. Mosely, Edwin L. 1940. The ninety-year precipitation cycle. Mich. Acad. Sci, Arts and Letters (1939). 25:491-496.

Brief discussion relating to lake levels. Covered are the sand and gravel ridges of Cedar Point, which were piled up by waves during great northeast storms. Storms that occurred during times of abnormally high levels of water built ridges that endured. It can be seen that a ninety-year cycle exists in this record. (SM)

499. Moyer, Carl A. 1966. The make-up of the Great Lakes. In: The Great Lakes--How Many Masters Can They Serve? Mich. Nat. Resources Council. 11th Annual Conf. pp. 6-14.

A portion of this paper gives information on the Great Lakes' physical and historical background. An overall description of the Great Lakes is reported with little depth to any specific lake.

500. Mozola, A. J. 1962. The bedrock topography of Wayne County, Michigan. Mich. Acad. Sci., Arts and Letters Papers (1961). 47(1):19-28.

The topography, preglacial drainage patterns, and the changes that have been imposed upon this pattern by repeated glaciation during the Pleistocene in the area bordering the Detroit River are discussed. (SM)

Mudrochova, Alena - See: A. L. W. Kemp, et al, No. 388.

501. Mull, Max W. 1972. Great Lakes environmental monitoring and prediction services of the National Weather Service. In: Proceedings of the First Federal Conference on the Great Lakes. Interagency Committee on Mar. Sci. and Eng. for the Federal Council for Science and Technology. Washington, D. C. pp. 192-196.

Presentation of research and data concerning The Lake Erie Storm Surge Forecast Program, a statistical technique which forecasts the storm surge at Buffalo and Toledo, and the forecasts of wind over Lake Erie, current research in that field.

Mundinger, P. C. - See: C. F. Powers, et al, No. 596.

502. Munter, Caimir J. 1960. Chemical observations on pollution. In: C. J. Fish and Associates (Eds.), Limnological Survey of Eastern and Central Lake Erie 1928-29. U. S. Fish and Wildlife Service.

Washington, D. C. Spec. Sci. Rept. Fish. No. 334. pp. 111-122.

Discussion of pollution sources and their effects on the ecology of Lake Erie is contained. Surface waters presented graphically and in discussion cover the temperature, pH, free carbon dioxide, percentage of oxygen saturation, and chlorides. Turbidity likewise is presented for some of the study areas. A point in the conclusions states that the diluting action of the Lake was so great that detectable evidence of waste was not found at a distance greater than a mile from shore, except at Fairport and Toledo. Pollution is described as a shore effect more than an offshore one. Survey was conducted during the summer of 1929.

Murphy, D. L. - See: D. F. Paskausky, No. 559.

503. Murthy, C. R. 1971. An investigation of diffusion characteristics of the hypolimnion of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 799-804. Also in: Project Hypo. U.S. Environmental Protection Agency. Tech. Rept. TS-05-71-208-24. pp. 39-44.

A dye patch diffusion experiment was carried out in early August to study large scale diffusion characteristics of hypolimnion waters in Central Lake Erie. Experimental data were obtained by Fluorometric sampling, to define the peak concentration, horizontal and vertical spread of the dye patch at different times. The vertical spread of the patch was restricted to the hypolimnion because of the strong thermocline. The horizontal spread was an order of magnitude less, corresponding eddy diffusivity two orders of magnitude less, and the observed peak concentration was two orders of magnitude greater compared to surface layer diffusion for comparable time scales of the order of 60 hrs.

504. Murty, T. S. and D. B. Rao. 1970. Wind-generated circulations in Lakes Erie, Huron, Michigan and Superior. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 927-941.

The wind-generated circulations in Lakes Erie, Huron, Michigan and Superior were computed using a steady state linear model with topography and rotation taken into account. This is a homogeneous model and is thus applicable to late fall and early spring situations only. The Lake Erie circulation pattern shows basically three cells. An elongated clockwise cell near the southern shore terminates at its western end in the shallow Western Basin. This cells becomes strong to the east of Erie and persists to midway between Silver Creek and Buffalo. The second cell is clockwise and is in the northern part of the Lake. The third cell is clockwise and it is in the northeastern part of the Lake.

505. National Planning Association. 1969. The role of marine science in the multiple uses of the coastal zone of Lake Erie and Lake Superior. National Council on Marine Resources and Engineering Development. Washington, D. C. 244 p.

This report is a study of the uses and management of the various types of coastal zone areas and an assessment of the effect which science and technology have had on the use of coastal resources. Emphasis is placed on future research and development. The information on Lake Erie is of a very general nature.

506. Nattress, Thomas. 1910. The contour of the Sylvania Sandrock and related strata in the Detroit River area. Mich. Acad. Sci. Annual Rept. 12:47-50.

The author states that the contour of the "Anderson beds" is continuous throughout the area traversed between the extreme points, Elliots Point in Essex County, Ontario, and the southeast corner of Wayne County, Michigan. He maintains that the intercalated beds under discussion have, through at least a great part of the same area and distance, their own independent horizon. (SM)

507. Newberry, J. S. 1871. The surface geology of the basins of the Great Lakes and the valley of the Mississippi. Am. Nat. 4(4):193-214.

Lake Erie has a basin excavated in undisturbed sedimentary rocks. Depth is 204 feet, with a surface level of 565 feet. An old, excavated, now-filled channel connects Lake Erie and Lake Huron. The Cuyahoga enters Lake Erie more than 100 feet above the rock bottom of its excavated trough. Other streams show similar phenomena indicating the surface level of the Lake to have been 100 feet lower. Report continues with the glaciated trough, the natural distribution and evidences of glacial action and the origin of Lake Erie and some of the other Great Lakes. Material transportation by glacial action and icebergs are also included. (BU)

508. Newberry, J. S. 1873. Geological structure of Ohio. Ohio Geol. Surv. 1(1):89-139.

The report contains the physical structure and relationships of strata in Ohio and extends to the Lake Erie shore. Attention is given to the Cincinnati Anticlinal geological structure and history, the Islands in Lake Erie, the Waterlime group at Put-in-Bay Island and its composition. (BL)

509. Newberry, J. S. 1873. Physical geography of Ohio. Ohio Geol. Surv. 1(1):16-49.

General physical geography of Ohio with reference to the Erie shore and Islands with mention of climatology, precipitation, temperature, historical geology, drainage, depth, water levels, seiches, and other general references to Lake Erie. (BL)

510. Newberry, J. S. 1873. Report on the geology of Cuyahoga County. Ohio Geol. Surv. 1(1):171-200.

Topography, geology, structure, soil, drift deposits (Erie clay and Delta sand), lake ridges, geological history, and terraces are discussed on the Lake Erie shore and the Cuyahoga and Rocky Rivers. Rock sections and their stratifieations are likewise presented. (BL)

511. Newberry, J. S. 1874. Report on the geology of Erie County and Islands. Ohio Geol. Surv. Geol. Vol. 2, Pt. 1, Sec. 2. pp. 183-205.

Although describing the geology of the area, this paper relates the lake and bay waters in respect to the land. (BL)

512. Newberry, J. S. 1874. Report on the geology of Lorain County. Ohio Geol. Surv. Geol. Vol. 2, Pt. 1, Sec. 2. pp. 206-224.

This is a detailed description of the geology and paleontology of Lorain County, Ohio. (BL)

513. Newberry, J. S. 1878. Review of the geologic structure of Ohio. Ohio Geol. Surv. 3(1):1-51.

A review of the development and description of the stratigraphy of Ohio in relation to adjacent areas. Little mention is made of Lake Erie except for some of the clay and shale formations exposed along the shoreline and the glacial history of the area. (SM)

514. Newberry, J. S. and J. P. Lesley. 1882. On the origin and drainage of the basins of the Great Lakes. Am. Phil. Soc. Proc. 20(111):91-101.

Discussed are the geological history on topics concerning past continental levels, the extensive system of drainage lines which once traversed the continent (filled up and obliterated by the drift of the Ice Period), desertion of the modern rivers from their ancient valleys (now flowing hundreds of feet above their former beds), and the movement of glaciers in lines of the major axis of the Great Lakes. Erosion of the ancient topography by glaciers and the formation of the Erie Basin are included. (BU)

515. Newton, A. C. 1958. Offshore exploration for gas under the Canadian waters of the Great Lakes. Ontario Dept. of Mines. Toronto, Ont. Geol. Circ. 7. 30 p.

A brief survey is made of the history of offshore exploration on Lakes Erie and St. Clair. The geology of the known fields on shore is given as the geology of the fields under the Lakes is merely an extension of the same structures and reservoirs as on land. Existing offshore wells are described as to their geology. Methods of exploration and equipment used are included. Geophysical data is collected by a gravity survey. (CCIW)

516. New York Department of Environmental Conservation. 1967. Periodic report of the Water Quality Surveillance Network 1965 thru 1967 water years. N. Y. Dept. Env. Cons. Albany, N. Y. pp. 16-19, 22-23.

The results of tests taken of New York waters are listed in a water quality percentile summary chart. Data is provided for the eastern section of Lake Erie and Cattaraugus Creek.

517. New York Department of Health. 1963. Lake Erie (West End) and tributary drainage basins in Chautauqua County. N. Y. Dept. Health. Water Resources Comm. Albany, N. Y. Lake Erie-Niagara River Drainage Basin Ser. Rept. 6. pp. 14-21, 45-65.

A description of drainage basin, flow information, lake levels, topography, and geology is presented for Lake Erie in the vicinity of Chautauqua County and several rivers in the area. Data is given on the results of sampling for turbidity, color, odor, and suspended matter.

518. New York Department of Health. 1965. Cattaraugus Creek Drainage Basin. N. Y. Dept. Health. Water Resources Comm. Albany, N. Y. Official Classifications. 42 p.

Classifications and standards of quality and purity assigned to fresh surface waters within the Cattaraugus Creek Drainage Basin, including its tributaries. Maps are included with location and classification keys. The standards are based upon types of solids and deposits encountered, effluents and toxic wastes, and chemistry.

519. New York Department of Health. 1965. Lake Erie (West End) and tributary drainage basins in Chautauqua County, except Cattaraugus Creek and Silver Creek Drainage Basin. N. Y. Dept. Health. Water Resources Comm. Albany, N. Y. Official Classifications. 36 p.

Classifications and standards of quality and purity assigned to fresh surface waters within the Lake Erie (West End) and tributary drainage basins. Maps are included with locations and classification keys. The standards are based upon types of solids and deposits encountered in sampling, effluents, toxic wastes, and chemistry.

520. New York Department of Health. 1965. Periodic report of the Water Quality Surveillance Network: 1960 thru 1964. N. Y. Dept. Health. Albany, N. Y. 345 p.

Surface water quality in Buffalo, Niagara River, Cattaraugus Creek and Lake Erie at Buffalo is analyzed in terms of stream flow, lake level, temperature, color, turbidity, and dissolved residue. The Lake was found to have an average temperature of $11.6^{\circ}C$, an average level of 570.43 feet, and a suspended residue concentration of 202 milligrams per liter.

521. New York Department of Health. 1966. Cattaraugus Creek Drainage Basin. N. Y. Dept. Health. Water Resources Comm. Albany, N. Y. Lake Erie-Niagara River Drainage Basin Ser. Rept. 4. pp. 11-12, 34-52, 57.

A description of drainage basin, flow information, topography, and geology is presented for Cattaraugus Creek and several creeks within the area. Charts on data for turbulence, color, odor, suspended matter, temperature, and air are given.

522. New York Water Resources Commission. 1967. Summary appraisal, developing and managing the water resources of New York State. N. Y. Water Resources Comm. Div. Water Resources. Albany, N. Y. 53 p.

A general mention is made of Lake Erie in regard to the discussion of the Western Region of New York State with respect to physical, climatological and water supplies in the vicinity of the Erie-Niagara Basin.

523. Oak, W. W. 1957. Ice on the Great Lakes. Mariners Wea. Log. 1(2):21-24.

Ice, which was the architect of the Great Lakes, continues to be a primary control factor in its use today. The work of the Weather Bureau's "Ice Reporting" program is explained in detail including forecasting graphs for opening of Great Lakes navigation. In general, the Lakes do not freeze from shore to shore. Ice forms in the shallow and protected areas of bays and harbors, building out from the shoreline. High and persistent winds cause broken ice to form windrows and pressure ridges, extending from 10 to 20 feet above the water to 30 to 35 feet below, often anchoring to the lake bottom. (BECPL)

524. Ohio Department of Natural Resources. 1953. Lake Erie pollution survey, supplement. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. 125 p.

This supplement contains the detailed chemical and physical analyses of stream tributaries and lake intakes in the Lake Erie area of Ohio. Also included is data concerning specific conductance, water temperature, and suspended sediments.

525. Ohio Department of Natural Resources. 1959. Shore erosion in Ohio. Ohio Dept. Nat. Resources. Div. Shore Erosion. Columbus, Ohio. 39 p.

A very general report including the following topics: geology of shoreline, causes of erosion, lake levels and currents, methods of control, and terminology. (CCIW)

526. Ohio Department of Natural Resources. 1961. Preliminary estimate of erosion or accretion along the Ohio shore of Lake Erie and critical erosion areas. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Tech. Rept. 8. 13 p.

Briefly discussed are the changes in shoreline in Ohio which represent only a preliminary estimate of conditions. They are general and not detailed for the beaches covered. (CCIW)

527. Ohio Department of Natural Resources. 1961. Water inventory of the Mahoning and Grand River Basin and adjacent areas in Ohio. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. Ohio Water Plan, Inventory Rept. 16. 90 p.

Report deals with the water supply and use, flood problems, watershed management, and future developments. Related topics to the physical aspects pertinent to the Erie Basin include glacial and flood history, climate, precipitation data, flow frequency and rates, and water supply. Further topics deal with groundwater resources (hydrologic characteristics and aquifers), surface water, and the proposed Grand River Reservoir. A soil association map with conservation needs in the Grand River Basin is also included. (CA)

528. Ohio Department of Natural Resources. 1974. List of publications. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. 39 p.

Contains a listing of all current and past publications that are obtainable through the Division of Geological Survey. Reprint series, periodicals, maps, bulletins, and all other maps and publications pertinent to the geology of Ohio are listed.

529. Ohio Environmental Protection Agency. 1973. Radiological monitoring report, surface and ground waters of Ohio, 1969-1970-1971-1972. Ohio Env. Protection Agency. Div. Surveillance. Columbus, Ohio. 19 p.

Results from samples taken from Lake Erie stations indicated somewhat lower average total radioactivity than those from other station groups. Yearly average total radioactivity apparently decreased from 10 pCi/l in 1969, to 8 pCi/l in 1971. Results for six sampling stations were similar. Station locations, methods and radioactivity data for suspended and dissolved matter of beta and alpha radiation are given.

530. O'Kelly, W. A. and E. C. Masteller. 1972. A preliminary survey of the diatom communities and physiochemical characteristics of a Lake Erie tributary, Erie County. Penn. Acad. Sci. Proc. 46:53-55.

The species diversity of the benthic diatom communities near the confluence of two streams of the Lake Erie Drainage Basin was calculated for samples collected on several dates in the spring of 1971. Chemical analysis of the streams was determined at regular intervals. A computer program was developed in order to calculate species diversity index. A great variation as to sensitivity to chemical and physical conditions of water makes it possible for one to find some diatoms in any aquatic habitat inhabited by plants and animals, while some have a very narrow range in tolerence. Thus it is proposed that these organisms (which are representative of some of the lake communities) can act as indicators of water quality. Study was done at Four Mile Creek and the tributaries associated with it. (CA)

531. Okubo, A. and J. S. Farlow. 1967. Analysis of some Great Lakes drogue studies. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. Great Lakes Res. pp. 299-308.

The Great Lakes-Illinois River Basins Project of the U. S. Federal Water Pollution Control Administration conducted six field studies of horizontal diffusion in the Great Lakes. In each experiment, 50 to 90 individually identifiable drogues (current-following devices) were released at each test depth and were located at a series of later times. Lagrangian characteristics of diffusion, for example the root-mean-square distances between a pair of drogues, were evaluated by computer techniques. It was found that the intensity of turbulence differs little between Lakes Michigan and Erie, a typical value being 0.3 cm/sec, and that an effective diffusivity ranges from $3 \times 10^4$ to $6 \times 10^4$ $cm^2/sec$. In Lake Erie the rate of energy dissipation per unit mass at a depth of 20 feet is less, by an order of magnitude, than that at 5 feet; a typical (5 feet) value being $2 \times 10^{-4}$ $cm^2/sec^3$. Computations of diffusion velocities according to the theories of Joseph-Sendner and Okubo-Pritchard show that the turbulent diffusion in the surface layer seems to be more intense in Lake Erie than in Lake Michigan. In general, the values of diffusion characteristics obtained in the drogue studies are consistent with those obtained by other methods, such as dye studies.

532. Olds, Nicholas V. 1966. Great Lakes water levels. In: The Great Lakes--How Many Masters Can They Serve? Mich. Nat. Resources Council. 11th Annual Conf. pp. 26-33.

The fluctuations in Great Lakes levels are governed by hydraulics, hydrology, meteorology and other physical sciences. A general description of the natural phenomena is given and then related to economics and law in regard to navigation, ports, harbors, conservation, recreation, etc.

533. O'Leary, L. B. 1966. Synoptic vector method for measuring water mass movements in Western Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:337-344.

During the summer of 1963, the synoptic vector method of determining movements of water masses was used in the Michigan area of Lake Erie. By means of a high speed survey boat, a series of dye drops were made at preselected stations. The dye movements were measured after a period of 15 to 20 minutes. This was repeated under a variety of wind conditions and water temperatures. At each station, vertical temperature profiles were measured as an indicator of homogeneity of the water mass. The plotted results show reasonable consistency. It was concluded that this method is a useful tool for determining water mass movements in a shallow area of limited extent. Vector data coupled with long-term averages of wind direction were used to indicate the percent of time the various water mass movements are expected to prevail.

534. Olson, Franklyn C. W. 1950. The currents of Western Lake Erie. Ph.D. Dissertation. Ohio State Univ. 370 p.

The most striking feature of the behavior of Lake Erie in the vicinity of the Bass Islands is the highly variable character of the lake level. Most prominent of these is a 14-hour seiche oscillation whose amplitude normally varies from 2 to 24 inches, but on occasion may be as great as 5 or 6 feet. Superimposed on this are many other oscillations of shorter periods. Distinct current measurements under the ice revealed a highly turbulent but uniform current at all depths, correlated to changes in lake level. Drift card studies, releasing at least 10 cards simultaneously, revealed positive significant correlation between drift speeds and resultant wind velocity while adrift. Water mass analysis was used to identify the various water masses existing in the lake. Turbidity was found to be the most sensitive and reliable characteristic for distinguishing water masses. (CCIW)

535. Olson, Franklyn C. W. 1951. A plastic envelope substitute for drift bottles. J. Mar. Res. 10(2): 190-193.

A plastic envelope of 0.004-inch thickness made of polyethylene is suggested as a substitute for drift bottles. The return card is sealed hemetically in the envelope, thus forming an inexpensive, compact and convenient means for studying surface currents rather than by conventional drift bottle technique. Tests indicate that "drift cards" actually indicate surface flows and are not at the complete mercy of the winds. (CCIW)

536. Ontario Hydro-Electric Power Commission. 1968. Nanticoke thermal generating station, Lake Erie, ice investigations. Ont. Hydro-Electric Power Comm. Hydraulic Dev. Dept. Hydraulic Sec. Prog. Rept. 1. 38 p.

Presented are the results and analysis of investigations made during January to April of 1967 and 1968 to obtain a knowledge of the formation and action of ice offshore of the Nanticoke thermal generating station site in Long Point Bay and in Lake Erie east and south of the Bay. Such information is necessary for the design of the project, particularly offshore structures, and for the prediction of operating conditions. Air observations of ice, local inquiry of past conditions, and related records of water temperature, air temperature, wind, and water level fluctuations made up the investigation. (CCIW)

537. Ontario Hydro-Electric Power Commission. 1968. Nanticoke thermal generating station, hydrological investigations Lake Erie 1967, report on offshore water temperatures. Ont. Hydro-Electric Power Comm. Hydraulic Dev. Dept. Hydraulic Sec. Rept. 3. 3 p.

In this report the temperature measuring locations, instruments and procedures employed, and results for two programs are presented. The first program was to obtain a daily record of temperature in the condenser cooling water intake area. The second program dealt with obtaining an indication of temperature and changes in temperature with depth throughout the vicinity of the site. This was done by taking measurements at monthly intervals between May and September at 36 locations extending about 3 miles east and west from the site and two miles from the shore. (CCIW)

538. Ontario Petroleum Institute Inc.-Lake Erie Committee. 1969. Potential oil pollution incidents from oil and gas well activities in Lake Erie, their prevention and control. Internat. Joint Comm. Washington, D. C. 98 p.

Report presents information on the geology of the Erie Basin, with respect to oil and gas. Included is information concerning drilling history, drilling equipment, drilling practices, and reports on the pollution problems associated with drilling operations. (CCIW)

539. Ontario Water Resources Commission. 1965. Water quality data 1964-65. Ont. Water Resources Comm. Toronto, Ont. 1: 287 p.

Data is given for water temperature, DO ppm, 5-day BOD ppm, total solids ppm, turbidity units, conductance, and chemical measurements in ppm of the tributary systems emptying into the Erie Basin on the Canadian side.

540. Ontario Water Resources Commission. 1966. Water quality data for Ontario lakes and streams 1965-66. Ont. Water Resources Comm. Toronto, Ont. 2: 364 p.

Data is given for water temperature, DO ppm, 5-day BOD ppm, total solids ppm, turbidity units, conductance, and chemical measurements in ppm of the tributary systems emptying into the Erie Basin on the Canadian side.

541. Ontario Water Resources Commission. 1967. Water quality data for Ontario lakes and streams. Ont. Water Resources Comm. Toronto, Ont. 3: 373 p.

Data is given for water temperature, DO ppm, 5-day BOD ppm, total solids ppm, turbidity units, conductance, and chemical measurements in ppm of the tributary systems in Ontario. Included is the Grand River and other tributary systems emptying into the Erie Basin.

542. Ontario Water Resources Commission. 1968. Industrial

wastes survey of gas well drilling operations on Lake Erie. Ont. Water Resources Comm. Div. Industrial Wastes. Toronto, Ont. 27 p.

Field staff from Ontario Water Resources Commission visited some of the offshore drilling rigs in order to become familiar with the drilling operations in general, and to determine whether such operations contributed significantly to the pollution of Lake Erie. It is concluded that the offshore gas drilling industry does not constitute a source of significant water pollution. (CCIW)

543. Ordon, Chester J. 1965. Stage-fall-discharge relationships in connecting channels. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:342-348.

Power and pollution control problems have created a need for better flow formulas in the connecting channels of the Great Lakes. Current formulas based on stage, fall, and discharge fail to agree with measured flows by several percent in some instances. It may be possible to improve upon the current U. S. Lake Survey method of formulating flow based on measured parameters by adding new factors not now taken into consideration. These are as follows: (1) Temperature effect on current meter calibration. (2) Temperature effect on the constants in the flow equation. (3) Season effect due to growth and death cycle of weeds in the stream bed. (4) Consideration of the fact that the flow may be non-uniform. A theoretical temperature correction factor has been developed. A possible weed correction curve for one reach has been plotted. Evidence that practically all connecting channels are draw down curves is presented.

544. Orr, Lowell P. 1968. The fishes of the Upper Cuyahoga River. In: G. Cooke (Ed.), Cuyahoga River Watershed. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. pp. 57-86.

The intent of this study is to provide data to determine the general physico-chemical condition of the Upper Cuyahoga River. The data includes average width, depth, velocity, turbidity, water temperature, and bottom conditions.

545. Owens, G. L. 1967. The Pre-Cambrian surface of Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 64. 8 p.

The Pre-Cambrian basement surface of Ohio and adjacent areas, including the bottom of Lake Erie, were studied using material obtained from 133 wells. The accompanying map shows a structurally high Pre-Cambrian surface in Western Ohio historically described as the "Cincinnati arch" and located approximately 3300 feet below the surface. (SM)

Ownbey, C. R. - See: H. W. Poston, No. 594.

Paine, Douglas A. - See: James E. Jiusto, et al, No. 380.

Paine, Douglas A. - See: Michael L. Kaplan, et al, No. 384.

Paine, Douglas A. - See: Michael L. Kaplan, et al, No. 385.

546. Paine, Douglas A. and Michael L. Kaplan. 1970. The parameterization and prediction of synoptic-scale influences on Great Lakes snowstorms. N. Y. Atmospheric Sci. Res. Center. S. U. N. Y. at Albany. pp. 81-94.

A medium scale trough has been found in some deep cyclonic systems which plays an important role in the more severe of the mesoscale lake-effect snowstorms. The trough's associated upward increase of positive vorticity advection provides organized ascent from 1 to 6 $cm/sec^{-1}$ below 600 mb. This upward motion enhances convective cloud growth by destabilizing the layer toward the moist adiabatic lapse rate.

The prediction of this trough's movement and an approximation of its subsequent upward vertical motion field is determined by it's pattern of positive vorticity advection on the 850 mb surface. This forecast employs an equivalent barotropic model near the feature's nondivergent level with a grid spacing of 127 km utilized to produce a 6, 12, 18, 24 and 30 hr prognosis. The predicted ascent correlates with maximum snowfall rates to the lee of both Erie and Ontario. Of equal value, the orientation of predicted longest lake fetch shows encouraging correspondence to observed zones of heaviest snowfall. This guidance is superior to the forecast product provided by either the standard 381 km barotropic and primitive equation models, or that information gained from analyzing 3-hourly surface sectional charts.

Palmer, M. D. - See: B. S. Kohli, No. 402.

547. Palmer, M. D. 1968. Currents in the Nanticoke region of Lake Erie. Ont. Water Resources Comm.

Toronto, Ont. 67 p.

Three recording devices were operated in the nearshore area on the northern shore of Lake Erie in Long Point Bay, up to 2.5 miles from shore and bounded by the Nanticoke shoal, Peacock Point, and the shoreline from August to November. Water movement was found to be predominantly from the west with the greater current persistence close to shore. However, the stronger currents were found offshore in deeper water. A time series analysis of data revealed that the north-south components of the currents were more periodic in nature than the east-west components. The predominant periods were related to Lake Erie free oscillation periods and diurnal effects. Cross correlations between various parameters demonstrated significant dependence of the east-west current components to both local wind and water levels but none for the north-south components, while no significant coherences existed in October for either component. The temperature data provides information on the away-from-shore temperature gradients during the fall with extensive temperature variations at all stations during October. (CCIW)

548. Palmer, M. D. 1968. Water quality prediction equations for a river input into Lake Erie. Ont. Water Resources Comm. Toronto, Ont.

Prediction equations were developed from the 1967 water quality data at 16 lake stations in the Grand River, Canada, outlet area of Lake Erie. These equations were determined by multiple regression techniques with transforms on a trial-and-error basis using the following independent variables: wind force and direction, loadings of the Grand River at the outlet, geographic location of the lake station, depth, and temperature gradient. Individual equations were developed for each of the following parameters: maximum turbidity, average turbidity, maximum conductivity, maximum total phosphate, maximum soluble phosphate, maximum dissolved oxygen, minimum dissolved oxygen, and maximum nitrate. As a check on the equations, they were tested on the 1966 data and found to predict the measured water quality parameters. (CCIW)

549. Palmer, M. D. 1969. User trials of a submersible water quality recording meter 1969. Ont. Water Resources Comm. Toronto, Ont. 32 p.

Two submersible water quality recording meters were field tested in the Great Lakes for accuracy and stability. Temperature, pressure, real time, turbidity, pH, conductivity, and dissolved oxygen are automatically evaluated every five minutes to one hour and recorded.

550. Palmer, M. D. 1970. Some operational notes on a submersible self-contained water quality meter. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 1015-1019.

The operation of two prototype water quality meters on the Great Lakes in depths of 7 m for four months is described. The stability and reliability of the meters was checked by laboratory calibrations and data reduction. With the exception of the turbidity sensor, the meters maintained a reasonable calibration. A vigilant field maintenance and inspection program coupled with a well-designed data system is required if valid water quality data is to be obtained.

551. Palmer, M. D. 1970. Submersible recording current and water quality meters. Water and Sewage Works. 117:R64-R70.

Some applications for water management based upon information gathered from a small completely self-contained submersible water quality meter and a recording current meter operated on Lake Erie at Nanticoke are discussed. Statistical methods of interpreting the data are described and it was concluded that the utilization of recording meters in the nearshore areas of lakes provides the necessary data for a computer model which will indicate: (1) The best location for water intakes and waste outfalls from the dilution point-of-view; and (2) The acceptable discharge concentrations and flows on the basis of not exceeding desirable values at locations in the proximity of the discharge point on a probability basis. (SE)

552. Palmer, M. D. and J. B. Izatt. 1969. Great Lakes nearshore modelling from current meter data. Ont. Water Resources Comm. Great Lakes Water Quality Surv. Program. Final Rept. 57 p.

Methods for the prediction of the dispersion patterns resulting from the continuous discharge of waste in the nearshore areas of lakes are developed. These methods are based upon the analysis of recording current meter records. The long-term dispersion characteristics are presented as monthly mean-concentration contours for various discharges. The short-term characteristics are presented as five hour probabilities and dilution rates for the four major compass directions. (CCIW)

553. Palmer, M. D. and J. B. Izatt. 1970. Determination of some chemical and physical relationships from recording meters in lakes. Water Research. 4:773-786.

Hourly readings of current, conductivity, pH and dissolved oxygen were collected during May and June, 1969 1.6 km offshore at the mid-depth of a total depth of 6 m on Lake Erie. The nearest major sewage outfall is 6 km to the west of the measuring location. Data collected in this manner requires extensive conditioning before meaningful time series analytical techniques are applied. The data conditioning is discussed. Conductivity was found to directly correlate with water movement in the nearshore areas of lakes and is considered to be transported by the currents. pH was related to currents for one month only. Whereas, dissolved oxygen is independent of currents and requires information other than currents to explain the measured values. Finally, probability techniques have been successfully applied to describe conductivity, pH and dissolved oxygen.

554. Palmer, M. D. and J. B. Izatt. 1970. Dispersion prediction from current meters. ASCE J. Hydraulics Div. 96(HY8):1667-1680.

Two-dimensional dispersion plumes for the nearshore area of Nanticoke on Lake Erie are predicted by applying turbulent diffusion concepts to recording current meter data. Eulerian integral time scales are found from autocorrelation coefficients, based on monthly data. Lagrangian integral space scales and one-dimensional diffusion coefficients may be predicted. Average monthly probability distributions are based on north-south and east-west diffusion coefficients. The prediction equation is an average of long and short time diffusion equations. Better dilution is found near the shore and parallel to it. It is assumed that vertical diffusion is negligible, that the Reynold's number is large, and that the effective diffusion coefficients are constant over long periods. (SE)

555. Palmer, M. D. and J. B. Izatt. 1970. Lakeshore two-dimensional dispersion. Internat. Assoc. Great Lakes Res. Prcc. 13th Conf. Great Lakes Res. Pt. 1. pp. 495-507.

Hourly two-dimensional dispersion characteristics are determined from recording current meter histories for the nearshore areas on Lakes Erie and Ontario. The current histories were obtained in areas within 4 km of shore and at water depths of 10 to 14 m during May to November 1968. A Markov chain process was applied to hourly current readings. Three different formulations of the stochastic process were tested prior to the selection of the most reliable one. The results obtained in applying the developed technique compare favourably with results obtained from conventional dye injection and drogue studies.

556. Palmer, M. D. and J. B. Izatt. 1971. Lake hourly dispersion estimates from a recording current meter. J. Geophys. Res. 76(3):688-693.

For the Great Lakes, mean hourly dispersion coefficients are predicted by using a first-order Markov chain model developed from continuous hourly current meter records at a fixed point. Dispersion coefficients compare favorably with other studies. The Eulerian data are assumed equivalent to Lagrangian because the Reynolds numbers were large, and because the velocity field was homogeneous over the distances considered. A conventional dye injection study at Port Maitland on Lake Erie verified the conversion of data from Eulerian to Lagrangian form. Concentrations were computed as a function of distance for a constant continuous point source of a passive contaminant. A method was developed for determining the maximum, mean, and minimum probable distances traveled by a particle in a period of hours. (BL)

557. Palmer, M. D. and J. B. Izatt. 1972. Lake movements with partial ice cover. Limnology and Oceanography. 17(3):403-409.

A recording current meter was operated under a winter ice sheet at Nanticoke, Lake Erie, in 11 m of water at a depth of 3 m from the bottom. Current magnitude and direction and water temperature were measured every 10 min. Current magnitudes up to 1 month after the ice sheet formed were similar to measurements made without ice; autovariance density spectra for this period showed energy concentrations at frequencies corresponding to the free oscillation modes of Lake Erie. Several months after the ice had been in place the measured currents were half as fast (3-9 cm/sec) and spectra during this period showed no energy concentrations at Lake Erie oscillation frequencies.

Parker, D. C. - See: A. M. Beeton, et al, No. 40.

558. Parmenter, Richard. 1929. Hydrography of Lake Erie.

In: Preliminary Report on the Cooperative Survey of Lake Erie--Season of 1928. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 14(3):25-50.

Extensive summary of the temperature recordings in the Eastern Basin, with measurements and observations at varying depths. Included are charts showing temperature distributions and water density of each of the cruises. Current dynamics, seiches, internal waves, and lake stratification follow with recorded data and discussion. A brief discussion of transparency concludes the report. Opening pages present the instrumentation used to measure the parameters in this report.

559. Paskausky, D. F. and D. L. Murphy. 1973. Two-dimensional numerical prediction of wind surge in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 808-817.

During a wind storm, Lake Erie is essentially barotropic due to mixing; therefore, the hydrodynamics of the lake can be represented by a prognostic two-dimensional barotropic mathematical model developed from the vertically integrated momentum and continuity equations. A time-dependent wind stress drives the lake and the model includes effects of bottom friction, bottom topography, lateral boundary configuration and lateral mixing. A vorticity equation developed from the momentum and continuity equations is used to predict the circulation. The divergence of the vector form of the momentum equations is used to obtain the water level fluctuation consistent with the continuity equation and with velocity fields predicted by the vorticity equation.

Twenty m/sec winds are uniform over the model, but from 8 points of the compass are applied for 1.5 days to show effects of the boundaries and bathymetry on the circulation and water level fluctuation. Point Pelee, Pelee Island and Long Point are removed to show that they segment the lake into three circulation and setup regimes. Finally winds varying similarly to a tropical storm are applied twice in the model, once with the present lake and once with fill to represent the proposed airport at Cleveland.

560. Patterson, Thomas M. and Harley F. Lawhead. 1968. History and present status of regulation and regulation studies of water levels and flows on the Great Lakes. In: Proceedings of Great Lakes Water Resources Conference, June 24-26, 1968.

Eng. Inst. Canada. Toronto, Ont. pp. 201-228.

The paper considers those quantitative and timing problems and conflicts which are associated with the growing use and multi-purpose uses of the water resources of the Great Lakes and connecting channels and which may be susceptible to composite improvement through artificial controls and regulation of the levels and outflows. It reviews the regulation studies of the past; the progress in the application of methods and plans with respect to Lake Superior and Lake Ontario and brings out the international nature of controlling the levels of the Great Lakes. It outlines the purposes of the study which the Governments of Canada and the United States have placed in the hands of the International Joint Commission in the Lake Levels Reference of 7 October 1964 and provides the background to the series of papers which follow it.

561. Paul, J. F. and J. L. Wilbert. 1973. A numerical model for a three-dimensional, variable-density jet. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 818-830.

A numerical model for the time-dependent, three-dimensional, variable-density and variable-temperature flow of a rectangular jet horizontally entering a basin of semi-infinite extent has been developed. Steady-state results are presented comparing the heated, constant-temperature and cooled jet for conditions similar to that which would be typical for the Cuyahoga River entering Lake Erie in the late summer months. The results indicate the importance of the coupling of the energy and momentum equations for this particular problem. The variable-density term in the momentum equation causes the jet to spread near the surface or the bottom and this affects the convection of energy in the fluid. For the constant-density jet, vertical velocities are relatively small. However, for the variable-density jet, the vertical velocities are relatively large and are important in the transport of mass, momentum and energy.

Peace, Robert L. - See: R. A. Brown, et al, No. 72.

Peace, Robert L. - See: G. E. McVehil, et al, No. 475.

Peace, Robert L. - See: G. E. McVehil, No. 476, 477.

562. Peace, Robert L. 1966. Radar characteristics of lake-effect storms. Am. Meteor. Soc. 12th Conf. on Radar Meteorology. Norman, Okla. pp. 454-460.

For the past two years, Cornell Labs has been conducting a study on the nature of lake-effect storms under initial sponsorship of the U. S. Army Signal Corps and ESSA. The lapse time film record of the Buffalo, N. Y. WSR-57 radar PPI scope has been utilized as a primary tool for this study. The Buffalo radar is located in a unique position to observe lake-effect storms, because both the eastern half of Lake Erie and all but the eastern end of Lake Ontario lie within 100 nautical miles of Buffalo. Since the prevailing winds in lake-effect storm situations are generally in the western quadrant, this radar is in a position to simultaneously observe the upwind end of Lake Ontario storms and the downwind end of Lake Erie storms. This paper presents the different characteristic lake-effect storms as interpreted from radar observations. (CCIW)

563. Peattie, R. 1923. Geography of Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Bull. 27. 137 p.

The effect of the proximity of Lake Erie on climate, topography, and agriculture is discussed in very broad terms and in very elementary language as this book was published for use in public schools. (SM)

564. Pegrum, Reginald H. 1929. Topography of the Lake Erie Basin. In: Preliminary Report on the Cooperative Survey of Lake Erie--Season of 1928. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 14(3):17-24.

Major topics considered are the stratigraphy of Lake Erie (explanation of lithology and distribution), shore topography (formation), bottom deposits and their distribution. The study area is primarily in the Eastern Basin.

565. Pennsylvania Electric Company. 1972. Lake City combined cycle power plant, environmental report. Penn. Electric Co. 150 p.

Environmental impact statement of the Lake City combined cycle power plant presenting the thermal, discharge, emission and construction problems. Wind patterns, the physical geography, geology, lake bottom, seismicity, groundwater, water quality, and chemical characteristics for the proposed site on Lake Erie are also included.

566. Pentland, R. L. 1968. Runoff characteristics in the Great Lakes Basin. Internat. Assoc. Great Lakes

Res. Proc. 11th Conf. Great Lakes Res. pp. 326-359.

Maps showing the distribution of runoff are presented for the entire Great Lakes Basin on a monthly and annual basis. Computerized methods have made possible the utilization of more than 250 hydrometric stations within and surrounding the basin for each of the 13 runoff maps. A graphical representation of the area-runoff distribution for the sub-basins is also presented. The paper includes a general discussion of the effects of climatological and physical features in relation to the runoff characteristics.

567. Pentland, R. L. and N. E. Eryuzlu. 1969. A dynamic programming algorithm for the operation of the Great Lakes. Dept. of Energy, Mines and Resources. Inland Waters Branch. Ottawa, Ont. Reprint Ser. 53. 25 p.

A program for developing regulation plans which would produce the most beneficial levels and outflows for power, navigation, water supply, recreation, etc. on the Great Lakes including Lake Erie.

568. Pepper, J. F., W. DeWitt and D. F. Demarest. 1954. Geology of the Bedford shale and Berea sandstone in the Appalachian Basin. U. S. Geol. Surv. Professional Paper. 259: 111 p.

Report deals primarily with geological formations in Ohio. Relevency to Lake Erie in regard to the shoreline is mentioned. The Bedford and Berea formations are discussed extensively as well as the paleogeography, stratigraphy, and sedimentation. (BL)

569. Preformed Line Products Co. 1969. Fighting water pollution. Undersea Technology. 10(5):46-47.

A buoy system developed by the Preformed Line Products Co. of Cleveland, Ohio was tested by mooring this system in Lake Erie five miles north of Cleveland. The system is being designed to measure acidity of the water, temperature variation and gradient, wave height and frequency, wind speed, wind direction, turbidity, conductivity, bottom sediments, and penetration of light at various depths and times. (SE)

570. Petterssen, Sverre. 1960. Some weather influences due to warming of the air by the Great Lakes in

winter. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:9-20.

A preliminary survey of the effects of the Great Lakes on the pressure configurations and the patterns of precipitation in the vicinity of the Great Lakes during a cold spell is presented. In particular, an attempt has been made to isolate the effects which are due to the transfer of heat from water to the air during typical winter conditions. The status of Lake Erie was essentially frozen over. (RL)

571. Pettijohn, F. J. and A. C. Lundahl. 1933. Shape and roundness of Lake Erie beach sands. J. Sed. Petrol. 13(2):69-78.

Seven beach sand samples were collected at mile intervals along Cedar Point spit on the south side of Lake Erie. Shape and roundness analyses were made on the light, carbonate-free fraction of the six size grades common to all samples. Sphericity declined slightly and roundness considerably in the direction of sand shift. The feldspar content, about 25 per cent, was unchanged.

Data obtained in this study and the published field and laboratory work on other sands, shows that simple abrasion cannot account for the observed trends. Water currents, sorting the sands of the beach in the down-current direction, carry the less spherical grains further than the more spherical, other things being equal, and since roundness was found to be closely correlated with sphericity, concomitant roundness decline takes place. The correlation of roundness and sphericity is the result of abrasion in earlier cycles of sedimentation. (BL)

572. Pettijohn, F. J. and J. D. Ridge. 1932. A textural variation series of beach sands from Cedar Point, Ohio. J. Sed. Petrol. 2(2):76-88.

Eighteen samples of beach sand were collected at half-mile intervals along the shore of Cedar Point spit and connected mainland near Sandusky, Ohio. The samples were screened and treated with acid and the per cent of sand and carbonate in each size-grade was computed.

A marked decrease is size-grade of the sand from the mainland beach to the far end of the spit is shown by the shifting of the maximum grade towards the finer sizes and by a decrease in both the median size and the equivalent grade. There is no appreciable increase in degree of sorting in the same direction as indicated by the grading factors determined from the cumulative curves. Secondary maxima of the samples on the beach near the mainland or on the mainland beach appear to be due to loading of the samples with material from nearby wave-cut cliffs or to the inclusion of lag concentrates in the sampling.

The carbonate at first decreases and then increases through the series. In the individual samples it is found to make a larger proportion of the coarse and fine grades than of the intermediate grades. No satisfactory explanation of the latter relationship is known to the writer.

The decrease in size-grade is not due to abrasion to any important extent but either to a selective sorting by the littoral currents or to some factor in the environment, such as the subaqueous slope, that changes progressively from place to place along the beach. (BL)

573. Pettijohn, F. J. and J. D. Ridge. 1933. A mineral variation series of beach sands from Cedar Point, Ohio. J. Sed. Petrol. 3(2):92-94.

The mineral composition and variations of a collected series of beach samples from Cedar Point, Ohio, on Lake Erie are described. The progressive decrease of certain minerals and increase of certain others in the direction of littoral current movement is attributed to selection on the basis of shape and density. (BL)

Pfister, Robert M. - See: D. L. Howard, et al, No. 342.

Pfister, Robert M. - See: Walter O. Leshniowsky, et al, No. 443.

574. Pfister, Robert M., Patrick R. Dugan and James I. Frea. 1968. Particulate fractions in water and the relationship to aquatic microflora. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 111-116.

Water samples from a 15-foot depth of Lake Erie and from the surface of Sandusky River, Ohio, were subjected to gradient centrifuging. Different submicroscopic fractions of suspended particulates (minera and detritus) were investigated by electron microscopy and examined their ability to influence biological reactions. Addition of the particulate fraction

0.3 micron and larger to a carbon-free salts medium caused a significant increase in the biomass of micromonospora and streptomyces. An aggregation of submicroscopic particles of magnesium silicate with an exocellular polymer, produced by a floc-forming pseudomonad, was demonstrated. A system of ecological control of pollution involving a buildup of larger aggregates by association of inorganic particles and organisms is postulated.

575. Pfister, Robert M., Patrick R. Dugan and James I. Frea. 1969. Microparticulates: Isolation from water and identification of associated chlorinated pesticides. Science. 166(3907):878-879.

The association of chlorinated hydrocarbon pesticides with microscopic particles suspended in Lake Erie was investigated using water samples collected 15 feet below the surface in the vicinity of the Bass Islands in the Western Basin of Lake Erie. Pesticides appeared to be selectively associated with microparticles of different densities. Samples taken at different times from different locations revealed different associations with hexane-soluble, electron-capturing compounds. (BU)

576. Pfister, Robert M., J. I. Frea, P. R. Dugan, C. I. Randles, K. Zaebat, J. Duchene, T. McNair and R. Kennedy. 1970. Chlorinated hydrocarbon, microparticulate effects on microorganisms isolated from Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 82-92.

Water samples from the Western Basin of Lake Erie have been analyzed with regard to the distribution of colloidal microparticles. Size analyses of particulate samples placed on a sucrose density gradient revealed that the most common size particle was in the range of 0.1 um. Chlorinated hydrocarbon pesticides such as endrin, aldrin, heptachlor and lindane were found in association with these particles and the data suggest that aldrin and heptachlor were found more frequantly on the smaller, less dense particles, while lindane was associated with the larger, more dense fractions. Bacteria isolated from these water samples prior to chemical analyses were grown in the presence of clay microparticles freed of pesticides, microparticles containing known amounts of pesticides, and purified pesticides alone. Bacterial growth effects were measured by changes in the turbidity of the medium, total DNA content of the culture and standard plate counts. Results demonstrate that different bacteria in the presence of endrin or aldrin could be affected in different ways. In some cases the organisms were stimulated to produce a cell yield of four to five times that of the control cultures. A survey of 151 heterotrophic aerobic bacteria isolated from Lake Erie has shown that 55 were stimulated by aldrin, 54 by endrin and 45 by dieldrin. Forty-six cultures were inhibited by aldrin, 43 by endrin and 43 by dieldrin. Eighteen cultures were stimulated by the three compounds, while 27 cultures were inhibited.

Phillips, D. W. - See: M. S. Webb, No. 886.

577. Piech, Kenneth R. 1969. Identifying and measuring the pollutants in our waterways. Research Trends. Cornell Aeronautical Laboratory, Inc. Buffalo, N. Y. 17:42-47.

Discussion of monitoring system developed by CAL for water quality observations using sophisticated aerial photography. The method adopted provides a quantitative measure of reflectance of the polluted waters. Interpretations, some results of detection in Lake Erie, and future possibilities of filters of greater sophistication are presented.

Pilie, Ronald J. - See: William J. Eadie, et al, No. 220.

578. Pillay, K. K. S., C. C. Thomas, Jr., J. A. Sondel and C. M. Hyche. 1972. Mercury pollution of Lake Erie ecosphere. Env. Res. 5(2):172-181.

The distribution of mercury in the ecosphere of Lake Erie was monitored using a highly sensitive and reliable neutron activation analysis procedure. A variety of samples from the fauna and flora of the lake as well as those from its immediate environment were analyzed for their mercury content. The results of this survey indicate a widespread distribution of mercury in air particulates; coal samples of the region; sediments, plankton/algae and fish samples from the lake; and in the brain tissues of long-time residents of the Lake Erie Basin.

579. Pincus, Howard J. 1953. Introduction. In: Howard J. Pincus (Ed.), 1951 Investigations of Lake Erie Shore Erosion. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 18. pp. 1-4.

General introduction into the processes of erosion and the instrumentation used in the studies that follow in this opening statement. (See: Metter 1953; Humphries 1953; Bowman 1953; Kleinhampl 1953 for each of the studies.) (SM)

580. Pincus, Howard J. 1960. A report on the status of Lake Erie geological research in Ohio. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:95-107.

Presented is a history and purpose of the Lake Erie Geological Research Program of the Ohio Division of Shore Erosion, types of research undertaken and suggestions for cooperative efforts. Mapping work of the Ohio shoreline and the geology and disposition of the shoreline are discussed. Other physical parameters were investigated as to the hydrology of Lake Erie and an appendix is included directing the readers to papers and reports pertinent to these parameters. (RL)

581. Pincus, Howard J. 1961. Engineering geology of the Ohio shoreline of Lake Erie. Ohio Dept. Nat. Resources. Div. Shore Erosion. Columbus, Ohio. Tech. Rept. 7. 7 sheets.

A compilation of data on the engineering geology of the Ohio shoreline of Lake Erie presented in seven sheets. Data presented graphically included water level fluctuations, profiles, and wave and wind of each of the areas presented. Map presentation included base map with surface material distribution, map on core section showing their location and correlation, general cross sections, regional geologic map, engineers soil map. Brief discussion for each of the seven sections covered bedrock, features concerning shoreline and surficial deposits, littoral drift, source of beach building materials, hydrology, lake level, and ice. (CCIW)

582. Pincus, Howard J. 1962. Recession of Great Lakes shorelines. In: Howard J. Pincus (Ed.), Great Lakes Basin, a symposium. Am. Assoc. Adv. Sci. Washington, D. C. Pub. 71:123-137.

Shoreline erosion, which is a geometric concept, involves the landward displacement of shore bluff lines; erosion is a mass concept, involving the net removal of material. Recession, which is what both the trained and untrained observe, is not as fundamental a term as is erosion.

The consideration of shore processes in terms of energy, material, and geometry demonstrates the importance of interac-

tion between factors and groups of factors contributing to recession and erosion. The proposition that the operation of a single factor accounts unequally for an erosional or recessional event is at best an oversimplification.
(SM & BU)

583. Pincus, Howard J. 1964. Retreat of lakeshore bluffs. ASCE J. Waterways and Harbors Div. 90(WW1): 115-134.

From a qualitative descriptive approach of the analysis of retreat of lakeshore bluffs, the key factors in failure and retreat are determined to be: wave action, currents, wind, surface runoff, subsurface flow and sapping, raindrop impact, frost action, gorging by ice, chemical weathering, composition of materials, vegetation, lake levels, and shore protective structures. It is concluded that failure of bluffs does not lead immediately to retreat, but usually does so ultimately. In fact, retreat need not result solely from failure, i.e. from landslides. Cumulative resistance of glacial tills to all types of erosion is shown to be intermediate between that of bedrock and lacustrine materials, although in many areas, particularly where wave action is dominant and the tills develop nearly vertical faces, the retreat of till bluffs does not differ significantly from that of shale bluffs. The cumulative resistance of erosion to a bluff in which a combination of materials is exposed is shown to depend, in most instances, on the resistance to wave attack and ice push of the material exposed at lake level. Quantitative data on sills and rock properties, available only in small quantities, are consistent with the behavior of corresponding material in lakeshore bluffs. (BECPL)

584. Pincus, Howard J., M. L. Roseboom and C. C. Humphris. 1951. 1950 investigation of Lake Erie sediments, vicinity of Sandusky, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 9. 37 p.

This report is concerned with sediments collected in the mouth of Sandusky Bay and along the Cedar Point and East Harbor Beaches. Included in this report is the general geology of the area of study, field methods employed for sampling, laboratory methods, and a summary of analytical results of outer Sandusky Bay (which includes mechanical, mineralogical analyses and the subsurface sediments), Cedar Point and East Harbor Beaches.

585. Pinsak, Arthur P. 1967. Water transparency in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. Great Lakes Res. pp. 309-321.

Water transparency as measured with an in situ turbidity meter is consistently low in the Western Basin of Lake Erie because of influence of tributaries and shallow mud bottom which is easily agitated by surface waves. Changes in geographic position of high clarity water masses within the Central and Eastern Basins are influenced predominantly by wind effect on the Lake which is strong enough to mask or distort turbidity patterns normally expected from tributary influx. A general 50% increase in suspended material from summer to winter can be attributed to movement of water from the western part of the Lake, seasonal increase in organic material, turbulent storm effect, and vertical circulation of the entire water column as the thermocline lowers and disappears.

A direct correlation exists between temperature structure and transparency profiles with least transparency below the thermocline and near the sediment-water interface during periods of stratification. Microstratification persists in the hypolimnion and is much more detailed and complex than conventionally depicted thermal stratification.

586. Pinsak, Arthur P. 1972. Physical characteristics. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2):4-313 to 4-416.

This report contains a study on the transparency of Lake Erie. Basically, Lake Erie's physical characteristics have not changed significantly in the past 40-year period.

Platzman, George W. - See: S. M. Irish, No. 372.

587. Platzman, George W. 1963. The dynamical prediction of wind tides on Lake Erie. Meteor. Mono. 4(26): 44 p.

Lake Erie is an enclosed, shallow sea with approximate mean dimensions of 60 feet in depth, 240 miles in length, and 40 miles in width. It is located in the region of confluence of the principal winter-time tracks associated with Alberta and Colorado lows, and therefore is exposed to wind action from severe cyclonic storms many of which reach their full intensity while well within range of influence upon the Lake. The associated wind tides are well known and in extreme cases have produced wind set-up in excess of 13 feet difference between Buffalo and Toledo at opposite ends of the longitudinal axis.

In this investigation numerical computations have been made for nine cases of record of extreme wind tide on Lake Erie. The computations are based upon an approximate, two-dimensional form of the Ekman boundary-layer equations, in which the viscous dimension is parameterized by an Ekman number. Effects of gravity, friction (with an eddy viscosity 40 $cm^2$/sec) and the earth's rotation are included.

The prediction equations are amenable to numerical integration by standard methods applicable to the momentum form of the dynamical equations; a pair of conjugate Richardson lattices is used for this purpose. Wind stress was obtained by an interpolation prodedure based upon hourly surface-wind observations at six first-order stations located on the periphery of the Lake. A quadratic resistance formula with skin-friction coefficient $3.0 \times 10^{-3}$ gave good results for computed wind set-up.

Although prediction of resurgences associated with the 14-hr free period was unsatisfactory, the average coefficient of correlation obtained between computed and observed set-up at various stations where hourly lake-level data are available is greater than 0.90. In general, the results of the investigation may be regarded as confirming that a sound basis exists for operational prediction of wind tides on Lake Erie by dynamical methods. (SE)

588. Platzman, George W. 1965. The daily variation of wind set-up on Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:273-277.

The daily variation of lake level is computed from six months of hourly data at each of several gage locations on Lake Erie. The results show a distinct diurnal constituent of longitudinal oscillation of the Lake as a whole, with Buffalo high water and Toledo low water at or shortly after noon. The amplitude of this oscillation is about 0.05 ft. A similar analysis is made of the daily variation of the surface wind vector at each of several anemometer locations on the periphery of the Lake. These results show a distinct diurnal constituent of the longitudinal component of the wind-square vector, with maximum in the direction Toledo to Buffalo at about one hour after noon. The amplitude of this variation is about 50 $mi^2$ $hr^{-2}$. All evidence is consistent with the hypothesis that the diurnal constituent of lake level is caused by a diurnal constituent of wind stress. On the other hand, the semidiurnal constituents of lake level are caused mainly by astronomical tides.

589. Platzman, George W. 1966. The daily variation of water level on Lake Erie. J. Geophys. Res. 71(10): 2471-2483.

The daily variation of the water level of Lake Erie is investigated. Particular attention is given to determining the extent that this variation can be accounted for by a corresponding daily variation of wind stress.

The daily variation is computed from 6 months of hourly data at several lake-level recording stations on Lake Erie. Results are consistent with the hypothesis that the 24-hour constituent of the lake level is caused almost entirely by wind stress. On the other hand, the 12-hour constituent is affected substantially by the gravitational tidal force as well as by wind stress. The effect of the atmospheric pressure gradient force is negligible in both cases. Also, an earth-tide correction as applied to the semidiurnal response by means of Jeffrey's values for the Love numbers. (BU)

590. Platzman, George W. and D. B. Rao. 1963. The 14-hour period of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:231-234.

An abstract on the longitudinal uninodal free oscillation of Lake Erie by spectral analysis gives a summary of the author's work.

591. Platzman, George W. and D. B. Rao. 1964. Spectra of Lake Erie water levels. J. Geophys. Res. 69(12): 2525-2535.

Variance and covariance spectra of Lake Erie hourly scaled water levels are analyzed with resolution 0.1 cycle per day (in some instances 0.05 cpd) in the frequency range 0 to 8 cpd for thirteen stations in the 6-month 'summer' period April through September 1958, and for some of these stations in the 6-month 'winter' period October 1958 through March March 1959. The main contribution to variance spectra at most stations is in the range 0 to 1 cpd. Inherent noise levels are between $10^{-4}$ and $10^{-3}$ $ft^2$/cpd; scaling noise is at most about $10^{-4}$ $ft^2$/cpd. The most conspicuous features of summer variance spectra are strong and consistent peaks near periods of 14.1 hr, 9.2 hr, 6.0 hr, and 4.1 hr, which correspond to the first four modes of longitudinal free oscillation of the lake. A diurnal peak appears consistently in analysis with 0.1 cpd resolution; with 0.05 cpd resolution a distinct semidiurnal peak emerges at 12.3 hr. Covariance spectra give phases consistent with the hypothesis that the fundamental mode of oscillation is an amphidromic Kelvin-type wave, in which there is counterclockwise rotation of the phase of high water. (BU)

592. Polcyn, F. C. 1973. A new dimension in remote sensing. In: Communicator. Great Lakes Basin Comm. Ann Arbor, Mich. 4(3):3-4.

The NASA ERTS-1 satellite multispectral imagery has been found useful in obtaining information on land and shore processes including sediment suspension, circulation patterns, and temperature anomalies. The accompanying image shows the western end of Lake Erie just after flooding and the sediment load being carried back to the Lake. (SM)

593. Policastro, A. J. 1973. Thermal discharges into lakes and cooling ponds. Argonne National Laboratory. Center for Env. Studies. p. 10.

Table III. Effects of Utility Discharges on the Great Lakes --Present and Projected. Lake Erie is mentioned and the energy input, utility discharge, annual average increase in water surface temperature, and annual average increase in evaporation water loss are given.

594. Poston, H. W. and C. R. Ownbey. 1968. The Great Lakes water resource. Am. Water Works Assoc. J. 60(1):15-20.

General discussion of eutrophication in the Lake Erie watershed. Lake Erie is cited as being the largest discharger of municipal effluents. Suggestions as to curtailing discharge of effluents and organizing effective action, correlating efforts of physical scientists, engineers, economists, lawyers and political scientists are presented. Increase of chlorides as related to salt mining and chemical industry and oxygen depletion are briefly mentioned. (SE)

Potos, Chris P. - See: Robert P. Hartley, No. 307.

595. Potos, Chris P. 1970. Hypolimnetic oxygen depletion mechanisms in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 707-714.

To the present, the mechanism of hypolimnetic deoxygenation of temperate lakes has been little understood. It is the consensus among limnological investigators that a slow, progressive, sediment biochemical oxygen uptake rate, exerted by microbiological flora in the decomposition of sedimented plankton and other degradable organic debris, is the mechanism responsible for depleting any hypolimnion of oxygen during stratification periods.

Success in the measurement of a positive depletion rate in the summer of 1968 in the Lake Erie Central Basin and correlation of this rate with existing sediment and hypolimnion oxygen demand, infers the probability of still another operative factor--that of chemical oxygen demand satisfaction. The total mechanism of the depletion, abetted by sediment resuspension due to wind-induced water turbulence, can be chemical and microbiological in nature, both at one and the same time.

596. Powers, Charles F., D. L. Jones, P. C. Mundinger and J. C. Ayers. 1960. Applications of data collected along shore to conditions in Lake Erie. Univ. Mich. Great Lakes Res. Div. Pub. 5:1-52.

A comprehensive report on Lake Erie which covers topics on selection of representative stations, surface circulation, wind pattern techniques, environmental history (1854), rainfall (since 1810), lake levels (since pre-1860), and water chemistry.

597. Powers, Charles F. and A. Robertson. 1966. The aging Great Lakes. Sci. Am. 215(5):94-100, 102, 104.

The author discusses the physical and biological processes that will eventually result in their extinction. These processes are being accelerated by human activities.

598. Powers, W. E. 1962. Drainage and climate of the Great Lakes. In: H. J. Pincus (Ed.), Great Lakes Basin, a symposium. Am. Assoc. Adv. Sci. Washington, D. C. Pub. 71:29-40.

The drainage basin of the Great Lakes is characterized by obscure boundaries, the relatively large proportion of the total area covered by the Lakes themselves, and the absence of major tributaries. Most of the basin has small relief with such landforms as glacial till plains, moraines, outwash plains, and lacustrine plains. The drainage pattern shows many adjustments to the minor relief afforded by moraines and beach ridges. Climate is severely continental. Current geologic processes affecting the drainage basin include gentle regional warping, shore erosion, and dune building. Not all topics apply to Lake Erie. (SM)

Prahl, J. - See: A. Strazisar, No. 703.

599. Prest, V. K. 1970. Quaternary geology of Canada. In: R. J. W. Douglas (Ed.), Geologic and Economic Minerals of Canada. Dept. Energy, Mines and Resources. Geol. Surv. Canada. Queen's Printer. Ottawa, Ont. pp. 681-687, 713-729.

Major topics concerning Lake Erie are in reference to its formation (including illustrations of the glacial lake phases and discussion of the sequence of events) and the buried organic deposits on Lake Erie's bluffs in the vicinity of Port Talbot (basically a repetition of the Dreimanis paper - See: A. Dreimanis, 1958, No. 214). (SM)

600. Prosser, C. S. 1912. The Devonian and Mississippian formations of Northeastern Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Bull. 15. 574 p.

From Cuyahoga Falls, the Cuyahoga River, flowing in a general northwesterly direction, has excavated a valley of considerable depth. At Cuyahoga Falls the banks are high and precipitous, below which it enters a pre-glacial valley and is bordered by fairly steep hills with occasional cliffs.

The Chagrin River, below Chagrin Falls, is frequently bounded by steep hills on one or both sides with occasional precipitous cliffs.

These circumstances have enabled the stratigraphy of the area to be studied in detail and sections to be constructed. (SM)

Proulx, R. - See: P. A. Allee, et al, No. 6.

601. Puleo, J., M. C. Lanighan and C. O. Masters. 1974.

Erie County stream study (1973). Erie County Laboratory. Public Health Div. Buffalo, N. Y. 294 p.

The primary phase of this study was to determine if water samples were in violation of New York State standards and to identify sources of pollution. Included in the study were Rush Creek, Cayuga Creek, and Eighteen Mile Creek. In addition to analyzing water samples and describing biota, the streams and their bottoms are described. The second phase of the study investigated the effects of local industries located on, or discharging directly into streams. In general, there was very little effect in the water in the streams due to the discharges. The third phase was concerned with the study of benthic organisms as they relate to stream quality.

Putman, D. F. - See: L. J. Chapman, No. 137.

Quigley, R. M. - See: P. J. Gelinas, No. 252.

602. Quigley, R. M. and D. B. Tutt. 1968. Stability - Lake Erie North Shore Bluffs. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 230-238.

The 145-foot high bluffs along the north shore of Lake Erie are retreating about 5 feet per year through a combination of large circular arc toes failures and toe erosion by wave action. Drained direct shear tests run on the clayey silt till, which comprises the bulk of the slopes, yielded peak cohesion intercepts of 280 to 700 pounds/square foot and peak friction angles of 26 to 28 degrees. A much reduced residual cohesion intercept of 100 pounds/square foot was obtained on all samples whereas the residual friction angles were about the same as the peak values. Stability calculations, assuming a horizontal flow pattern, and field observations showed that toe circles are more critical than deeper failures, however, the latter in certain situations could also fail.

603. Quinn, F. H. 1964. Stage-fall discharge equations for the connecting channels of the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:267-282.

Experience and examination of the hydraulic elements of the channels under consideration have shown that uniform flow equations do not adequately describe the phenomenon of flow in the connecting channels. Thus, the development of a non-uniform flow stage-fall discharge equation is necessary. The presented method for determining the stage-fall discharge equations is used by the Lake Survey to determine the flows and effects of regimen changes on the connecting channels of the Great Lakes with the Detroit River being one of them.

604. Quinn, F. H. 1972. Water quality modeling of the Great Lakes. In: Communicator. Great Lakes Basin Comm. Ann Arbor, Mich. 3(1):3-4.

Water quality models aid in computing the effects of proposed water quality changes in the system on navigation, power production, lake levels, and shoreline erosion. The model inputs consist of hydrologic parameters such as precipitation, evaporation, diversions, and the effect of ice. A schematic diagram of a hydraulic response model (flow chart) used as an illustration includes Lake Erie. (SM)

605. Quinn, F. H. 1973. Effects of ice retardation on Great Lakes water levels. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 549-555.

Ice retardation in the connecting channels is one of the important mechanisms in the natural regulation of the Great Lakes System. It reduces the winter flows in the connecting channels, thus storing additional water on the lakes for release during the remainder of the year. It is also an important factor to consider when evaluating the impact on lake levels of such activities as winter navigation and thermal discharges in connecting channels. The analysis of the effects of ice retardation on water levels was accomplished using a hydrologic response model of the Great Lakes System with ice retardation rates as variable input parameters. A base period of 1950-1966 was selected to define the ice retardation rates in the St. Clair, Detroit, and Niagara Rivers. These retardation rates were then varied and their system effects determined by the model. Historical perspective was obtained by comparing ice retardation rates during the early 1900's with those of the base period. The results of the study show that ice retardation in the Detroit and Niagara Rivers has little effect upon the water levels of the system. However a reduction in ice retardation since the early 1920's in the St. Clair River has resulted in an average increase in lake levels at the end of December ranging from -10 cm for Lake Michigan-Huron and -6 cm for Lake Erie.

The seasonal cycle for each of the lakes was also modified. Design curves were developed and are included for use in estimating effects of future changes in ice retardation upon the water levels of the Great Lakes.

606. Rafter, G. W. 1905. Hydrology of the State of New York. N. Y. S. Museum Bull. 340. 902 p.

Description of the St. Lawrence River System including Lake Erie and its tributaries in Western New York. Information given for each tributary includes drainage basin, direction of flow, general location, and elevation. Information on Lake Erie includes discharge, evaporation, precipitation, wind action, and lake levels. (BU)

Randles, Chester I. - See: Walter O. Leshniowsky, et al, No. 443.

Randles, Chester I. - See: R. M. Pfister, et al, No. 576.

Rao, Desiraju B. - See: T. S. Murty, No. 504.

Rao, Desiraju B. - See: George W. Platzman, No. 590, 591.

607. Rao, Desiraju B. 1967. Response of a lake to a time-dependent wind stress. J. Geophys. Res. 72(6): 1697-1708.

The response of a lake of uniform depth and finite length to a time-dependent wind stress is studied, with particular reference to the occurrence of resonance, ignoring the earth's rotation. The relevant equations are solved using the method of characteristics. For bandwidths less than the length of the lake, resonance is obtained when the speed of propagation of the stress band is the same as the free gravity wave speed in the lake. For bandwidths greater than the length of the lake, resonance is obtained for a speed of propagation of the stress band, for which the time taken by the band to cross a fixed point in the lake is the same as the time taken by the free gravity wave to cross the lake. An analysis of the response of the fundamental mode of the lake is also made. In particular, it was shown that the free oscillation of the fundamental mode in the lake after the passage of the stress band is suppressed for certain adverse combinations of the stress bandwidth and speed of propagation. (BL)

608. Rau, Jon L. 1968. The evolution of the Cuyahoga River:

Its geomorphology and environmental geology. In: G. Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. pp. 9-39.

This is a paper on the Cuyahoga watershed as a geophysical unit. Contained within the report are the physiography, stratigraphy, drainage changes and pre-glacial topography. Maps and geologic cross-sections are used.

609. Read, M. C. 1878. Report on the geology of Huron County. Ohio Geol. Surv. Columbus, Ohio. 3:289-309.

The valleys and tributaries of the Vermilion and Huron Rivers are described in terms of geology and their effect on modifying the topography of the area is discussed. (SM)

Reavely, G. H. - See: A. Dreimanis, No. 217.

610. Redmond, C. E., T. J. F. Hole, C. H. Innis and M. Wachtman. 1971. Soil survey of Erie County, Ohio. U. S. Dept. Agric. Soil Cons. Ser. 166 p.

Comprehensive description of soils in Erie County, including the formation, classification, and general nature of the county. Use and management of soils are discussed. Added is a general soil map, with 32 sheets that are aerial photographs with soil types marked off within boundaries. (SM)

611. Reeder, Neil E., Victor L. Riemenschneider and Paul W. Reese. 1973. Soil survey of Ashtabula, Ohio. U. S. Dept Agric. Soil Cons. Ser. 114 p.

Description of the soils found in Ashtabula County, Ohio, use and management of the soils and the formation and classification of the soils are presented. General information concerning climate, physiography, geology, relief and drainage are also included. Soil maps are included in the report. (SE)

612. Reitze, A. W. 1968. Wastes, water, and wishful thinking: The battle of Lake Erie. Case Western Reserve Law Rev. 20(1):18, 34-42.

In the author's report is a summary of the effects of chemical pollutants, siltation from erosion, and thermal pollution in Lake Erie.

613. Reitz, Robert D. 1973. Distribution of phytoplankton and coliform bacteria in Lake Erie. Ohio Env. Protection Agency. Div. Surveillance. Columbus, Ohio. 67 p.

General information concerning the Erie Drainage Basin, hydrology, bottom topography, lake currents, and the physical characteristics of the sediment. Ohio section of Lake Erie is considered.

614. Remick, John T. 1942. The effect of Lake Erie on the local distribution of precipitation in winter (1). Am. Meteor. Soc. Bull. 23(1):1-4.

This is a report on winds passing over the Lake and how they are physically changed by the Lake's presence. (BL)

615. Remick, John T. 1942. The effect of Lake Erie on the local distribution of precipitation in winter (2). Am. Meteor. Soc. Bull. 23(3):111-117.

Remick uses maps to back up the first part of his paper [23(1):1-4] and discusses the types of air patterns and local storms. (BL)

616. Richards, T. L. 1963. Meteorological factors affecting ice cover on the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:204-215.

This particular study was undertaken to assess the ice cover of two Lakes, namely Erie and Superior. Since the degree-day concept appeared to be useful not only as a method of accounting for temperature but also as an index of other meteorological factors, the first approach was to correlate the percentage of ice cover on the day of the flight to the accumulation of freezing degree days, as recorded at a nearby meteorological observing station. Further investigations were undertaken to assess the importance of other meteorological and limnological parameters.

617. Richards, T. L. 1964. The meteorological aspects of ice cover on the Great Lakes. Mon. Wea. Rev. 92(6):297-302

The formation and break-up of ice on the Great Lakes as observed by regular ice reconnaissance flights is discussed in terms of the meteorological parameters involved. Ice cover on the individual lakes over the past four years is correlated with winter temperature regime and an index of the heat stored in each lake using the concept of cumulative degree-days of freezing and thawing. (SE)

618. Richards, T. L., H. Dragert and D. R. McIntyre. 1966. Influence of atmospheric stability and over-water fetch on winds over the lower Great Lakes. Mon. Wea. Rev. 94(7):448-453.

Five years of wind observations taken by research vessels were compared to simultaneous observations taken at land stations upwind of the ship. The resultant ratios of over-lake winds/over-land winds have been sorted by speed classes, conditions of atmospheric stability, and the length of the over-water fetch to assess the relative influence of each factor on the over-lake wind. (SE)

619. Richards, T. L. and J. P. Fortin. 1962. An evaluation of the land-lake vapor pressure relationship for the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9: 103-110.

Utilizing data of land-lake vapor pressure, humidity ratios are derived for Lake Erie and displayed graphically. Interpretation as to annual and diurnal variations are discussed with application to forecasting.

620. Richards, T. L. and J. G. Irbe. 1969. Estimates of monthly evaporation losses from the Great Lakes 1950 to 1968 based on the mass transfer technique. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 469-487.

The Meteorological Service of Canada is currently making estimates, at the end of each month, of the monthly evaporation losses from each of the Great Lakes bordering on Canada. These estimates are based on the mass transfer technique using modified wind and vapor pressure data from shoreline climatological stations and surface water temperature data from regular airborne radiation thermometer flights and ships' surveys. This paper presents a brief review of the technique and provides a record of monthly evaporation losses from each of the Lakes over a relatively long period.

621. Richards, T. L., J. G. Irbe and D. G. Massey. 1969. Aerial surveys of Great Lakes water temperatures

April, 1966 to March, 1968. Dept. Transport. Meteor. Branch. Toronto, Ont. 57 p.

The requirement for surface water temperature data from the Great Lakes is becoming increasingly important not only to the meteorologist but to a variety of scientists working in a wide spectrum of disciplines. In addition to the need for forecasting meteorological conditions over the lakes and their adjacent land areas, these data are now a key to month to month evaporation estimates, and are also used in increasingly sophisticated wind and wave studies and in the development and application of ice forecasting techniques. It has also recently been established that a sharp surface water temperature discontinuity, prevalent during the spring in many large lakes, is an important factor in water pollution investigations.

622. Richards, T. L. and P. Loewen. 1965. A preliminary investigation of solar radiation over the Great Lakes as compared to adjacent land areas. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:278-282.

This preliminary investigation includes observations from sectors of Lakes Ontario, Erie, Huron and Superior within 100 miles of Sault Ste. Marie, Cleveland and Toronto during the months of April to December inclusive and presents the comparisons as monthly ratios of total radiation over water to total radiation over land. Results based on data collected since 1960 confirm the physical concept of substantially greater incoming solar radiation over the Lakes during the summer (due to less cloud cover over the water areas) with the opposite effect particularly evident in the early spring and late fall.

Ridge, J. D. - See: F. J. Pettijohn, No. 572, 573.

623. Risley, Clifford and William L. Abbott. 1966. Radioactivity in Lake Erie and its tributaries. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:416-422.

Gross alpha and gross beta radioactivity levels of water, bottom sediment, and plankton samples in Lake Erie and in the tributary mouths were determined in a study conducted by the U. S. Public Health Service from 1963 to 1965. Values for dissolved solids and bottom sediment beta activities in the Lake were generally quite low with ranges of less than

1 to 39 picocuries per liter and 11 to 81 picocuries per gram, respectively. The tributary alpha and beta radioactivity values were low with slightly higher activities evident during the spring season, which may only be reflecting increased precipitation and runoff.

624. Robb, D. C. 1970. Land and water usage in the Lake Erie Basin. John Carroll Univ. Carroll Business Bull. 10(1):13-14.

In this report mention is made by the author of thermal pollution and effects of sedimentation and the erosional process.

Robertson, A. - See: C. F. Powers, No. 597.

625. Robertson, James F. 1967. Drive for Lake Erie gas mushrooming. Oil and Gas J. 65(23):59-60.

Drilling has already started on a 1.3 million acre block off Ontario. Ohio, Pennsylvania, and New York are planning major leasing on the U. S. side of the Lake for the first time. The Clinton-Cataract Silurian producing trend cuts a wide swath across the Lake, so it is hoped that the U. S. side will be as productive as the Canadian side has proven to be. Because all three states are interested in guarding against any possible pollution, gas development in the U. S. side of Lake Erie has moved very slowly. (SE & BECPL)

626. Robison, F. L. 1969. Floods in New York - 1967. U. S. Geol. Surv. Albany, N. Y. Rept. Invest. R1-3. pp. 1-32.

This report presents information on floods reported in New York State during the calendar year 1967. Data and information are derived from newspaper clippings, U. S. Weather Bureau publications, "Storm Data and Unusual Weather Phenomena, 1967" and "Daily Precipitation Records", and from records of the U. S. G. S. Particular information is also given for Cattaraugus Creek and some of the areas adjacent to the Lake Erie vicinity. Data on discharge water heights and historical flood data are also given.

627. Robison, F. L. 1969. Floods in New York - 1968. U. S. Geol. Surv. Albany, N. Y. Rept. Invest. R1-9. pp. 13-30.

Report contains some newspaper clippings on the reports of flooding for 1968. Some of the clippings are in regard to the Western New York area and its tributaries.

Robson, L. - See: R. R. Rumer, No. 637.

628. Rockwell, D. C. 1966. Theoretical free oscillations of the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:352-368. Also found as: Tech. Rept. 20 to National Sci. Foundation.

The lowest five modes of longitudinal free oscillation of each of the Great Lakes are investigated by numerical integration of the hydrodynamical channel equations. The corresponding periods, surface profiles, and volume transports are presented and discussed.

Rodgers, G. Keith - See: D. V. Anderson, No. 10.

Rodgers, G. Keith - See: J. P. Bruce, et al, No. 78.

Rodgers, G. Keith - See: J. P. Bruce, No. 79.

Rodgers, G. Keith - See: James R. Kramer, No. 414.

629. Rodgers, G. Keith (Ed.). 1963. Lake Erie data report 1960. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Preliminary Rept. 11. 138 p.

This report is divided into four sections as follows: A. Synoptic Weather Observations, B. Radiation, C. Limnological and Meteorological Data (which includes wind, temperatures, visibility, cloud amount, relative humidity, water depth, waves, secchi disk transparency, color, temperature at depth, dissolved oxygen, pH, alkalinity, conductivity), and D. Bathythermograph Traces. Included are maps locating the stations that each of the measurements was made at.

630. Rodgers, G. Keith. 1972. Great Lakes Institute data catalogue and methods for 1960 to 1970. Univ. Toronto. Inst. Env. Sci. and Eng. Toronto, Ont. Pub. EG-7. pp. A-22, B-28, C-63, D-192.

This publication provides a systematic inventory of data collected in various programs. It includes the methods used in collecting the data and charts of the Great Lakes (including Lake Erie).

Rogers, C. W. C. - See: G. E. McVehil, et al, No. 478.

631. Rondy, Donald R. 1972. Great Lakes ice cover. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4:4-279 to 4-284, 4-312.

Definitions of the types of ice and their effects on the climate are examined in this report. The extension of the navigation season on the lakes is discussed in regard to all the Great Lakes.

Roney, H. B. - See: C. C. Davis, No. 185.

632. Roosen, James J. and Robert C. Ball. 1971. Ecological effects of a thermal power plant on the aquatic habitat of a large fresh water lake in the United States. 8th World Energy Conf. Bucharest, Romania. June 28-July 2, 1971. Div. 2. Paper 2.1-47. 19 p.

In a discussion on the change in temperature and its relation to the habitat in Western Lake Erie an account of Lake Erie's physical aspects is presented.

633. Root, D. L. 1952. The Great Lakes in Niles' National Register. Inland Sea. 8(2):121-123.

Geographical description of the Maumee and Sandusky Rivers and vicinity during the year 1816. (BU)

Rosenberg, H. B. - See: A. M. Beeton, No. 41.

Roseboom, M. L. - See: H. J. Pincus, et al, No. 584.

Ross, C. - See: N. W. Burns, No. 88, 89, 90.

Roth, James C. - See: Claire L. Schelske, No. 646.

Rukavina, N. A. - See: L. R. Culp, et al, No. 173.

Rukavina, N. A. - See: D. A. St. Jacques, No. 699.

634. Rukavina, N. A. and D. A. St. Jacques. 1971. Lake Erie nearshore sediments, Fort Erie to Mohawk Point, Ontario. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 387-393.

Bottom samples, echo sounder records, and underwater television and diver observations have been used to map the geology and bathymetry of the nearshore zone of northeastern Lake Erie. Nearshore materials consist of bedrock (25%), glacial drift (25%), and the recent sediments sand (35%) and silt-sand (15%). Bedrock is exposed in the inshore half of the zone. Glacial drift occurs inshore at the western end of the area and offshore in the central portion. Recent sediment is present on the submerged Port Maitland moraine, in the offshore half of the zone east of Point Abino, and as shallow-water bay deposits. The sand on the moraine is a lag deposit produced by reworking of underlying glacial drift. The eastern deposit and the bay sediments result from accumulation of sediment transported by eastward-mov'-- longshore currents. The minimum depth at which offshore sand occurs varies across the area from 10 to 18 m.

Rumer, Ralph R. - See: P. J. Buechi, No. 86.

Rumer, Ralph R. - See: J. A. Howell, et al, No. 343.

635. Rumer, Ralph R. 1970. Dynamic model study of Lake Erie, part I: Similitude criteria and experimental set-up. U. S. Federal Water Pollution Control Admin. Civil Eng. Rept. 18.1. 43 p.

Both analytical and experimental investigations employed to provide basic information concerning water movement in the Lake. The knowledge and experience acquired in the course of this study should improve our capacity to construct and operate rotating hydraulic models. This information should also assist in the overall water quality management of the Lake. The studies reported here deal with the idealized conditions of zero wind stress (including the inflow of the Detroit River and the outflow of the Niagara River) and, under this same flow condition, with the superposition of a uniform westerly wind over the surface of the Lake. The water mass is isothermal and variations in density are assumed absent. Under these conditions, investigations of the circulation patterns were conducted. Also studied was the oscillation of the entire water mass in the model lake. In particular, attention was given to the transient effect that this mass oscillation had on the otherwise steady-state circulation pattern and its effect on the mixing and dilution of waste discharges into the Lake. The mixing and dilution of tracers introduced at various positions in the model lake were also studied under these same conditions of zero wind stress and constant throughflow and with the superposition of the westerly wind. A highly idealized model of Lake Erie was also constructed and operated. This model was rectangular in shape, of constant depth, and had the same length to width ratio as Lake Erie. Circulation patterns, the decay of seiches, and mixing of tracers were also studied in this idealized model. The results obtained from the idealized rectangular basin helped to delineate the major effects of geometrical variations that were present in the scaled Lake Erie model. This report recounts the development of the laboratory and the model lake and summarizes the analytical and experimental work accomplished thus far. (SE)

636. Rumer, Ralph R. 1970. Dynamic model study of Lake Erie, part II: Analytical and experimental results. U. S. Federal Water Pollution Control Admin. Civil Eng. Rept. 18.2. 40 p.

The second report considers the experimental results obtained and the relationship of these results to various mathematical model approaches to the hydraulic study of Lake Erie. Based on the experimental and analytical results of this study, the following summarizing statements are made regarding the dynamic behavior of Lake Erie. In the absence of wind, the throughflow caused by the inflow of the Detroit River and the outflow of the Niagara River generates significant currents and easily observable patterns of circulation. The presence of westerly wind significantly alters the circulation patterns of Lake Erie as observed in the absence of wind. A procedure for relating model wind speeds to prototype wind speeds based on similarity between wind set-up in model and prototype has been presented. The period for the first mode mass oscillation in the model lake is in good agreement with calculated and observed periods. Observed detention periods show significant short circuiting for the homogeneous lake with no wind stress. Only limited correspondence can be achieved in modeling dispersion in vertically distorted Froude models of very large bodies of water. (SE)

637. Rumer, Ralph R. and L. Robson. 1968. Circulation studies in a rotating model of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 487-495.

Experimental results obtained from a rotating vertically distorted Froude model of Lake Erie are presented. The model has a horizontal length scale of 1:200,000 and a vertical scale of 1:500. The experiments were conducted in a completely enclosed rotating laboratory to simulate the effect of the earth's rotation. The laboratory is briefly described.

Data related to mass oscillation, residence time in the Lake, and circulation patterns are presented and discussed. These initial studies have been made for the idealized case of zero wind stress with the inflow of the Detroit River made equal to the outflow of the Niagara River.

Experience, thus far, has shown that the model can be operated and that reproducibility of results is good. The significance of the results and future studies are discussed.

638. Russell, A. Brant and Charles E. Herdendorf. 1972. Delineation of Great Lakes estuaries. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 710-718.

The arms of the lakes that extend landward have evaded description and recognized distinction. For the most part such linear bodies of water have been referred to as rivers to some indistinct proximity to the lake. Resulting confusion has led to misunderstandings by public, legal and scientific interests.

This study's approach to the generically related extensions of the lake is to treat these bodies of water physically and hydraulically and in this context to show these fundamental earth factors to be the essential characteristics of estuaries and that this term may be logically and usefully applied in the Great Lakes. The physical approach is in consonance with the general application of the term and the use of the concept and term would provide a more definite basis for limnological, biological, geological and legal considerations.

Lake Erie examples are the basis for the conclusions drawn, but more general application is anticipated. The estuaries extend to as far as 25 km from what may be termed the estuary mouth. Correlation is shown in a gross way by examination of lake survey charts and large scale topographic maps. More detailed lake level relationships are shown by use of hydrographic and water quality records.

639. Russell, F. 1971. Legend of a lake. Am. Heritage. 22(3):14-23.

A romanticized history of Lake Erie with emphasis on its deterioration--geologically, ecologically, and biologically. (BU)

640. Russell, I. C. 1893. Geologic history of the Laurentian Basin. J. Geol. 1:394-408.

General discussion of the Pleistocene history of the Laurentian Basin with minor mention of Lake Erie concerning origins, sediments, shore records, and fossils (forest remains in lacustral clays on the south shore). (BL)

641. Russell, I. C. 1898. Geography of the Laurentian Basin. Am. Geog. Soc. J. 30(1):226-254.

The Laurentian or Great Lakes are discussed as to their preglacial, glacial, and post-glacial history. Also included are sections on the influence of geographical conditions on exploration and settlement, mineral and agricultural resources, forests, and commerce. (SM)

642. Ryder, R. A. 1965. A method for estimating the potential fish production of North-temperate lakes. Trans. Am. Fish. Soc. 94(3):214-218.

Fish production (yield) is affected by three principal influences: the morphometric, edaphic, and climatic factors. Partial exclusion of the climatic factor reduces the complexity of the relationship of fish production and the other parameters. In this study of North-temperate lakes, the variability of the climatic factor is reduced to a minimum, and permits regression analyses of fish production on the morphometric and edaphic factors alone. Thirty-four North-temperate lakes were segregated into two groups: 23 lakes were moderately to intensively fished (this group included Lake Erie); 11 lakes had restricted catches or incomplete records. Regression of fish production on the "morpho-edaphic" index for each group was highly significant. The morpho-edaphic index, an expression equal to

$$\frac{\text{total dissolved solids (ppm)}}{\text{mean depth (ft)}}$$

provided a means for estimating the potential productivity of a North-temperate lake. (BU)

643. Sanderson, Marie E. 1966. The 1958-1963 water balance of the Lake Erie Basin. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res.

Pub. 15:274-282.

The study uses a climatic water balance method to determine monthly runoff at the 133 climatic stations in the Lake Erie Basin, permitting the preparation of monthly maps of runoff. An isopleth mapping technique is used to estimate total runoff. Monthly over-water precipitation is similarly estimated using data from perimeter stations. Monthly net lake evaporation is obtained as a remainder in the water balance when precipitation and runoff fail to meet the needs of lake evaporation and water is withdrawn from the Great Lakes System.

644. Savage, C. N. 1951. Mass wasting: Classification and damage in Ohio. Ohio J. Sci. 51(2):299-308.

A brief discussion of damage, origin, prevention, and classification of mass wasting is presented, followed by examples in Ohio. Some of the cited examples include areas of the Chagrin and Cuyahoga Rivers. (BU)

645. Saville, Thorndike. 1953. Wave and lake level statistics for Lake Erie. Corps of Engineers. Beach Erosion Board. Tech. Memo. 37. 76 p.

Four stations on Lake Erie were selected for a comprehensive wave analysis. It was felt that the stations would give adequate coverage to the entire lake shore in the U. S. and permit interpolation of values between stations. Data on wave statistics is given for each of the stations following the discussion. A monthly average of lake levels from 1860 to date of publication is presented in a discussion on the lake levels. (CE)

646. Schelske, Claire L. and James C. Roth. 1973. Limnological survey of Lakes Michigan, Superior, Huron and Erie. Univ. Mich. Great Lakes Res. Div. Pub. 17:44-61.

Eutrophic character of Lake Erie's western and southwestern Central Basin are discussed as to thermal stratification, chemical constituents, and current flow in this region of Lake Erie. Turbidity, water transparency, and comparison of data from previous studies are also briefly presented.

647. Schermerhorn, L. Y. 1887. Physical characteristics of the Northern and Northwestern lakes. Am. J. Sci. 33(196):278-284.

An assemblage of the latest data on the Great Lakes at the time including surface area, watershed dimension, depth, variations in levels, elevation above sea level, annual mean precipitation. (BECPL)

648. Schmidt, George W. 1970. Near-shore water chemistry of Eastern Lake Erie. Lake Erie Environmental Studies. N. Y. S. Univ. College at Fredonia. Tech. Data Rept. 2. 34 p.

The results of a lakeside study near Van Buren Point by the State University College at Fredonia are presented in charts and graphs. The parameters used were temperature, precipitation, turbulence, and waves.

Schneider, H. - See: R. K. Fahnestock, et al, No. 227.

649. Sears, Paul B. 1930. Common fossil pollen of the Erie Basin. Bot. Gaz. 89:95-106.

This paper is intended chiefly to assist in the identification of common and significant pollen found embalmed in bog deposits in North-Central United States. Techniques, keys, and plates are included. (BU)

650. Sears, Paul B. 1930. A record of post-glacial climate in Northern Ohio. Ohio J. Sci. 30(4):205-217.

This paper reports the probable course of post-glacial forest succession in Northern Ohio. Reference is made to the south shore of Lake Erie. (SE)

651. Sears, Paul B. 1948. Varves in the bed of Lake Erie. Science. 108:542.

This article describes a freezing technique used in varve counting. It is a follow up on I. T. Wilson's study that can be found in the Ohio Journal of Science, 1943, 43:195-197. (BL)

652. Sears, Paul B. 1966. Evaporation and plant zones in Cedar Point marsh, Ohio. Ohio J. Sci. 16(3): 91-100.

In a discussion of plant zones, the author gives water depths and daily water loss. (SE)

653. Sears, Paul B. and Elsie Janson. 1933. The rate of

peat growth in the Erie Basin. Ecology. 14(4):348-355.

There appears to be a period of maximum compression during the first 15 to 20 years of peat accumulation, after which it is much slower. Comparing measurements for the first 70 years with that of peat between 6,000 and 8,000 years old, a mean rate of peat accumulation of between 20 and 30 years to the inch for the past several thousand years in the Great Lakes area was obtained. (BU)

Seckinger, K. - See: S. Abram, et al, No. 4.

654. Shaffer, P. R. 1951. Shore erosion on Sandusky Bay. Ohio J. Sci. 51(1):1-5. Also in: Ohio Dept. Nat. Resources. Div. Geol. Surv. Lake Erie Geol. Res. Program. Rept. Invest. 7. Contrib. 2. 5 p.

The south shore of Sandusky Bay is undergoing severe erosion as a result of wave attack. The author describes the shoreline material, how it is being eroded, and what the shoreline will be like in the year 2000 A. D. (BL)

655. Shelford, V. E. and M. W. Boesel. 1942. Bottom animal communities of the Island Area of Western Lake Erie in the summer of 1937. Ohio J. Sci. 42(5):179-190.

A study on the animal communities and environment in the Western Basin with reference made to bottom muds and sands and the erosional conditions that were observed during the time of this study.

Shema, Robert L. - See: Daniel G. Bardarik, et al, No. 30.

656. Sheng, Y. P. and W. J. Lick. 1973. The wind driven currents in a partially ice-covered lake. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 1001-1008.

The steady-state, wind-driven currents in a partially ice-covered lake have been calculated numerically. Welander's shallow lake model is directly applied in the ice-free portion of the lake. In the ice-covered portion, the ice cover causes the water velocity to be zero at the surface. With this boundary condition, the equations of motion can be integrated and a single equation for the integrated stream function is obtained. The equations for the integrated stream functions in the two portions of the lake are solved and solutions matched across the interface. Horizontal velocities as a function of depth and horizontal location are then obtained.

Solutions have been calculated for a rectangular, constant-depth lake for different wind stresses, different wind directions, and different amounts of ice coverage. Relatively large currents occur under the ice for particular wind directions and frictional depths.

Solutions have also been calculated for a realistic model of Lake Erie. Two limiting cases have been studied, (1) an ice-covered Eastern Basin and (2) an ice-covered Western Basin. The effects of the ice cover in these two cases are considerably different due to the large differences in depth in the two basins.

657. Shepard, F. R. 1937. Origin of the Great Lakes. J. Geol. 45(1):76-88.

Attention is called to a growing tendency to overlook the hypothesis of glacial excavation as the primary cause of the Great Lakes. Alternate hypotheses, particularly diastrophism, are compared with the glacial hypothesis, and it is concluded that the evidence is much more favorable to glaciation. Points favoring glacial erosion include: the great depth of the basins; the finding of similar basins widespread over other glaciated areas; the absence of any evidence of recent diastrophism in the vicinity except that owing to isostatic recoil following deglaciation; the similarity of the basins to other features which are clearly the result of glaciation; and the thickness of the drift to the south of the Great Lakes. (BL)

Shepps, V. C. - See: J. C. Tomikel, No. 724.

658. Sheridan, L. W. 1941. The influence of Lake Erie on local snows in Western New York. Am. Meteor. Soc. Bull. 22(10):393-395.

This is a study using weather charts of local storms in Western New York and an analysis of the changes of air characteristics as it passes over the Lake. (BL)

659. Sherzer, W. H. 1900. Geologic report on Monroe County, Michigan. Michigan Geol. Surv. Lansing, Mich. 7(1): 240 p.

Topics pertinent to Lake Erie deal with the lake level, celestite occurrence, gypsum, sulfur springs in the Erie marsh and the Lake Erie trough. Geologic description of glacial deposits and formations are included, as well as geomorphology, drainage, and water level. (SM)

Sikes, C. S. - See: L. J. Walters, et al, No. 882.

660. Simpson, George D., L. W. Curtis and H. K. Merkle. 1969. The Cuyahoga River: Lake Rockwell to Lake Erie. In: G. Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. pp. 87-120.

This paper comprises a brief summary of a report on the Cuyahoga River and contains a short discussion of the biological studies, the chemical and physical data, and the development of the engineering project plan.

661. Sitler, Robert F. and Carleton A. Chapman. 1955. Microfabrics of till from Ohio and Pennsylvania. J. Sed. Petrol. 25(4):262-269

Microscopic study of oriented thin sections of Wisconsin till from Northeastern Ohio and Northwestern Pennsylvania reveals three principal types of microfabrics. These fabrics are: (1) microfoliation, (2) coarse fragment orientation, and (3) veining.

Microfoliation appears due to roughly parallel arrangement of silt flakes and elongate silt grains. Perfection of orientation generally decreases as the number of sand size particles increases. Microfoliation is roughly horizontal in till outcrop.

Coarse fragment orientation is well developed in the more sandy till, and is particularly striking where small fragments of coal are involved. Studies indicate that coarse fragment orientation is parallel to microfoliation.

Veining is a structure in which small thin veins or bands rich in silt flakes traverse the rock. Silt flakes roughly parallel vein walls, and veins may occur parallel to microfoliation or may cut it at a large angle. Branching and braided vein patterns are common. It is clear that veins postdate microfoliation. Veins are believed due to shearing of the till. The origin of the microfabrics is considered in detail, and problems worthy of further consideration are suggested. (BL)

Skoch, Edwin J. - See: N. W. Britt, et al, No. 69.

Skoch, Edwin J. - See: L. J. Walters, et al, No. 882.

662. Skoch, Edwin J. 1968. Seasonal changes in phosphate, iron, and carbon occurring in the bottom sediments near Rattlesnake Island in Western Lake Erie, 1966-1968. Ph.D. Dissertation. Ohio State Univ. Columbus, Ohio. 47 p.

The phosphate present in the sediments varies greatly with the seasons of the year and thus a report of the amount of phosphate present must be based on at least 3 consecutive months of sampling. The same holds true for organic carbon and iron. The amounts of carbon and phosphate are similar, while iron is 10 times greater. The top 5 to 7.5 cm of sediment, at this particular site, are affected by wave action and currents and are mixed. The amounts of total iron and total carbon have increased in the sediments since 1964. (CCIW)

663. Skoch, Edwin J. 1970. Changes in sediment chemistry of Lakes Erie and Ontario. In: R. A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Chemistry of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 25(2):67-76.

Lakes Erie and Ontario are quite similar in their sediment characteristics. Differences in the chemical composition of the sediment are possibly due to depth differences and material flow. Specific data is given for non-organic and organic sediments.

664. Skoch, Edwin J. and N. Wilson Britt. 1969. Monthly variation in phosphate and related chemicals found in the sediment in the Island Area of Lake Erie, 1967-68, with reference to samples collected in 1964, 1965, 1966. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 325-340.

Samples of sediment collected in 1964, 1965, 1966, and on a monthly basis from May, 1967 through November, 1968 were analyzed for total phosphate, iron and organic carbon. Samples were collected by means of an Ekman Dredge and by means of a core technique developed by Dr. Skoch. The cores were sectioned at 2.5 cm intervals and each of the six sections was analyzed for the same factors.

Results of the analyses showed only a slight increase in phosphate since 1964. However all three factors showed a definite increase from May, 1967 through November, 1968. Monthly variation was quite distinct and more severe than the differences between years. The two sampling methods yielded slightly different results. The sediment was found to consist of two distinct layers, with the upper 5 cm of sediment being usually higher in concentrations of materials than the lower portions.

665. Skoch, Edwin J. and J. M. Turk. 1972. Fluctuations in the level of mercury in sediments collected from the Island Area of Lake Erie, 1964 to 1968. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 291-297.

Samples of sediment collected in 1964, 1965, 1966 and on a monthly basis from May 1967 through November 1968 were analyzed for total mercury content. Samples were collected by means of an Ekman grab and a core technique.

Results of the analyses show only a slight increase in total mercury since 1964. However there was a greater increase from May 1967 through November 1968. Monthly variation was quite distinct and larger than the differences between years. The core samples do not indicate a definitive layering of mercury. The results from these analyses of the samples show similar patterns of fluctuation when compared to the varying levels of phosphate, iron and organic carbon in these sediments as previously reported by the first author.

666. Sly, P. G. 1971. Submersible operations in Georgian Bay and Lake Erie, 1970. Dept. Energy, Mines and Resources. Ottawa, Ont. Tech. Bull. 44. 36 p.

The operations conducted consisted of a study of bedrock and sediment relationships, bottom structures, erosional features, and seismic profiling in the vicinity of Point Pelee.

667. Sly, P. G. 1973. Sediment processes in Great Lakes. In: Proceedings of Hydrology Symposium, University of Alberta, Edmonton, May 8-9, 1973. Fluvial processes and sedimentation. pp. 464-492.

Although most sedimentary processes recorded under marine conditions appear to have been recognized in lakes, there are significant differences. In lakes, the active beach zones are confined to narrow vertical ranges, sediment transport paths are restricted to within basins, flocculation rates are less rapid, and silt size particulates appear to be less well-differentiated from sand and clay end members. There is a scarcity of sedimentary features. These characteristics reflect the fact that in lakes the energy associated with fluctuations of water level, seiches, and baroclinic circulations is considerably less than that of most tide-driven systems of epicontinental and partly enclosed seas. Wind-wave action is also less intense, and lacks the compounding effect of surface swell, generated beyond the confines of local areas. (CCIW)

Smith, K. R. - See: N. W. Britt, et al, No. 69.

668. Smith, S. H. 1962. Lake Erie or Lake Eerie? The Izaak Walton Mag. April. pp. 4-5.

Brief account of the physical changes in Lake Erie in recent times, taking into account siltation and temperature changes.

669. Smith, W. H. 1949. Sand and gravel resources in Northern Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 6. 24 p.

The bulk of information in this report is concerned with the occurrence, extent, and quantity of sand and gravel deposits in Ohio. A small section on the sand deposits on the bottom of Lake Erie states that although little information on the occurrence, distribution, and movement of sand on the bottom of the Lake has been compiled, the significance of such information in regard to the study of erosion on the south shore of the Lake cannot be dismissed. (SM)

670. Snow, P. D. and D. S. Thomson. 1968. Comparisons of hydroxy-apatite saturations and plankton concentrations in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 130-136.

The saturation of hydroxy-apatite and plankton concentrations in Lake Erie are compared and their interdependences are noted. The Eastern and Central Basin waters appear to be undersaturated with respect to hydroxy-apatite, but the Western Basin waters are near saturation (late fall) or supersaturated (late summer) with respect to hydroxy-apatite. In the late fall, the plankton concentrations are low in the eastern and central waters and are predominantly copepods and cladocerans. The Western Basin has a much higher plankton concentration and are predominantly blue-green algae. In the late summer, a similar pattern predominates, but the concentrations are much higher and plankton types are different. This suggests a relationship between plankton concentrations and the degree of saturation of hydroxy-apatite, or a close relationship of inorganic phosphate reactions and organic (biological) phosphate reactions.

Sondel, J. A. - See: K. K. S. Pillay, et al, No. 578.

671. Spangler, Miller B. 1969. The role of marine sciences in the multiple uses of the coastal zone of Lake Erie and Lake Superior. National Council on Mar. Resources and Eng. Dev. Washington, D. C. 387 p.

The purpose of this study was to derive important general principles concerning marine and related science and technology, and institutional developments which can contribute to effective social and economic utilization of the nation's coastal margin. The unique characteristics of the different coastal regions was also considered. Physical content is very general with a comparison between Lakes Erie and Superior and a mention of the drainage and water budget of the Great Lakes.

672. Sparling, D. R. 1967. Anomalous drainage pattern and crustal tilting in Ottawa County and vicinity, Ohio. Ohio J. Sci. 67:378-381.

Ottawa County, Ohio, is situated near the western end of Lake Erie on a flat glacial plain that is interrupted by bedrock highs only at the western and eastern ends of the county. The drainage pattern on the lake plain is anomalous in that the course of the major streams do not trend directly down the present slope normal to its strike. The entire region has apparently experienced tilting down to the north about an axis trending approximately east-west, producing an increased gradient to the north and resulting in considerable stream piracy. The tilting involved differential movement on the order of 2.8 feet per mile and is believed to be related to isostatic adjustment during and following the last stages of Pleistocene glaciation. (SE)

673. Sparling, D. R. 1970. The Bass Island Formation in

its type region. Ohio J. Sci. 70(1):1-33.

The Upper Silurian Bass Islands Formation has as its type region the Bass Islands, of Ottawa County, Ohio. Originally divided into the Greenfield, Tymochtee, Put-in-Bay, and Raisin River subunits, it has been classed as a series, group, and formation by different workers, and has been redefined, restricted, and even eliminated in the subsurface by others. The Bass Islands is here considered to be a formation, divisible, in the type region, into the four members listed above. The formation, which consists entirely of hypersaline facies, disconformably overlies the marine Lockport ("Guelph") Dolomite and is separated from the overlying Amherstburg Dolomite by the Tippecanoe-Kaskaskia unconformity.

The Greenfield Member consists of about 110 feet of dolomite lacking in argillaceous matter. It is equivalent to the $A_1$ unit of the Salina of subsurface terminology, and a widespread disconformity at its top corresponds to the "Newburg" zone of the subsurface. The Tymochtee Member comprises about 560 feet of dolomite, anhydrite, gypsum, and shale which correspond to the $A_2$ and other lettered subdivisions of the Salina.

Disconformably overlying the Tymochtee are about 80 feet of dolomite forming the Put-in-Bay and Raisin River Members, which can be differentiated (by degree of brecciation) only in the Lake Erie islands. Brecciated units characterize the Put-in-Bay, and breccias locally occupy channels cut into the upper part of the Tymochtee. The Raisin River is characterized by more limited brecciation and by pseudobreccias.

The paleogeographic setting and association with penesaline facies suggest that most carbonates of the Bass Islands formation have been dolomitized by seepage refluxion prior to final lithification.

674. Spencer, J. H. 1926. Late ice on Lake Erie. Mon. Wea. Rev. 54(5):215.

At the end of April, 1926, ice fields approximately 35 miles long occupied the eastern end of the Lake except for small patches of open water along the Canadian side. The almost unprecedented coldness of the spring was responsible for the lingering of the ice cover. The mean temperature for March was 4.3°F colder than normal and for April 7.8°F below normal. (BECPL)

675. Spencer, J. W. 1881. Discovery of the pre-glacial outlet of the basin of Lake Erie into Lake Ontario. Penn. Second Geol. Surv. Rept. Prog. (1879). Q4:357-406.

Paper deals with the ancient river that drained the Great Lakes Basin, running through the Erie Basin, in through the vicinity of the Grand River and the Dundas Valley, and on into the Ontario Basin. Established drainages are mentioned (pre-glacial) and the evidences of the drift and deposits supporting the paper are presented. (SM)

676. Spencer, J. W. 1882. Discovery of the preglacial outlet of the basin of Lake Erie into that of Lake Ontario; with notes on the origin of our lower Great Lakes. Am. Phil. Soc. Proc. 19:300-337.

The author connects the Dundas Valley, Grand River, and Lake Erie and traces through geologic evidences the preglacial outlet of Lake Erie into Lake Ontario. The second part deals with the origin of the lower Great Lakes. The outlet from Lake Huron and accumulation of drift are also discussed as well as a closing of glacial effects on the basins. Map included. (BU)

677. Spencer, J. W. 1882. A short study of the features of the region of the lower Great Lakes during the great river age; or notes on the origin of the Great Lakes of North America. Am. Assoc. Adv. Sci. Proc. (1881). 30:131-146.

Author discusses evidences for the three theories of formation of the lower basins. He supports that the basins were excavated by atmospheric and fluviatile erosion, with their outlets closed by the drift of the Ice Age, assisted by geologic uplifts. Outlets and river flows are discussed for the lower Great Lakes. (SM)

678. Spencer, J. W. 1887. Notes upon warping of the earth's crust in relation to the origin of the basins of the Great Lakes. Am. Nat. 21(2):168-171.

Evidence of unequal oscillation of continental areas producing warping of the crust of the earth in the valley of the Mississippi and in the basins of the Great Lakes. Low Anticlinal extends from the head of Lake Ontario westward between Lake Huron and Lake Erie. It is along the axis of this fold that the Dundas Valley--part of the ancient outlet of the

Erie Basin--is located. Local warpings can be seen and old shorelines about Lake Erie rise to the eastward and northward, showing that the basins across the old outlet have been recently raised. (BU)

679. Spencer, J. W. 1888. The St. Lawrence Basin and the Great Lakes. Am. Geologist. 2:346-348.

Review of five papers read at the meeting of the American Association for the Advancement of Science. Topics deal with the ancient drainage systems of the Great Lakes, the glacial lakes, and "Lake Erie, the youngest of the Great Lakes". (SM)

680. Spencer, J. W. 1889. Notes on the origin and history of the Great Lakes of North America. Am. Assoc. Adv. Sci. Proc. (1888). 37:197-199.

During a period of high continental elevation, the ancient St. Lawrence rose in Lake Michigan, flowed across Lake Huron and down Georgian Bay and a channel (now filled with drift), to Lake Ontario, receiving on its way the ancient drainage of the Erie Basin. In time, Lake Warren gave rise to Lake Erie and the beaches in the vicinity of Cleveland belong to the older lake. (SM)

681. Spencer, J. W. 1890. Origin of the basins of the Great Lakes of America. Quart. J. Geol. Soc. (London). 46:523-533. Also in: Am. Geologist. 7(2):86-97.

A report on the origin of the basins based on investigations of: (1) hydrography of modern lake basins and submerged channels upon the coast of America, (2) the deep wells bored into or thru drift deposits revealing buried channels, (3) elevation of the continent, (4) direction of glaciation in the lake region, and (5) former beaches recording uplifts and deformation of the earth's crust. The valleys of the lakes are the result of erosion of land surfaces by the ancient St. Lawrence River and its tributaries during a long period of continental elevation. (BECPL)

682. Spencer, J. W. 1891. High level shores in the region of the Great Lakes and their deformation. Am. J. Sci. 51(243):201-211.

Certain of the deserted shores about the Great Lakes have been confined to existing basins. However, above these beaches (Iroquois and Algonquin) there are others not confined to any of the existing basins but at elevations which required all of the Lakes to have been united into one sheet of water (Lake Warren). These beaches are described as to elevation and location. (BECPL)

683. Spencer, J. W. 1891. Origin of the basins of the Great Lakes of America. Am. Geologist. 7(2):86-97.

The formation of the basins were originated by the Laurentian Valley, which became closed and altered by the end of the Pleistocene. The ancient valleys and outlets (especially in the Erie Basin in the vicinity of Niagara) became filled with drift material and the terrestrial warpings allowed for the basins to form and fill to the present levels. (SM)

684. Spencer, J. W. 1891. Post-pleistocene subsidence versus glacial dams. Geol. Soc. Am. Bull. 2:465-476.

In this paper, Spencer gives evidence of regional emergence and considers the role of glacial dams in the formulation of the geology of the Great Lakes area. (BL)

685. Spencer, J. W. 1894. Deformation of the Lundy Beach and the birth of Lake Erie. Am. J. Sci. 47(279):207-212.

The crest of the Lundy Beach is from 100 to 200 feet wide and forms a conspicuous sand and gravel ridge which forms a split between the Erie and Ontario Basins. Warping or deformation of deserted shores due to unequal terrestrial movements was slight in the Warren beaches, somewhat greater between the Forest (on Canadian side) and Lundy beaches, but the greatest amount of deformation was after the dismemberment of Lake Lundy. Lake Lundy reached as far west as Point Pelee and the islands opposite. After Lundy, the waters were gradually drained to lower levels until they were held in the Erie Basin forming a "lakelet" by a Devonian limestone escarpment rising 20 to 30 feet above Erie's present outlet. There was no connection between the Huron Basin and the Erie until after the deformation following the Iroquois episode. Then the Huron waters overflowed the southern rim of its basin and emptied into the youthful Lake Erie. The outlet of the Erie Basin was also raised. (BECPL)

686. Spencer, J. W. 1894. A review of the history of the Great Lakes. Am. Geologist. 14(5):289-301.

A general review of the formation of the Great Lakes. Of interest is the section explaining that the whole upper Ohio River flowed to the Erie Basin as did the upper Allegheny and other streams prior to the Pleistocene. (BECPL)

687. Spencer, J. W. 1895. The geological survey of the Great Lakes. Am. Assoc. Adv. Sci. (1894). 43:237-243.

The following topics are discussed in relation to Lake Erie: character of the Lake Erie Basin covering buried channels and submerged valleys; glaciation; buried tributary (named Erigan); reversal of the drainage of the upper Ohio as well as Allegheny before the Pleistocene in the Erie Basin; deserted beaches (Lakes Warren, Algonquin, Lundy, and Iroquois); and drainage via the Mississippi River. (SM)

688. Spencer, J. W. 1896. How the Great Lakes were built. Pop. Sci. Mon. 49:157-172.

Popular rendition of the formation of the Great Lakes written for non-scientists. The now shallow Erie Basin was a portion of a plain across which the ancient Erigan River flowed in a valley 200 feet or more in depth. One of the buried and submerged tributaries is at Cleveland. From the Erie Basin, the Erigan River crossed by a channel about 40 miles west of the Niagara River, which did not then exist, and passed down the Dundas Valley into the head of the Ontario Basin, and farther eastward joined the Laurentian River.

The Allegheny flowed to the Erie Basin as did the upper Ohio. These and other streams, now reversed, were tributaries of the Erigan River. Their valleys became filled with drift which turned the waters of the rivers to the south. (BECPL)

689. Spencer, J. W. 1907. The Falls of Niagara. Canada Geol. Surv. Rept. (1905). 405 p.

The fluctuations of Lake Erie and their causes are discussed in relation to Niagara Falls. Also included is a great deal of information on warping of the crust in the area, glaciation, discharge, and a concise history of the eastern end of the Lake. (SM)

690. Spencer, J. W. 1910. Interruption in the flow of the

falls of Niagara in February, 1909. Geol. Soc. Am. Bull. 21:447-448.

In describing the cessation of flow over Niagara Falls by ice blockage, an account of Lake Erie lake levels is cited. (BL)

691. Spencer, J. W. 1913. Relationship of the Great Lakes Basins to the Niagara limestone. Geol. Soc. Am. Bull. 24:229-232.

In discussing the Niagara limestone belt through the Great Lakes area, reference is made to where it crosses below the Erie level. (BL)

692. Spencer, J. W. 1913. Post-glacial changes of level versus recent stability of the lake region of America (abstract). British Assoc. Adv. Sci. Proc. 82nd Meeting (1912). pp. 476-477.

Between the head of Lake Ontario and a point near its outlet (Watertown, N. Y.) there is a rise of land of 367 feet. If the uplift is taken from the head of Lake Erie to the same point it amounts to 507 feet. The focus of maximum uplift is situated near latitude 49°N and longitude 76°W. Using the mean for every five years of the record of lake levels, between 1855-1859 and 1906-1910, there have been no movements of the earth's crust over the Great Lakes drainage area, a theory in opposition to Gilbert's ideas. (BECPL)

Stansbery, D. H. - See: J. L. Verber, No. 866.

693. Stauffer, Clinton R. 1909. The Middle Devonian of Ohio. Ohio Geol. Surv. (4th Ser.). Bull. 10. 204 p.

Investigations of the Devonian formations of Ohio, including Devonian geology of Sandusky, Johnson Island, Marblehead, and Kelleys Island. Index fossils and listings of the lithologies of the Devonian stratigraphy are included. (SM)

694. Stauffer, Clinton R. 1916. Relative age of the Detroit River series. Geol. Soc. Am. Bull. 27:72-78.

This paper is a detailed description of the strata in terms of formation, paleontology, and age. (BL)

695. Stevenson, Anne L. and W. S. Benninghoff. 1969.

Late post-glacial rise of Lake Erie and changes in vegetation on the Maumee Lake Plain. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 347-350.

Natural vegetation of the Maumee Lake Plain in Northwestern Ohio is composed of mosaics of dry and wet prairie patches, oak openings or savannas, oak-hickory forest, mesophytic hardwood forest, and swamp hardwood forest. The post-glacial sequence and times of arrival of these vegetation elements are in question, but there is evidence from vegetation and soils that swamp and marsh communities have been expanding in recent centuries.

A 2 m long core with a buried forest layer at its base was recovered from Terwilliger's Pond at Put-in-Bay Harbor, South Bass Island, in Western Lake Erie. Coniferous wood from the forest bed yielded a radiocarbon date of 2500 $\pm$ 270 years BP. The 5 cm thick layer recovered from the forest soil contains dicotyledonous wood, tissue fragments from broad leaves, and abundant fungus mycelia in a matrix of subaerially decayed black amorphous muck. Mesic site conditions with mull humus are indicated. The forest bed is overlain successively by fibrous (marsh?) peat, pond ooze, and allochthonous detrital peat. If the pond basin has not subsided due to solution of gypsum layers in the underlying bedrock, the stratigraphy and sequence of fossil pollen argues for a rise in lake level of at least 3 m since 550 BC.

It is probable that this dated evidence for relatively recent rise in lake level is causally linked with extension of wet soils and hydric plant communities on portions of the Maumee Lake Plain through the raising of stream base levels.

696. Stewart, K. M. 1973. Winter conditions in Lake Erie with reference to ice and thermal structure and comparison to Lakes Winnebago (Wisconsin) and Mille Lacs (Minnesota). Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 845-857.

A flotation-equipped helicopter was utilized to obtain data on ice thickness, extent of ice coverage and thermal conditions at 50 to 83 stations in Lake Erie from February to April 1972. Without considering pressure ridges and areas of ice rafting, the average (1972) maximum ice thickness in the Western, Central and Eastern Basins was about 25, 18 and 26 cm, respectively.

In contrast to findings from smaller ice-covered lakes, Lake Erie has little to no vertical stratification during winter. In addition, the water temperatures are unusually cold. For example, in early March during one of the sampling periods, most of the water throughout the Lake was less than 0.1°C. Thus Lake Erie tends to behave not as a dimictic lake, but rather as an extremely well-mixed monomictic lake, even though it is covered extensively with ice. Part of the reason for the cold water and lack of stratification is that the ice sheet acts as a giant movable "sieve" with irregular openings and with some portions sealed completely.

By comparison, a well-developed vertical stratification and parabolically shaped isotherms were found beneath the total ice cover of Lakes Winnebago (Wisconsin) and Mille Lacs (Minnesota). The 1972 winter transects on Lake Erie suggest no obvious problems of waste heat disposal.

697. Stith, D. A. 1973. Mercury concentrations in sediments of the Lake Erie Basin, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Info. Circ. 40 14 p.

In 1970, sediment and water samples of a general survey nature were taken from six different Ohio tributary/harbor systems of Lake Erie. Detailed sampling of the Black River Basin was also carried out. Analyses for mercury contamination were run on these sediment samples soon after collection, and the results are presented. Definite mercury contamination was detected in the Ashtabula, Black, and Grand Rivers; minor to relatively insignificant levels of mercury were noted in the Cuyahoga and Maumee Rivers, Sandusky Bay, and Lake Erie. The mercury is concentrated in stream sediments by the leaching action of ground water on soil and the removal of mercury from the atmosphere by rain. (SM)

St. Jacques, D. A. - See: N. A. Rukavina, No. 634.

698. St. Jacques, D. A. 1974. The nearshore sediment survey techniques and applications. Canada Centre for Inland Waters. Burlington, Ont. Canadian Hydrographic Service. 13th Ann. Canadian Hydrographic Conf., March 5th-7th, 1974. pp. 101-110.

The nearshore sediment survey is concerned with mapping the surficial geology and bathymetry of the area between the shoreline and the 20 meter depth contour in the Great Lakes. Acoustic profiles, bottom grab samples, and underwater television and dive observations are used to map the distribution of nearshore bottom types. The data collected by the survey is used as background information by a variety of economic, scientific and engineering projects. The delineation of the modern depositional areas can also assist in the planning of future hydrographic surveys. (CCIW)

699. St. Jacques, D. A. and N. A. Rukavina. 1973. Lake Erie nearshore sediments - Mohawk Point to Port Burwell, Ontario. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 454-457.

Echo soundings and bottom samples were used to map the bottom materials of the Lake Erie nearshore zone (0-20 m) from Mohawk Point to Port Burwell, Ontario. The following bottom types were identified and delineated: (1) bedrock (10%), (2) glacial drift (50%), and (3) unconsolidated sediment (40%). Bedrock is exposed inshore between Mohawk Point and Port Dover. Glacial material occupies the offshore portion of the same area and a broad offshore shelf southwest of Long Point. The unconsolidated sediments were found along the crests of the Port Maitland and Long Point-Erie moraines, in Long Point Bay, inshore from Long Point to Port Burwell and offshore south of Port Burwell.

The shoreline adjacent to the study area is comprised of: (1) bedrock between Port Maitland and Peacock Point, (2) beach, dunes and marsh along Turkey and Long Points, and (3) clay and sand-clay bluffs in Mohawk Bay, between Peacock and Turkey Points and from the base of Long Point to Port Burwell. The erosion of bluffs within the study area provides approximately 1,500,000 cu m of sediment to the nearshore zone annually.

The prevailing southwesterly winds generate eastward littoral currents that transport sediment derived mainly from shoreline erosion from west to east across the study area. Accumulation occurs at Long Point, which is prograding eastward at a rate of 7 m/yr, and in Long Point Bay. A reversal in the eastward drift pattern occurs in Long Point Bay and movement is westward along the southern and northwestern shorelines. The easterly sediment movement pattern resumes in the vicinity of Port Dover and applies throughout the remainder of the study area.

700. Stout, W. 1940. Marl, tufa rock, travertine, and bog

ore in Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Bull. 41. 56 p.

In Ohio, marl deposits are confined almost entirely to the lake and swamp areas of the Wisconsin drift. They are usually associated with peat, commonly occurring below such a mantle of organic material. The swamp may contain marl with little peat or peat with no marl. Tufa is a commonly associated material with the marl where the calcareous matter is largely of spring origin. (SM)

701. Stout, W. 1941. Dolomites and limestones of Western Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Bull. 42. 468 p.

This report gives specific data on the dolomites and limestones of Western Ohio as to their geology and composition. A regional picture of the geology and a detailed study of the chemical composition and the mineral components in the carbonate rocks is given. (SM)

702. Stout, W., Karl Ver Steeg and G. F. Lamb. 1943. Geology of water in Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Bull. 44. 694 p.

In Ohio, a wide variation exists both locally and regionally as to the quantity, quality, and availability of the underground waters. Such deviation and abnormalities are due to many causes, some of which are purely geological in nature in that they are dependent upon the manner of deposition, and upon changes wrought during subsequent history. Ground waters of Ohio may be considered under two general headings: (1) waters from the glacial deposits and outwash formations and (2) waters in the consolidated rocks, such as sandstones, conglomerates, shales, limestones, etc. (SM)

703. Strazisar, A. and J. Prahl. 1973. The effects of bottom friction on river entrance flow with cross flow. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 615-625.

Experimental results are presented for the trajectory of a rectangular non-buoyant jet entering perpendicular to a cross-flow of constant depth equal to that of the jet. A comparison with theoretical predictions based on a momentum integral approach including bottom friction is made. The experimental investigation was carried out on a 1.73 x 6.1 m water table, using constant temperature hot-film anemometry for velocity measurements and photographic techniques with dye injection for streamline traces. Results indicate that the penetration of the jet depends on the ratio of the initial jet velocity to crossflow velocity, the initial jet Reynolds number, the jet width-to-depth ratio, $\gamma$ , and the channel width-to-jet width ratio, $w/b_o$. Large values of $\gamma$ increase the effect of bottom friction on the jet, thus decreasing the jet penetration. Predictions, based on analysis and laboratory experiments, for the Cuyahoga River entering Lake Erie are compared to field observations of the Cuyahoga River.

704. Stroop, L. J. 1871. Did a glacier flow from Lake Huron into Lake Erie? Am. Nat. 4(10):623-625.

Critique on J. S. Newberry's article on the surface geology of the basins of the Great Lakes. According to data in Newberry's paper, the glacial flow would have gone from a lower elevation to a higher elevation in the excavations of the basins, which is impossible. The author adds further explanations as to the origin and evolution of the Erie Basin and the subsidences and elevations that have since occurred. (BU)

705. Sutherland, J. C. 1970. Silicate mineral stability and mineral equilibria in the Great Lakes. Environmental Sci. and Technology. 4:826-833.

Equilibrium concepts involving silicate minerals and water are applied to chemical data from the North Channel and Lakes Erie, Ontario, and Huron, for understanding of chemical self-regulation in the Great Lakes. Equilibria involving silicates and water are inferred from aqueous chemical data. Concentrations of dissolved silica attain minimum values of $10^{-4.8}$ mole/liter in surface waters of the remote lakes through dissolution of kaolinite,

$$\underset{\text{kaolinite}}{Al_2Si_2O_5(OH)_4} + 5H_2O \rightarrow \underset{\text{gibbsite}}{Al_2(OH)_6} + \underset{\text{aq. silica}}{2H_4SiO_4}$$

In deeper waters, metastable equilibria, Ca montmorillonite $\rightleftharpoons$ gibbsite and muscovite $\rightleftharpoons$ gibbsite may impose upper limits upon concentrations of $SiO_2$(aq.). Silica concentrations in the enclosed waters of sediments from North Channel reach metastable equilibrium with amorphous silica at values of $SiO_2(aq.) = 10^{-2.8}$ mole/liter; values of less than $10^{-3}$ mole/liter are imposed in sediments from the other lakes through

Ca montmorillonite ⇌ kaolinite. The major chemical character of the Great Lakes is inherited from the carbonate-silicate mineralogy of bedrock, soils, and glacial drift in their drainage.

Sweeney, Robert A. - See: J. Hassan, No. 310.

706. Sweeney, Robert A. 1973. Impact of detergent phosphate reductions on water quality. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 967-976.

Stream quality was measured at 164 stations on 28 major streams during June through August 1970-1972 in Erie County, New York. Parameters for the water measured included phosphates (ortho and total), chlorides, nitrates, and BOD and for sediment included total phosphates, solids, oils and greases, nitrogen (ammonium, organic and nitrates), and chlorine demand. Decreases in ortho and total phosphates of the streams were proportionally higher than the phosphate reductions noted in the sewage influents. This was attributed to the maintenance of aerobic conditions in the tributaries, under which phosphates were released more slowly from the sediments than under anaerobic conditions which prevailed during the summer prior to the detergent phosphate limitations. There was no major difference in rainfall or discharge between the study periods.

Sykes, R. - See: R. Falconer, No. 232.

707. Tarr, R. S. 1898. Physical geography of New York State. Am. Geog. Soc. J. 30(5):375-385.

The section on the Upper Allegheny discusses the reversal of drainage of the Allegheny and points out the nearness of the Erie-Allegheny divide to Lake Erie. Pre- and post-glacial drainage of New York and the Ohio section of the Erie shore are discussed. Numerous maps show present tributaries and drift-filled valleys along the lake shore. (SM)

708. Taublieb, Edward J. 1969. Recent sediments in Eastern Lake Erie. M. A. Thesis. S. U. N. Y. at Buffalo. Buffalo, N. Y. 33 p.

Bottom samples were collected along a transection between Point Abino, Ontario, and Sturgeon Point, New York. Bottom samples were also collected off the mouth of Eighteen Mile Creek and off Windmill Point, Ontario. They were examined by textural, mineralogical, and chemical methods to determine the nature and distribution of sediments. The Point Abino samples are finer, better sorted, and contain less quartz, sand, and opaque minerals than those collected at Sturgeon Point. Bedrock type and structure greatly influence the nature of the sediment. Ultimate sources of sediment was found to be the Canadian Shield and the Adirondack Mountains. Variations in heavy mineral percentages of relatively unstable heavy minerals may be useful in evaluating sedimentary processes. (BL)

709. Taylor, David C. 1960. Soil survey of Erie County, Pennsylvania. U. S. Dept. Agric. Soil Cons. Service. Ser. 1957. No. 9. 119 p.

Soil survey of the lake plain and uplands of Erie County, Pennsylvania. Description of the soils found in Erie County and formation and classification is presented as the bulk of the report. The report includes soil maps, facts on the local geology, erosion, climate, and water supply. (SE)

Taylor, Frank B. - See: Frank Leverett, No. 453.

710. Taylor, Frank B. 1895. Changes of level in the region of the Great Lakes in recent geological time. Am. J. Sci. 49(289):69-71.

The Erie beaches are undoubtedly the shores of an ice-dammed lake of the glacial recession; it was the largest lake produced in this way. The Niagara River was replaced by a much smaller stream, the "Erigan River", which drained only the Erie Basin and made the narrower, more shallow gorge of the Whirlpool Rapids. (BECPL)

711. Taylor, Frank B. 1895. Niagara and the Great Lakes. Am. J. Sci. 49(292):249-270.

The map which accompanies this paper shows the probable distribution of land at the maximum of marine submergence. This paper was written to present a view intermediate to those presented by Spencer (1894, Am. Geol. 14(5):289-301) and Upham (1895, Am. J. Sci. 49(289):1-18). Ice dams have played an important part, but not to the exclusion of marine submergence even at high levels. Marine invasion is not an explanation for some of the most important areas of submergence. (BECPL)

712. Taylor, Frank B. 1895. The second Lake Algonquin.

Am. Geologist. 15(2):100-120, 15(3):162-179.

The plane of Nipissing Beach was extended to Buffalo, making Buffalo the hinge upon which all subsequent eastward elements of deformation turn. The eastward elevation amounts to approximately 35 ft at Buffalo. Buffalo also has become the hinge of the northward component of deformation. A map shows the entire Great Lakes Region with isobases of deformation connecting places of equal deformation. All the rivers of Lake Erie are without deltas and have open estuaries. The recent drowning of its shores due to the eastward uplift is responsible for these harbors. (BECPL)

713. Taylor, Frank B. 1898. Some features of the recent geology around Detroit. Am. Assoc. Adv. Sci. (1897). 46:201-202.

This article deals with the glacial history of the Detroit River and the influence it had in carrying the drainages from the Upper Great Lakes. At one point the beds were abandoned for a considerable period of time and then returned to again. Drowned tributaries and rejuvenation by uplift are also discussed. (SM)

714. Taylor, Frank B. 1905. Relation of Lake Whittlesey to the Arkona beaches. Mich. Acad. Sci. Ann. Rept. 7:29-36.

Studies on the glacial drift and lake deposits of Southeastern Michigan have shown that the history of the glacial lakes has been more complex than supposed. Previously it had been believed that all the principal changes of the glacial waters in the Erie Basin were changes to lower levels, produced by the uncovering of a new and lower point of discharge by the retreating ice sheet. In some instances the order of change was reversed and beaches which had been made at lower levels were submerged as the lake level was raised and the ice front advanced. (SM)

715. Taylor, Frank B. 1909. Field work on the Pleistocene deposits of Southwestern Ontario. Canada Dept. Mines. Geol. Surv. Branch. Summary Rept. pp. 102-111 (1908); 164-167 (1909).

Brief discussion of moraine deposits on the Lake Erie north shore. (SM)

716. Taylor, Frank B. 1913. The glacial and postglacial

lakes of the Great Lakes region. Smithsonian Inst. Ann. Rept. 1912. pp. 291-327.

Historical account of the formation of the Great Lakes from the glacial lakes, oscillations of ice fronts, postglacial lakes, and the formation and stability of Lake Erie are discussed. (SE)

717. Taylor, Frank B. 1927. Evidence of recurrent depression and resilience in the region of the Great Lakes. Mich. Acad. Sci., Arts and Letters. Papers (1927). 7:135-143.

Depression and resilience have occurred in connection with at least the last three of the Pleistocene ice-sheets and probably with the first one also. For part of the time, the full drainage of the upper lakes was each time restored to the Niagara district after having been temporarily taken away. The gorge of the Wisconsin Niagara (present one), gorge of the Illinoian Niagara (buried St. David's gorge) and the gorge of the Kansan Niagara (Spencer's Erigan Canyon) are discussed as to the outlets going through the Erie Basin from the upper lakes. With each ice-sheet, a new course and a new outlet was produced. (SM)

718. Taylor, Frank B. 1927. The present and recent rate of land-tilting in the region of the Great Lakes. Mich. Acad. Sci., Arts and Letters. Papers (1927). 7:145-157.

Tracing the hinge lines of tilting, the historic level change in regard to Lake Erie are evidenced by the erosional and depositional characteristics. Rates for land uplift and the implications of Lake Erie's level of water changes are presented. (SM)

719. Taylor, Frank B. 1929. The status of Lake Erie in present and recent land-tilting. Mich. Acad. Sci., Arts and Letters. Papers (1928). 10:251-260.

A recapitulation of present work done on the uplift, hinge-lines, and lake levels (historic) of Gilbert and Moore. The author goes on with a study that the increased level in the Western Basin has had its influence on the erosional processes and the drainage entering Lake Erie. Outflow from the Lake Erie Basin is discussed historically. (SM)

720. Taylor, Frank B. and E. M. Kindle. 1913. Description

of the Niagara quadrangle, New York. U. S. Geol. Surv. Washington, D. C. Geol. Atlas of the United States. Niagara Folio No. 190. 25 p.

Though the bulk of the information deals with an area outside the study area, Lake Erie is cited numerous times in the geologic setting and history of the area, making this a good, brief overview of the Lake. (SM)

Thomas, C. C., Jr. - See: K. K. S. Pillay, et al, No. 578.

721. Thomas, M. K. 1964. A survey of Great Lakes snowfall. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub. 11:294-310.

This is a survey citing past observations and publications on snowfall of the Great Lakes. In addition, a short analysis is presented on the causes of snowfall in the Great Lakes Region.

Thomas, N. A. - See: A. M. Lucas, No. 462.

722. Thomas, R. L. 1969. A note on the relationship of grain size, clay content, quartz and organic carbon in some Lake Erie and Lake Ontario sediments. J. Sed. Petrol. 39:803-809.

An examination of the geochemistry of fine-grained sediments in relation to size frequency distribution was carried out on sediment samples from Lakes Erie and Ontario. This study demonstrated a direct relationship between the $<2$ micron grain size and the theoretical clay content computed from the organic carbon, quartz and carbonate content. A sympathetic relationship was observed between clay content and organic carbon, and also between median grain size and quartz content. The former relationship is believed to be the result of absorption from solution; the latter is brought about by natural sedimentation from suspension.

Thomson, D. S. - See: P. D. Snow, No. 670.

Tidd, Wilbur M. - See: Stillman Wright, No. 922.

723. Todd, J. H. 1900. Some observations of the preglacial drainage of Wayne and adjacent counties. In: The Preglacial Drainage of Ohio. Ohio State Acad. Sci. Spec. Papers No. 3. pp. 46-67.

Topography and stratigraphy are discussed in relation to the drainage features of preglacial waters. An account of the drainage system into the Lake Erie Basin as evidenced by till deposits and drilled wells is given for the vicinity. (SM)

724. Tomikel, J. C. and V. C. Shepps. 1967. The geography and geology of Erie County, Pennsylvania. Penn. Geol. Soc. Harrisburg, Penn. Info. Circ. 56. 64 p.

A discussion of Erie County, Pennsylvania, including geology, surface water, and a short discussion of Lake Erie and the evolution of its drainage system. (SM)

Traversy, W. J. - See: V. K. Chawla, No. 140.

725. Troost, G. 1822. Description of some crystals of sulphate of strontian from Lake Erie. Philadelphia J. Acad. Nat. Sci. 2(2):300-302.

Mineralogical description is given of a crystal collected on the southwestern part of Moss Island, giving the lattice structure, color, form, and light properties. (SM)

Tung, C. - See: R. T. Cheng, No. 141.

Turk, J. M. - See: E. J. Skoch, No. 665.

Tutt, D. B. - See: R. M. Quigley, No. 602.

726. Ulteig, J. R. 1964. Upper Niagaran and Cayugan stratigraphy of Northeastern Ohio and adjacent areas. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 51. 48 p.

This paper presents a regional sub-surface stratigraphic study of the upper Niagaran and Cayugan sedimentary rocks of Northeastern Ohio and adjacent areas. Data derived from sample descriptions or geophysical logs of 118 wells are employed to construct eight isopach maps, a structure map, and seven cross-sections that illustrate the stratigraphic relationships of the various lithogic units present in the subsurface. (SM)

727. U. S. Army Corps of Engineers. 1874. Bridging the channel between Lakes Huron and Erie. Board of Engineers. 43rd Congress, 1st Session. House Document No. 64. pp. 3-4.

The report itself is concerned with the practicability of bridging, consistently with the interests of navigation, the channel between Lake Huron and Lake Erie at such points as may be needful for the passage of railroad trains across the channel. Included are a description of the Detroit River and data pertinent to the river concerning widths of the channel and the river, depths, bank heights, nature of the bottom, maximum distance to the bedrock as well as the average distance, and current flow rates. (CE)

728. U. S. Army Corps of Engineers. 1896. Resurvey of the port of Fairport, Ohio. Board of Engineers for Rivers and Harbors. 54th Congress, 1st Session. House Document No. 347. 4 p.

Fairport Harbor, Ohio, is a part of the Grand River mouth, where it flows into Lake Erie. Construction of breakwaters and dredging are recommended in this report. Lake levels, bottom geology, and shoreline processes such as erosion are discussed. (CE)

729. U. S. Army Corps of Engineers. 1899. Regulation of the level of Lake Erie. Board of Engineers on Deep Waterways. 56th Congress, 1st Session. House Document No. 200. 26 p.

Proposition of regulation of Lake Erie water levels by regulating works at the foot of Lake Erie and the head of the Niagara River is presented. Effects on all associated water bodies are presented, all aspects applicable to the water budget are considered, wind effect and design of regulating structure are likewise discussed. Data on elevation, inflow, and discharge from 1865 are given. Included with the report are six sheets: (1) Lake Ontario water levels and Niagara River discharge from 1865 to 1898; (2) Slope of the Detroit and St. Clair Rivers, for their lengths; (3) Curves showing monthly water levels of Lakes Huron, St. Clair, and Erie and Slopes of Detroit and St. Clair Rivers from 1873 to 1898; (4) Water soundings at site of proposed regulation works at the foot of Lake Erie and the head of the Niagara River; (5) Diagram of Lake Erie regulating works, masonry and superstructure; and (6) Diagram of sluice gate and counterweight. (See: International Waterways Commission 1910. "Regulation of Lake Erie".) (CE)

730. U. S. Army Corps of Engineers. 1900. Examination and plan and estimate of cost of improving Cleveland Harbor, Ohio. Board of Engineers for Rivers and

Harbors. 56th Congress, 2nd Session. House Document No. 118. 17 p.

Included in the report are two maps: one indicating the Cleveland lakefront water depths from Edgewater Park to Gordon Park to a distance of up to 3/4 mile out, the second giving specification as to protection of Cleveland Harbor entrance. (CE)

731. U. S. Army Corps of Engineers. 1910. Preliminary examination and survey of Ashtabula Harbor, Ohio. Board of Engineers for Rivers and Harbors. 61st Congress, 2nd Session. House Document No. 654. 8 p.

Some of the proposed improvements to Ashtabula Harbor include: extend one breakwater, remove another and rebuild it, and enlarge the outer harbor. (CE)

732. U. S. Army Corps of Engineers. 1910. Preliminary examination and survey of Dunkirk Harbor, New York. Board of Engineers for Rivers and Harbors. 61st Congress, 2nd Session. House Document No. 720. 11 p.

The Dunkirk Harbor, New York, is described as to its bottom topography and materials prior to recommendations that the channel be excavated to 18 ft mean lake level. (CE)

733. U. S. Army Corps of Engineers. 1913. Preliminary examination of Huron Harbor, Ohio. Board of Engineers for Rivers and Harbors. 63rd Congress, 1st Session. House Document No. 5. 14 p.

It is recommended that certain improvements be made to the harbor and lower section of the Huron River, Ohio. Information included in this report that must be taken into consideration includes: fluctuations in lake levels, wave action, erosion due to wind, and shore processes. (CE)

734. U. S. Army Corps of Engineers. 1914. Cuyahoga River, Ohio. Board of Engineers for Rivers and Harbors. 63rd Congress, 2nd Session. House Document No. 707. 96 p.

This report deals with proposals for the elimination of bends in the Cuyahoga River. The recommendation proved to be partly unfavorable. Included in the report is a description of the river, a table listing the borings of the river describing the sediments at each of the sites (pp. 30-31), a discussion on the relation between contemplated cut-off channels along the Cuyahoga River, flood waters, discharge information, and stage level during flood conditions. (CE)

735. U. S. Army Corps of Engineers. 1914. Preliminary examination and survey of Sandusky Harbor, Ohio. Board of Engineers for Rivers and Harbors. 63rd Congress, 2nd Session. House Document No. 871. 18 p.

Due to the increased demand in cargo traffic, proposals are made toward improving the conditions at the harbor of Sandusky. Due to oscillations in lake levels due to wind, the channel, it is proposed, should be dredged to a depth of 23 feet below mean lake level from its present depth of 21 feet. Other improvements include extension of jetty, construction of a pier with fog lights, and cutting an opening through the east jetty for the use of small craft. Survey data maps showing soundings and profiles are included. (CE)

736. U. S. Army Corps of Engineers. 1916. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 64th Congress, 1st Session. House Document No. 980. 9 p.

A preliminary examination and survey of Lorain Harbor, Ohio, with a view to preventing erosion of banks, if any, caused by the extension of the government breakwater on either side of the Harbor. It proved that the review was favorable to extending the west breakwater in the later reports. The map included in the report shows the existing depths in the harbor and in the vicinity of the proposed breakwater and the position of the shoreline in 1902 and in 1915. The extent of erosion between the end of the west breakwater and the shore and deposits farther eastward are shown by several sections. A discussion on the erosional forces and sedimentation is presented. (CE)

737. U. S. Army Corps of Engineers. 1916. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 64th Congress, 1st Session. House Document No. 985. 11 p.

The report proposes dredging certain parts of the harbor to project depths. The map accompanying the report shows by comparative depths that considerable shoaling has taken place in the western portion of the outer harbor. This map, together with observations of wave action and currents at Lorain, also indicate very plainly that the bulk of the material deposited in the West Basin comes in through the gap between the west breakwater and the shore, and that most of it would therefore be shut off if this gap were closed. Further discussion is given as to the erosional processes and changes that have occurred in the area. (CE)

738. U. S. Army Corps of Engineers. 1916. Reexamination of Sandusky Harbor, Ohio. Board of Engineers for Rivers and Harbors. 64th Congress, 1st Session. House Document No. 982. 19 p.

Progress report on the improvements recommended in House Document No. 871, 63rd Congress, 2nd Session. Modifications of the project are outlined and reasons for the modifications are given. As a result, channel depth specifications are decreased to 21 feet. (CE)

739. U. S. Army Corps of Engineers. 1918. Black River at Lorain, Ohio. Board of Engineers for Rivers and Harbors. 65th Congress, 2nd Session. House Document No. 1200. 11 p.

In its original condition when the government first undertook the improvement of the mouth of the Black River in 1828, a natural channel about 100 feet wide and 8 to 12 feet deep extended from the mouth upstream for about 3 miles. The mouth of the river was obstructed by a sand bar, over which the depth was usually 3 feet. Fluctuations of water level tend to be 3 feet above the low-water datum and extreme fluctuations produced by winds are from 5 feet above and 2 feet below that plane. Included is a map with water depths given from the mouth to the Turning Basin. (CE)

740. U. S. Army Corps of Engineers. 1919. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 66th Congress, 1st Session. House Document No. 254. 12 p.

A report on the preliminary examination of Lorain Harbor, Ohio, with a view to the extension of the east breakwater and enlarging and deepening the harbor area. The extension of the east breakwater is apparently desired to prevent erosion of the shoreline and consequent shoaling of the harbor area. Discussion on the erosion activity in the area related to local storms, currents and breakwater construction as well as the sedimentation occurring in the area are presented. One map is included giving depths in Lorain Harbor and in the Black River. (CE)

741. U. S. Army Corps of Engineers. 1926. Preliminary examination and survey of Sandusky Harbor, Ohio. Board of Engineers for Rivers and Harbors. 69th Congress, 2nd Session. House Document No. 584. 18 p.

The previous report on Sandusky Harbor, No. 735, is amended to allow for dredging of the outer channel to a depth of 22 feet from 21 feet to meet the demands of commerce. Vessels could not load to capacity as the bottom of the channel is irregular and rocky. (CE)

742. U. S. Army Corps of Engineers. 1926. Preliminary examination and survey of the outer harbor of Fairport Harbor, Ohio. Board of Engineers for Rivers and Harbors. 69th Congress, 2nd Session. House Document No. 592. 20 p.

Next in the series following No. 728. The original condition of the Grand River is included in this report as are considerations for the construction of a breakwater and enlargement of the harbor and dredging to deepen the harbor channel. (CE)

743. U. S. Army Corps of Engineers. 1928. Preliminary examination and survey of the Great Lakes - connecting waters, principal harbors, and river channels. Special Board. 70th Congress, 1st Session. House Document No. 253. 92 p.

Discussed in this report are certain navigational channels in the northwestern section of Lake Erie: Bar Point Channel at the head of Lake Erie, the Amherstburg Channel in the Detroit River, and the Livingston Channel which leads from the Detroit River to the deeper part of the Western Basin. The first two channels are for upbound lake traffic and the last is for downward traffic. The merits of deepening all channels in the Great Lakes system to either a uniform depth of 22 or 24 feet are argued and it is recommended that the 24 foot uniform depth would be more advantageous. (CE)

744. U. S. Army Corps of Engineers. 1932. Cleveland Harbor, Ohio, including channel in Cuyahoga and Old Rivers. Board of Engineers for Rivers and Harbors.

72nd Congress, 2nd Session. House Document No. 477. 39 p.

The report recommends deepening to 25 feet the entrance channel through the outer harbor and between the piers up to the New York Central swing bridge and a part of the outer harbor and the construction of breakwaters. Soundings were taken of Cleveland Harbor and the Cuyahoga and are marked on the map accompanying the report. (CE)

745. U. S. Army Corps of Engineers. 1932. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 72nd Congress, 2nd Session. House Document No. 469. 31 p.

Recommendation for deepening of the harbor area and a widening of the first two bends in the Black River above the New York, Chicago & St. Louis Railroad bridge. The results of the field surveys on soundings and probings are included in the accompanying map of Lorain Harbor and the Black River. (CE)

746. U. S. Army Corps of Engineers. 1932. Preliminary examination and survey of Ashtabula Harbor, Ohio. Board of Engineers for Rivers and Harbors. 73rd Congress, 1st Session. House Document No. 43. 34 p.

Follow-up to No. 731. Includes recommendations to dredge the harbor to 25 feet, extend the breakwater, and form a new harbor entrance. A discussion of fluctuations of lake levels is included. (CE)

747. U. S. Army Corps of Engineers. 1932. Preliminary examination and survey of Fairport Harbor, Ohio. Board of Engineers for Rivers and Harbors. 72nd Congress, 2nd Session. House Document No. 472. 32 p.

Follow-up to No. 742. The outer harbor, it is proposed, will be dredged to 25 feet, the channel will be widened, and the breakwater and protective works will be extended. Includes a discussion of lake effects on the harbor, geology, and materials of the bottom. (CE)

748. U. S. Army Corps of Engineers. 1932. Preliminary examination and survey of Huron Harbor, Ohio. Board of Engineers for Rivers and Harbors.

72nd Congress, 2nd Session. House Document No. 478. 34 p.

Proposed plans for the improvement of the Huron Harbor, Ohio, include: deepening the harbor, widening and deepening the turning basin, and widening the mouth of the river. (CE)

749. U. S. Army Corps of Engineers. 1933. Conneaut Harbor, Ohio. Board of Engineers for Rivers and Harbors. 73rd Congress, 1st Session. House Document No. 48. 34 p.

Proposed are removal of a portion of the west breakwater, deepening of the outer harbor to 24 feet in soft material and 25 feet in hard material, deepening of the remaining triangular area of the outer harbor, and further modification of other protective structures. The location of structures and the depths of navigation waters in the vicinity are shown on the accompanying map dated 1931. Water fluctuations in the vicinity of the harbor are briefly discussed, and the cross currents due to storms are briefly mentioned. (CE)

750. U. S. Army Corps of Engineers. 1933. Preliminary examination and survey of Erie Harbor, Pa. Board of Engineers for Rivers and Harbors. 73rd Congress, 1st Session. House Document No. 52. 44 p.

Examination of the Erie, Pa., Harbor indicates that there is no immediate danger of a breach at Presque Isle Peninsula. Continuous erosion along the "neck" of the peninsula constitutes a threat to the future integrity of the harbor and to the State Park on the peninsula. Additional construction of protective works is recommended as is improvement of the harbor. (CE)

751. U. S. Army Corps of Engineers. 1933. Review of reports on Sandusky Harbor, Ohio. Board of Engineers for Rivers and Harbors. 73rd Congress, 1st Session. House Document No. 2. 25 p.

The Board of Engineers for Rivers and Harbors reviews the previous report on Sandusky Harbor, Ohio, No. 741. It found no need for the construction of a new harbor, for deepening the present channels, or for extending the channel west of the present terminals. However, the small, rock-confined turning channel is to be enlarged and improved. (CE)

752. U. S. Army Corps of Engineers. 1934. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 73rd Congress, 2nd Session. Senate Committee Print. 16 p.

This report is submitted for review of the report on Lorain Harbor, Ohio, House Document No. 469. Further dredging is proposed and an updated map giving soundings of the harbor and the Black River is included. (CE)

753. U. S. Army Corps of Engineers. 1935. Fairport Harbor, Ohio. Board of Engineers for Rivers and Harbors. 74th Congress, 2nd Session. House Document No. 79. 31 p.

Proposals to deepen the river channel to 24 feet, the outer harbor to 25 feet, widen the channel entrance, construct bulkheads, and enlarge and deepen the basin. (See: U. S. Army Corps of Engineers, 1932, No. 747.)

754. U. S. Army Corps of Engineers. 1935. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 74th Congress, 1st Session. House Document No. 51. 27 p.

Deepening of the navigational channels is again proposed. Data on sounding in the Black River and in Lorain Harbor is included in the enclosed map. (CE)

755. U. S. Army Corps of Engineers. 1935. Report on Ashtabula Harbor, Ohio. Board of Engineers for Rivers and Harbors. 74th Congress, 2nd Session. House Document No. 78. 36 p.

Follow-up to No. 746. The Ashtabula River is to be deepened to 24 feet, the eastern breakwater is to be extended shoreward, and the outer harbor entrance is to be deepened. A discussion of shore processes and lake levels is included. (CE)

756. U. S. Army Corps of Engineers. 1936. Cleveland Harbor, Ohio. Board of Engineers for Rivers and Harbors. 74th Congress, 2nd Session. House Document No. 84. 41 p.

The work considered deals with the maintenance and improvement of Cuyahoga and Old Rivers to a depth of 21 feet and an 18-foot turning basin. Report includes three maps showing soundings in Cleveland Harbor and the Cuyahoga River and the location of sections where proposed channel cuts are to be made. (CE)

757. U. S. Army Corps of Engineers. 1936. Preliminary examination and survey of Rocky River Harbor, Ohio. Board of Engineers for Rivers and Harbors. 75th Congress, 1st Session. House Document No. 70. 18 p.

Rocky River Harbor is on the south shore of Lake Erie at the mouth of a small stream, 6.5 miles west of Cleveland. Proposed improvements include: an extension of the pier, widening and deepening the entrance channel, the bottom of which is made up of shale. Fluctuations of water level of Lake Erie affect the harbor. The improvements are not recommended until after the area is opened to the public. Results of the survey are included on a map. There is no appreciable erosion or accretion of lake shore and river bed in the area. (CE)

758. U. S. Army Corps of Engineers. 1939. Cleveland Harbor, Ohio. Board of Engineers for Rivers and Harbors. 76th Congress, 1st Session. House Document No. 232. 28 p.

Proposals in this report concern improvements in Cleveland Harbor for a turning basin and channel extension to the Harvard-Denison viaduct. The recommendation for the extension was unfavorable. Included in the report is a description of Cleveland Harbor, effects that the improvements would have on the harbor, and local weather effects. One map is included giving soundings and description of improvements. (CE)

759. U. S. Army Corps of Engineers. 1939. Preliminary examination and survey of Erie Harbor, Pa., Beach No. 2. Board of Engineers for Rivers and Harbors. 76th Congress, 1st Session. House Document No. 116. 15 p.

The unprotected part of the neck of Presque Isle Peninsula at Beach No. 2, Erie Harbor, Pa., has been eroded so fast that property is in danger of being damaged. Construction of shore protective works is recommended. A chart illustrates the erosion which has occurred at the neck of Presque Isle Peninsula since 1828. (CE)

760. U. S. Army Corps of Engineers. 1939. Reexamination

of Sandusky Harbor, Ohio. Board of Engineers for Rivers and Harbors. 76th Congress, 1st Session. House Document No. 328. 11 p.

Review of the reports on Sandusky Bay, No. 741, in light of new conditions. A new dock and approach channel were constructed by private interests. It is recommended that the present project be modified to provide for the maintenance of the new (bay) channel to a depth of 22 feet. (CE)

761. U. S. Army Corps of Engineers. 1941. Lorain Harbor, Ohio. Board of Engineers for Rivers and Harbors. 77th Congress, 1st Session. House Document No. 161. 18 p.

Proposed is a request for the extension of the east breakwater, protection of shoreline from erosion, and channel modification. A map on a physical survey of the area, in regard to soundings, is dated as 1940. (CE)

762. U. S. Army Corps of Engineers. 1945. Beach erosion study, Ohio shore line of Lake Erie, from Ohio-Michigan State line to Marblehead, Ohio. Beach Erosion Board. 79th Congress, 1st Session. House Document No. 177. 27 p.

Comprehensive study of beach erosion in the area of the Ohio-Michigan State line to Marblehead, Ohio. Proposal of modification and control of erosional processes are discussed. The geology, coastal characteristics, changes of the coast, shore processes affecting the study area, dune formation, sand analysis and sedimentation are also discussed. Maps and illustrations are included at the end of the report. (CE)

763. U. S. Army Corps of Engineers. 1946. Beach erosion study. Lake Erie shore line in the vicinity of Huron, Ohio. Beach Erosion Board. 79th Congress, 1st Session. House Document No. 220. 28 p.

Study deals with shoreline and offshore changes, shore processes and its effects on the state of the shore and beach, wave action, influence of the wind, geology of the shore, and sand transport and deposition. Presentation also includes mechanical analysis of the sand, water level influence in the vicinity, and a discussion of present structures and plans for improvement for shore protection. Maps, profiles of the beach, and graphs are included. (CE)

764. U. S. Army Corps of Engineers. 1948. Reno Beach, Lucas County, Ohio. Beach Erosion Board. 80th Congress, 2nd Session. House Document No. 554. 38 p.

The flood area at Reno Beach, Lucas County, Ohio, is a low, flat area bordering on Lake Erie which has been reclaimed for agricultural purposes by the construction of a system of surrounding dikes and drainage canals. Report deals with problems of flood control. Physical aspects discussed deal with topographic and geographic description, including local geology, hydrology, particularly water level fluctuations of Lake Erie. Climatological information in regard to precipitation and runoff are also included. Maps and graphs on the study area and logs of auger borings are to be found at the end of the report. (CE)

765. U. S. Army Corps of Engineers. 1950. Appendix IX - shore of Lake Erie in Lake County, Ohio, beach erosion control study. Beach Erosion Board. 81st Congress, 2nd Session. House Document No. 596. 34 p.

Comprehensive beach erosion control study of approximately 10 miles of shoreline in Lake County, Ohio, between the mouth of the Chagrin River and the Grand River. Included in the report are the local geology, materials and their deposition, wind factor, shore processes and the changes that have occurred. Diagrams and maps are included, following the report. (CE)

766. U. S. Army Corps of Engineers. 1950. Cleveland and Lakewood, Ohio, beach erosion control study. Beach Erosion Board. 81st Congress, 2nd Session. House Document No. 502. 56 p.

Comprehensive study of 18 miles of Lake Erie shoreline between the west city line of Lakewood, Ohio, to the east city line of Cleveland, Ohio, dealing with the coastal erosion processes there. The historical geology, shoreline characteristics, beaches, and sources of building material are discussed. Factors affecting shore processes and the shoreline and offshore changes are also included and discussed. Maps and graphs are included at the end of the report. (CE)

767. U. S. Army Corps of Engineers. 1952. Appendices V and X - Ohio shoreline of Lake Erie between Ashtabula and Pennsylvania State line, beach erosion control

study. Beach Erosion Board. 82nd Congress, 2nd Session. House Document No. 350. 37 p.

A comprehensive beach erosion control study of 14 miles of shoreline extending from 1 1/4 miles east of the Ashtabula River, eastward to the Ohio-Pennsylvania State line. Emphasis is on effective and economical methods of shore protection. Included are geology and coast characteristics, shore processes active in the area, existing structures, the shoreline and offshore changes, and plans for their improvement. Maps and diagrams are included. (CE)

768. U. S. Army Corps of Engineers. 1952. Appendices III, VII, and XII - Ohio shore line of Lake Erie between Fairport and Ashtabula, beach erosion control study. Beach Erosion Board. 82nd Congress, 2nd Session. House Document No. 351. 46 p.

Comprehensive beach erosion control study of the shores of Lake Erie between Fairport Harbor and Ashtabula Harbor, Ohio. Study made for State of Ohio for effective and economical methods of shore protection. Included are a description of the study area, its geology and coast characteristics, shore processes, and the changes both on the shoreline and offshore. Maps and diagrams are included at the end of the report. (CE)

769. U. S. Army Corps of Engineers. 1953. Appendix VI - Ohio shore line of Lake Erie, Sandusky to Vermilion, Ohio, beach erosion control study. Beach Erosion Board. 83rd Congress, 1st Session. House Document No. 32. 40 p.

This report deals with the study on beach erosion from Sandusky to Vermilion. A supplemental investigation of offshore sand deposits was made to locate sources of sand for construction of shore protection and recreational beaches. Included in the study are geology and coast characteristics, existing structures and shoreline changes, factors affecting shore processes, analysis of principal features of the erosional problem, and plans for improvement. Maps and graphs are included. (CE)

770. U. S. Army Corps of Engineers. 1953. Appendix IV - Ohio shore line of Lake Erie, Sandusky Bay, Ohio, beach erosion control study. Beach Erosion Board. 83rd Congress, 1st Session. House Document No. 126. 16 p.

Erosion control study of approximately the easterly 2 miles of Sandusky County shore line of Sandusky Bay. The most economical method of protection against erosion of this shoreline is the use of quarry-stone revetment. Included are the local geology and coastal characteristics, factors affecting shore processes, and plans for improvement. Maps and graphs are included. (CE)

771. U. S. Army Corps of Engineers. 1953. Appendix XIV - Ohio shore line of Lake Erie, Sheffield Lake Village to Rocky River, beach erosion control study. Beach Erosion Board. 83rd Congress, 1st Session. House Document No. 127. 44 p.

Effective and economical shore protection and beach stabilization from Sheffield Lake Village to the Rocky River (15 mi) are discussed. Report includes local geology and shore characteristics, shoreline processes and factors affecting them, changes, both offshore and on the shoreline, and maps and graphs, which are found at the end of the report. (CE)

772. U. S. Army Corps of Engineers. 1953. Appendix VIII - Ohio shoreline of Lake Erie between Vermilion and Sheffield Lake Village, beach erosion control study. Beach Erosion Board. 83rd Congress, 1st Session. House Document No. 229. 44 p.

Determination of effective and economical methods of shore protection and beach stabilization from Vermilion to Sheffield Lake Village, a 14-mile distance, is the main theme of the report. Discussion on the geology, shoreline characteristics, factors affecting shore processes and shoreline and offshore changes are included. Maps and graphs are at the end of the report. (CE)

773. U. S. Army Corps of Engineers. 1953. Presque Isle Peninsula, Erie, Pa. beach erosion control study. Beach Erosion Board. 83rd Congress, 1st Session. House Document No. 231. 57 p.

Effectiveness of the experimental groins and seawall constructed in 1943-44, and improvement and protection of the peninsula is the central theme of this report. A description of the area is provided, as well as the local geology and shoreline characteristics, factors affecting shore processes, shoreline and offshore changes, and a listing of existing structures. Maps, diagrams, and graphs are included. (CE)

774. U. S. Army Corps of Engineers. 1954. Appendix XI - Ohio shore line of Lake Erie, Euclid to Chagrin River, beach erosion control study. Beach Erosion Board. 83rd Congress, 2nd Session. House Document No. 324. 39 p.

Study of 8 miles of shoreline in Cuyahoga and Lake Counties for the purpose of beach erosion control. The report covers the following topics: coast characteristics and geology (from historical to depositional aspects), factors affecting the shoreline processes, the changes that have occurred, and plans for improvement. At the end of the report, maps and graphs are included. (CE)

775. U. S. Army Corps of Engineers. 1957. Cleveland Harbor, Ohio. Board of Engineers for Rivers and Harbors. 85th Congress, 1st Session. House Document No. 107. 41 p.

Proposal for channel deepening is submitted for review. A description of the harbor is included in this report. One map showing soundings inside the harbor as well as outside the harbor is also included. (CE)

776. U. S. Army Corps of Engineers. 1958. Preliminary examination and survey of Vermilion Harbor, Ohio. Board of Engineers for Rivers and Harbors. 86th Congress, 1st Session. House Document No. 231. 28 p.

Local interests desire the improvement of the harbor entrance to permit safe entry and the provision of adequate depths in the river channel. The improvements consist of overlapping breakwaters to provide a new entrance and dredging of a channel with depths of 8 feet below low-water datum. Data included for consideration of the proposed improvements include a description of the drainage area of the Vermilion River, characteristics of its channel, variations in the level of the water in the harbor, and shoreline changes since 1854. (CE)

777. U. S. Army Corps of Engineers. 1960. Presque Isle Peninsula, Erie, Pennsylvania, beach erosion control study. Beach Erosion Board. 86th Congress, 2nd Session. House Document No. 397. 62 p.

This cooperative study by the Beach Erosion Board and the Commonwealth of Pennsylvania was made to determine the rates of loss and movement of the sand fill and to estimate the requirements of the existing cooperative shore protection project (1955-1956). A description of the area, local geology and shoreline characteristics, factors affecting shore processes and structures are discussed. Maps, diagrams, and graphs include grain-size distribution curves, a wind rose, and beach profiles.

It was concluded that periodic fill (approximately 154,000 cubic yards annually) must be added to the beaches to protect upland property and to provide a beach for recreational use. Analysis has shown the surface material in the beach is wind-blown sand which accounts for its reduced grain size. (CE)

778. U. S. Army Corps of Engineers. 1961. Great Lakes Harbor study - interim report on Huron Harbor, Ohio. Board of Engineers for Rivers and Harbors. 87th Congress, 1st Session. House Document No. 165. 48 p.

This report covers improvement of Huron Harbor in the interest of prospective iron ore, grain, quartzite, and coal commerce traffic. Specifications include improvement and maintenance of more of the river channel, deepening of the channel (from 24 to 27 feet), enlargement of the turning basin, and extension of the breakwater. The fluctuations of lake level at the harbor are important considerations and their specific causes and effects are discussed in detail. The entrance to the harbor has the unique and dangerous situation that waves from the northeast are refracted into the entrance and this intensifies their effect by concentrating energy at the harbor entrance. (CE)

779. U. S. Army Corps of Engineers. 1962. Coast of Lake Erie - interim report on West Harbor, Ohio. Corps of Engineers. North Central Div. Detroit, Mich. 26 p.

The purpose of this report is to consider the need for additional harbors and harbors of refuge for small craft to supplement the existing chain of small boat harbors located along the Lake Erie shoreline. Special field investigations included a sounding survey made over the sites proposed for access channels and the outlet to Lake Erie. Subsurface investigations were made in the channel areas and the proposed breakwater locations. Locations and logs of core borings are included. Data relative to sand transport and wave heights on Lake Erie in the vicinity of West Harbor were compiled. (CE)

780. U. S. Army Corps of Engineers. 1962. Great Lakes harbor study - interim report on Conneaut Harbor, Ohio. Board of Engineers for Rivers and Harbors. 87th Congress, 2nd Session. House Document No. 415. 75 p.

The work considered was the deepening of the easterly portion of outer harbor to 28 feet in soft material and 29 feet in hard material; deepening the triangular area of the outer harbor to 22 feet in soft material and 23 feet in hard material; deepening the inner harbor for a distance of 2,450 feet upstream of the outer portion of west pier to 27 feet in soft material and 28 feet in hard material; removal of the east pier; extension of the east breakwater to shore; and an access channel 8 feet deep in outer harbor to city dock. The recommendation proved favorable. This report contains the latest published map at time of printing. (CE)

781. U. S. Army Corps of Engineers. 1962. Great Lakes harbor study - second interim report on Erie Harbor, Pennsylvania. Board of Engineers for Rivers and Harbors. 87th Congress, 2nd Session. House Document No. 340. 49 p.

This report covers improvement to Erie Harbor in the interest of general cargo commerce. To this end, it is recommended that the harbor be dredged to a depth of 27 feet in soft material and 28 feet in hard material. (CE)

782. U. S. Army Corps of Engineers. 1962. Interim report on the Sandusky River, Ohio. Board of Engineers for Rivers and Harbors. 87th Congress, 2nd Session. Senate Document No. 136. 90 p.

The Chief of Engineers recommends improvements for flood control at the cities of Fremont, Bucyrus, and Tiffin, consisting of channel work along the Sandusky River. Levees, floodwalls, drainage structures, channel paving, deepening, widening and pumping plants are included in the proposed project. Since it is possible that the project will disturb the stream bottom habitat and restrict fish passage at the proposed drop structure, damaging the fish resources of the Sandusky River, further investigation is recommended. The drainage basin of the Sandusky is described in detail as to geology, geomorphology, extent of flooding, channel characteristics, as are its tributaries--the Tymochee, Wolf, Muskellinge, Honey, Broken Sword, Sycamore, and Green Creeks. (CE)

783. U. S. Army Corps of Engineers. 1963. Improvement of navigation conditions, Conneaut Harbor, Ohio. Corps of Engineers. Vicksburg, Miss. Tech. Rept. 2-617. 93 p.

A hydraulic model investigation of the harbor at Conneaut, Ohio, was conducted to determine the effects on waves and seiche currents at the entrance to and within the inner harbor area, of the various proposed modifications to the east pier and extensions to the east breakwater. The study was performed on a 1:125-scale, fixed-bed type model, constructed of concrete and equipped with a wave generator, electrical wave height measuring and recording devices, and a water circulating system for simulating currents resulting from the action of longitudinal seiches characteristic of Lake Erie. (CA)

784. U. S. Army Corps of Engineers. 1963. Interim survey of the Maumee River Basin, Findlay, Ohio. Board of Engineers for Rivers and Harbors. 88th Congress, 1st Session. House Document No. 158. 77 p.

This report discusses improvements to the Maumee River in Indiana and Ohio for the purpose of flood control. Solutions consist of levees, flood walls, appurtenant works, diversion of some tributaries, and the establishment of flood plain restrictions. The specific portion of the Maumee River that is under discussion is the Blanchard River, a tributary of the Auglaize River which is a tributary of the Maumee. Flood damage, problems, and controls are discussed. (CE)

785. U. S. Army Corps of Engineers. 1963. Review of reports for flood control and allied purposes, Chagrin River, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 134 p.

This report presents relevant general and detailed data on the Chagrin River Basin including its history of flooding, defines the extent of the existing flood problems and the areas and developments affected, outlines the types of improvements considered, provides details of the plans for improvement selected as most suitable considering both flood control and allied purposes. Included is information concerning climatology, precipitation, temperature, snowfall, geology, stream slopes, discharge, water levels, and shoreline processes in the lake area.

786. U. S. Army Corps of Engineers. 1964. Interim report on Rocky River Harbor, Ohio. Board of Engineers for Rivers and Harbors. 88th Congress, 2nd Session. House Document No. 352. 58 p.

Recommended improvements to the entrance of Rocky River, 6.5 miles west of Cleveland, consist of realignment and extension of the existing navigation channel and construction of an anchorage basin to meet the needs of small-boat navigation and to alleviate local flooding problems. This is the next in the series following reference 757. Discussion includes geomorphic features of the river, fluctuations of water level, effect and exposure to storms, flood problems, and stream flow. (CE)

787. U. S. Army Corps of Engineers. 1964. Flood plain information, Black River, Ohio from Lake Erie to Carlisle Township. Corps of Engineers. Buffalo District. Buffalo, N. Y. Main Rept. and Tech. Appendix. 61 p.

The study provides information on past flood occurrences as well as a guide to the relative frequency of occurrences of future floods. The main report presents the findings of the study and the technical appendix contains engineering details and technical data used in the preparation of the main report. Information and data concerning climatology, precipitation, stream flow, discharge, stream profiles and other data concerning flood information is presented in maps, graphical displays and tables. (CE)

788. U. S. Army Corps of Engineers. 1964. Flood plain information, Sandusky River, Ohio from Sandusky Bay to Tiffin. Corps of Engineers. Buffalo District. Buffalo, N. Y. Main Rept. and Tech. Appendix. 76 p.

The purpose of the report is to provide information on past floods and flooded areas with the intention of establishing precautions and planning toward future reoccurence of flooding. Information and data concerning climatology, rainfall, streamflow, areas of flooding, profiles and flooded outlines and discharge are presented in map, graphic and table form. (CE)

789. U. S. Army Corps of Engineers. 1964. Flood plain information, Sandusky River, Ohio from Sandusky Bay to Tiffin. Corps of Engineers. Buffalo Dis-

trict. Buffalo, N. Y. Summary Rept. 19 p.

This summary is a condensation of the information contained in the main report of the flood plain study and is intended to provide the general public with a brief description of the flood problem and the courses of action which are available to reduce future flood damage. Included is some flood history, ice jam floods, and profiles of the Sandusky River from Sandusky Bay to Tiffin, Ohio. (CE)

790. U. S. Army Corps of Engineers. 1965. Flood plain information report, Vermilion River, Ohio from Lake Erie to Mill Hollow. Corps of Engineers. Buffalo District. Buffalo, N. Y. 75 p.

The main report contains all the available pertinent information on flooding and the flood plain and was prepared for general use at the request of the Department of Natural Resources of Ohio. The technical appendix contains engineering details and technical data used in the preparation of the main report. Information on past flood occurrences as well as a guide to the extent and frequency of future floods is provided. Included is information concerning climatology, precipitation, snowfall, temperature, stream flow records and other hydrologic information pertinent to this study. (CE)

791. U. S. Army Corps of Engineers. 1965. Water levels of the Great Lakes - report on lake regulation. Corps of Engineers. North Central Div. Chicago, Ill. Main Rept. 57 p.

Existing and proposed regulatory proposals to reduce the range of fluctuations of the water level in the Great Lakes are discussed and evaluated with emphasis on the interrelations of the Great Lakes System. The effect of regulation on shore property, navigation, and power projects is noted. (CE)

792. U. S. Army Corps of Engineers. 1965. Water levels of the Great Lakes - report on lake regulation. Corps of Engineers. North Central Div. Chicago, Ill. Appendix A. 48 p.

The hydrology of the Great Lakes as it is presently known and the effects on lake levels and outflows of hydrologic factors are presented. Variations in the lake levels, the natural and artificial factors affecting the levels, and studies with a view to forecasting the levels are also discussed.

793. U. S. Army Corps of Engineers. 1965. Water levels of the Great Lakes - report on lake regulation. Corps of Engineers. North Central Div. Chicago, Ill. Appendix B. 57 p.

Tenative study plans developed for regulating the Lakes are presented and analyzed in terms of established criteria. Criteria include maximum and minimum monthly values for mean level and outflow.

794. U. S. Army Corps of Engineers. 1966. Coast of Lake Erie - Conneaut Harbor, Ohio. Board of Engineers for Rivers and Harbors. 89th Congress, 2nd Session. House Document No. 484. 51 p.

Further modifications are proposed for improvement of the harbor as well as deepening of certain portions. Local water levels and fluctuations and protection of the harbor from exposure to storms is briefly presented. (CE)

795. U. S. Army Corps of Engineers. 1966. Interim report on coast of Lake Erie - Elk Creek Harbor, Pennsylvania. Board of Engineers for Rivers and Harbors. 89th Congress, 2nd Session. House Document No. 512. 54 p.

This report was undertaken with a view toward the establishment of harbors and harbors of refuge for light-draft commercial and fishing vessels and for recreational vessels along the coast of Lake Erie. Recommendations include construction of a breakwater-protected entrance into the natural lagoons near the mouth of Elk Creek, an anchorage basin, dock channel and recreational fishing facilities. Information on water levels and fluctuations, exposure and effect of storms, and shoreline changes is included. Effect on the environment is also noted. Elk Creek enters the Lake 22 miles west of Erie, Pa. (CE)

796. U. S. Army Corps of Engineers. 1967. Report of floods 24 July and 3 August 1967, Conneautville, Pennsylvania. Corps of Engineers. Buffalo District. Buffalo, N. Y. 6 p.

This brief report deals with the floods occurring in Conneautville, Penn., and provides photographs and extent of flooding. Also included are an area map, a profile of Conneaut Creek and one of Thatcher Run (before and during flood state), and a rainfall intensity and duration frequency curves graph. (CE)

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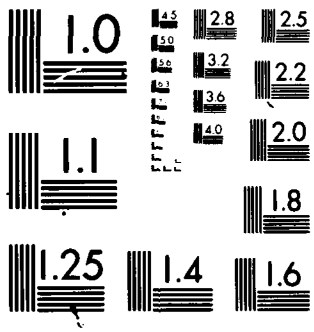


MICROCOPY RESOLUTION TEST CHART
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797. U. S. Army Corps of Engineers. 1968. Design memorandum on local flood protection, Sandusky River at Fremont, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. Vol. I of II. 52 p.

This report is concerned with flood protection on the Sandusky River proposing appropriate means of control. Physical aspects that are discussed include discharge and runoff information, stage levels, climatological data, locations of climatological stations pertinent to flood information, flood history and hydraulic design. (CE)

798. U. S. Army Corps of Engineers. 1968. Detailed project report on Kelleys Island Harbor, Ohio. Corps of Engineers. North Central Div. Detroit, Mich. 54 p.

This report contains information regarding bottom elevations and subsurface investigations of the harbor site, bedrock surface, water levels and fluctuations, wave action, shoreline changes, materials, data of borings and test pits, profiles and soil resistivity. (CE)

799. U. S. Army Corps of Engineers. 1968. Detroit River, Trenton Channel, Michigan. Corps of Engineers. North Central Div. 90th Congress 2nd Session. House Document No. 338. 112 p.

This report completes consideration of the need for improvement of the Trenton Channel under the July 1955 resolution. General information is included as to its mean flow, water level and fluctuations, general discussion of the tributary area, effects on lake levels for the plans of improvement. (CE)

800. U. S. Army Corps of Engineers. 1968. Flood plain information, Chagrin River in the Counties of Lake and Cuyahoga, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 53 p.

This report presents facts on past and potential floods in the future. Included are maps and graphs dealing with the extent of the flood plain, profiles and cross sections of varying flood stages. Historical flood occurrences are also presented. Data on flood heights, drainage areas, recorded highs for past floods in the area, peak discharges and velocities, rates of rise and durations of floods, and Lake Erie stages at Cleveland can also be found in this report. (CE)

801. U. S. Army Corps of Engineers. 1968. Flood plain information, Cuyahoga River, Big Creek and Tinkers Creek, Cuyahoga County, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 61 p.

Included in this report are maps, profiles, photographs and cross sections which indicate the extent of flooding that has been actually experienced in the past and which might be experienced in the future. (CE)

802. U. S. Army Corps of Engineers. 1968. Flood plain information, Rocky River in the cities of Rocky River and Lakewood, Cuyahoga County, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 54 p.

This report is based on hydrological facts, historical and recent flood heights, and technical data having a bearing on the occurrence and magnitude of floods within the study area. Included in this report are maps, profiles, photographs and cross sections which indicate the extent of flooding that has been experienced and which might occur in the future. Also included are data on drainage areas within the Rocky River Basin, maximum known flood discharges, and the influence of levels of Lake Erie and stage levels. (CE)

803. U. S. Army Corps of Engineers. 1969. Dredging and water quality problems in the Great Lakes: Pilot program summary. Corps of Engineers. Buffalo District. Buffalo, N. Y. 16 p.

This is a summary of the draft of a report on a two-year pilot study of the harbor dredging operations as they affect water quality and environment in the Great Lakes. Lake Erie is noted as having the biggest dredging operation and the most critical pollution problems of all the Great Lakes.

804. U. S. Army Corps of Engineers. 1969. Dredging and water quality problems in the Great Lakes. Corps of Engineers. Buffalo District. Buffalo, N. Y. Summary Rept. Vol. 1. 324 p.

As a result of soil erosion and waste discharges, heavy sediment loads wash into water channels of the Great Lakes. Year by year, this material has to be removed to maintain previous navigation channels. 10.8 million cubic yards of material are dredged each year from Great Lakes harbors; 6.7 million cubic yards from Lake Erie harbors alone. Most of the dredged material has been deposited in selected sites near the sources to keep costs down. As a result, most, but not all, of the sediments dredged at the commercially more important harbors have become contaminated by pollutants from municipal, industrial and agricultural sources. General physical data has been included in the report dealing with the water quality; discussion of the sedimentation in the major harbors of Lake Erie is also presented in regard to dredging.

805. U. S. Army Corps of Engineers. 1969. Great Lakes shoreline damage, causes and protective measures. Corps of Engineers. North Central Div. Chicago, Ill. 1 pamphlet.

Very general discussion of lake level and erosion, with general data on each of the Great Lakes.

806. U. S. Army Corps of Engineers. 1969. Review of reports for flood control and allied purposes, Cuyahoga River, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 140 p.

This report presents relevant general and detailed data on the Cuyahoga River Basin in Cuyahoga County (including its history of flooding), defines the extent of the existing flood problems and the areas and developments affected, outlines the types of improvements considered, provides details of the plans of improvement selected as most suitable considering both flood control and allied purposes, and presents the basis of selection thereof as developed from the field and office investigations. It also presents, insofar as there is a relationship with potential flood control improvements, data on a possible settling basin for reduction of sedimentation in navigation channels downstream. Data and information is likewise presented concerning general geology, sedimentation, discharge, stage levels and climatology. (CE)

807. U. S. Army Corps of Engineers. 1970. Flood plain information, flood hazard report of 4-7 July 1969 flood, Black River. Corps of Engineers. Buffalo District. Buffalo, N. Y. 9 p.

Information is presented on the 1969 flood of the Black River. Included in this report is a map containing areas where flood hazards must be considered. Further data is provided on discharge, rainfall intensity, water surface profiles, and stage-discharge and discharge frequency. Most of the data presented is graphical. (CE)

808. U. S. Army Corps of Engineers. 1970. Flood plain information, flood hazard report of 4-7 July 1969 flood, Vermilion River, Skellenger Creek, Bonney Creek, Ohio. Corps of Engineers. Buffalo District. Buffalo, N. Y. 18 p.

The flooded area map and the water profile of the July 1969 flood are shown in this report and are based on the information gathered during and immediately after the flood. The profiles indicate the amount of fill required or to what elevation flood proofing must be provided to prevent damage. Included are stage and discharge hydrographs, rainfall intensity-duration frequency curves and history of floodings. (CE)

809. U. S. Army Corps of Engineers. 1970. Interim report on Dunkirk Harbor, New York. Board of Engineers for Rivers and Harbors. 91st Congress, 2nd Session. House Document No. 91-423. 80 p.

Included in this report presenting the recommendation that a breakwater-protected small boat harbor be constructed in the west basin of Dunkirk Harbor, New York, are discussions of water levels and fluctuations, exposures to and effects of storms, shoreline changes and environmental impact. (CE)

810. U. S. Army Corps of Engineers. 1970. Report of flood 4-7 July 1969, Northern Ohio in Buffalo District. Corps of Engineers. Buffalo District. Buffalo, N. Y. 147 p.

This report presents detailed data on the Huron, Black and Vermilion Rivers with various other streams given minor coverage. The information presented contains precipitation and weather synopses, provisional stage hydrographs and peak discharges and preliminary damage estimates after the July 1969 storm. (CE)

811. U. S. Army Corps of Engineers. 1970. Report on Geneva-on-the-Lake, Ohio. Board of Engineers for Rivers and Harbors. 91st Congress, 2nd Session. House Document No. 91-402. 52 p.

Geneva-on-the-Lake, Ohio, is located on the south shore of Lake Erie, about 17 miles east of Fairport and 12 miles west of Ashtabula. The proposed plan provides for construction of a small-boat harbor as an integral part of Ohio's plan to develop the area as a state park. The project will provide a refuge for small boats cruising between the two deep-draft commercial harbors at Fairport and Ashtabula. Construction of general navigation and recreation facilities include breakwaters in Lake Erie, aggregating about 1400 feet in length, with a riprapped spending beach, 1000 feet of entrance channel, 1500 feet of dock channel, and a concrete walk and guard rail on the breakwaters for recreational fishing. (CE)

812. U. S. Army Corps of Engineers. 1971. Cuyahoga River Basin, Ohio: Restoration study. Corps of Engineers. Buffalo District. Buffalo, N. Y. Interim Rept. 104 p.

This study was released to show the need for an environmental clean-up program of the Cuyahoga River. Most of its contents are social and economic factors; however, it does contain sections on geology, geomorphology, and varying physical aspects of the river.

813. U. S. Army Corps of Engineers. 1971. Great Lakes Region inventory report national shoreline study. Corps of Engineers. North Central Div. Chicago, Ill. Inventory Rept. 221 p.

This report concerns erosion and the need for protection of the shoreline zone of the U. S. portion of the Great Lakes. The sections under discussion in this report include Lake Erie. Also included is an appraisal investigation, intended only to define the order of magnitude of the regional shore erosion problem. Discussion of connecting rivers and islands is limited.

814. U. S. Army Corps of Engineers. 1971. Lakeshore physiography and use. Coastal zone and shoreland management in the Great Lakes. Corps of Engineers. Chicago District. Chicago, Ill.

General discussion of shore structure and a map of Lake Erie with general outline of shore type.

815. U. S. Army Corps of Engineers. 1971. Vermilion Harbor, Ohio general design memorandum. Corps of Engineers. Buffalo District. Buffalo, N. Y. 49 p.

A hydraulic model investigation of the wave action problem at

Vermilion Harbor, Ohio, was conducted to test and develop plans of improvement proposed for reducing wave heights at the harbor entrance and in the outer reaches of the Vermilion River channel to a satisfactory level. (CE)

816. U. S. Army Corps of Engineers. 1973. Cooperative beach erosion project at Presque Isle Peninsula, Erie, Pa. - draft environmental impact statement. Corps of Engineers. Buffalo District. Buffalo, N. Y. 115 p.

General environmental setting, presenting climatology, lake level, wave action, currents, seiches and lake ice as it affects the local environment. The shore history, showing the changes in the shoreline and movement of sand along its lakeward perimeter since placement of the project fill, is described. A graphic description since 1790 showing the changes that have occurred on the peninsula is included. Sand study and its relation to erosion and accretion of sands is described in the shore processes in action. The latter part deals with engineering techniques to control the wave action and the environmental effects of bottom deposit movement and relocation with each technique proposed.

817. U. S. Army Corps of Engineers. 1973. Draft environmental statement: Lake City Station Unit 1. Corps of Engineers. Buffalo District. Buffalo, N. Y. 78 p.

This draft environmental impact statement for the construction and operation of an electric generating station adjacent to Lake Erie and Elk Creek, Pennsylvania, includes a lake bottom survey and profile, charts on wind velocity and direction, and precipitation for the area.

818. U. S. Army Corps of Engineers. 1973. Great Lakes Basin in Ohio. In: Water Resources Development in Ohio. Corps of Engineers. Ohio River Div. Cincinnati, Ohio. pp. 15-34.

Those projects that are being planned, underway or completed for areas in Ohio are summarized. The contents are primarily economic, but some physical and geological information is incorporated into the reports. The summaries cover most of the rivers and harbors on the south shore of Lake Erie between Toledo and Cleveland.

819. U. S. Army Corps of Engineers. 1973. Help yourself.

Corps of Engineers. North Central Div. Chicago, Ill. 1 pamphlet.

A discussion of the critical erosion problems on the Great Lakes and alternative methods of shore protection. This brochure has been prepared to provide owners of private shore property with technical assistance for the protection of the Great Lakes shoreline from erosion damages. Incorrect solutions are presented as well as the correct procedure to check erosion, all of which is done through graphic illustrations of techniques used to strengthen the shoreline against shore processes.

820. U. S. Army Corps of Engineers. 1973. Review of reports on Lake Erie-Lake Ontario waterway, New York. Corps of Engineers. Buffalo District. Buffalo, N. Y. Main Rept. 139 p.

This review of reports examines conclusions from the environmental, engineering, and economic studies of the construction of a waterway between Lake Erie and Lake Ontario. The impact of the proposed system on the Great Lakes-St. Lawrence Seaway is noted. Specific references to Lake Erie are few as most of the impact would be on Lake Ontario.

821. U. S. Army Corps of Engineers. 1973. Review of reports on Lake Erie-Lake Ontario waterway, New York. Corps of Engineers. Buffalo District. Buffalo, N. Y. Appendix B. 54 p.

This review is a written report on the geology of the area adjacent to the western end of Lake Erie in New York.

822. U. S. Army Corps of Engineers. 1973. Review of reports on Lake Erie-Lake Ontario waterway, New York. Corps of Engineers. Buffalo District. Buffalo, N. Y. Appendix C. 144 p.

Review of hydrology and hydraulic design concerning the eastern Lake Erie Basin. Included are data and discussion on lake level, climatology, ice occurrence and pertinent hydrological parameters.

823. U. S. Army Corps of Engineers. 1973. Review of reports on Lake Erie-Lake Ontario waterway, New York. Corps of Engineers. Buffalo District. Buffalo, N. Y. Appendix E. 165 p.

The baseline environment of the Lake Erie-Lake Ontario waterway is described prior to implementation of the project and with the proposed project in effect to discuss its impact on the environment for the period 1980-2030. The major portion of the report deals with the Niagara River.

824. U. S. Army Corps of Engineers. 1973. Southeastern Michigan wastewater management survey scope study, summary report. Corps of Engineers. Detroit District. Lansing, Mich. 144 p.

This summary report presents the overview of the entire study which is divided among seven appendices. The aim of the study is to develop long-range wastewater management plans for Southeastern Michigan. Included in this report is a general discussion of drainage from the Michigan area and the effluents observed that affect the water quality in the Lake Erie Basin in the vicinity of Michigan. (CE)

825. U. S. Army Corps of Engineers. 1973. Wastewater management study summary report for Cleveland-Akron Metropolitan and Three Rivers watershed areas of Ohio, 1970. Corps of Engineers. North Central Div. Chicago, Ill. 207 p.

This study is concerned with the formulation, design, and assessment of the impacts of four alternative plans for area-wide wastewater management in Northern Ohio. It examines wastewater treatment technology, systems for the collection of stormwater runoff, and systems to achieve high effluent quality.

826. U. S. Army Corps of Engineers. 1973. Water resources development in New York. Corps of Engineers. North Atlantic Div. New York, N. Y. pp. 19-25.

Projects that are being planned, underway, or completed for harbors and flood control between the New York-Pennsylvania border and Buffalo are summarized.

827. U. S. Army Corps of Engineers. 1973. Water resources development in Pennsylvania. Corps of Engineers. North Atlantic Div. New York, N. Y. 92 p.

This pamphlet cites a survey underway to consider the feasibility of a waterway between Lakes Erie and Ontario to accommodate large vessels. Included, too, is a proposal for harbors for light-draft vessels along the Lake Erie shore. A tributary, Conneaut Creek, is listed in a table of flood-control projects.

828. U. S. Department of Health, Education and Welfare, Public Health Service. 1963. Water pollution surveillance system, annual compilation of data, October 1, 1962 - September 30, 1963. U. S. Dept. Health, Education and Welfare. Div. Water Supply and Pollution Control. Washington, D. C. 4: 102 p.

Data is given for radioactivity measured in water, organic chemicals, temperature, color, turbidity and inorganic chemicals, as well as stream flow data for the Cuyahoga, Maumee and Detroit Rivers. (RL)

829. U. S. Department of Health, Education and Welfare. 1965. Proceedings, conference in the matter of pollution of Lake Erie and its tributaries. (3rd Session - August). U. S. Dept. Health, Education and Welfare. Washington, D. C. Vol. 1-4. 1099 p.

A recorded document on proceedings held to discuss pollution and pollution abatement in Lake Erie and its tributaries (U. S.). The discussion of physical parameters is general in the discussion on the opening statements on Lake Erie. Data that is presented goes into depth as to the type, quantitative and qualitative, and its source both industrial and municipal. Specific sources are cited. The parameters of hydrology in general, currents and other physical characteristics of Lake Erie are presented early in discussion. Siltation, suspended solids, and chemical pollutants are discussed likewise and their distribution and source in the Erie Basin are presented.

830. U. S. Department of Health, Education and Welfare. 1965. Proceedings, conference in the matter of pollution of the navigable waters of the Detroit River and Lake Erie and their tributaries in the State of Michigan. (2nd Session - June). U. S. Dept. Health, Education and Welfare. Washington, D. C. Vol. 1-6. 1787 p.

These volumes are a continuous series dealing with the pollution studies of the local geographic area. Throughout the presentation, there is mention to physical parameters dealing with topics of local pollution as to type of the source of the pollution, much of it being of man-made cause. Industry as well as civil sources are cited. Physical characteristics of suspended solids, chemical waste, discharge and flow characteristics are presented with substantial data, graphs, tables and maps. The opening volume itself deals with an introduction as to the local geology, climatology, flow (mention of flow characteristics due to seiches and the effect on discharge is mentioned) and sedimentation.

831. U. S. Department of Health, Education and Welfare. 1965. Report on pollution of Lake Erie and its tributaries, Lake Erie. U. S. Dept. Health, Education and Welfare. Washington, D. C. Pt. 1. 50 p.

A formal presentation of Lake Erie and its tributaries in description and the general physical processes that operate in lake pollution. This report is the basic source for the Proceedings that were held in Cleveland, August 3-6 of the same year. This is one of three reports, with Parts 2 and 3, that cover the tributary systems of Lake Erie. The subjects that are covered are area description, degradation of Lake Erie, waste inputs and Federal installations.

832. U. S. Department of Health, Education and Welfare. 1965. Report on pollution of Lake Erie and its tributaries, Ohio, Indiana, and Michigan Sources. U. S. Dept. Health, Education and Welfare. Washington, D. C. Pt. 2. 51 p.

A continuation of Part 1 with emphasis on the following areas: Maumee River Basin, Western Ohio, Rocky River Basin, Cuyahoga River Basin and Cleveland lakefront, Eastern Ohio and Detroit River and Michigan tributaries. Pollutant discharge and source are presented.

833. U. S. Department of Health, Education and Welfare. 1965. Report on pollution of Lake Erie and its tributaries, New York and Pennsylvania Sources. U. S. Dept. Health, Education and Welfare. Washington, D. C. Pt. 3. 18 p.

A continuation of the series covering the following areas: Pennsylvania, Western New York and Erie-Niagara. The Lake Erie tributaries in this area and their pollutant inputs are discussed.

834. U. S. Federal Water Pollution Control Administration.

1966. Water pollution problems of the Great Lakes area. Federal Water Pollution Control Admin. Great Lakes Region. Chicago, Ill. 22 p.

One of the earlier reports on pollution in the Great Lakes. Topics include definition of the problems, existing programs, and future programs. A very general report but the emphasis is on Lake Erie as one of the most polluted lakes. (SM)

835. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie environmental summary 1963-1964. Federal Water Pollution Control Admin. Great Lakes Region. Chicago, Ill. 170 p.

A complete report covering the physical characteristics (bottom, water supply and balance, temperatures and its effects, currents and lakewide circulation and observations), chemical characteristics (both water and sediment chemistry, with radiochemistry included also), biological characteristics, and bacteriological as well. The report is well presented with data and explanations.

836. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie South Shore tributary loading data summary 1967. Federal Water Pollution Control Admin. Great Lakes Region. Cleveland, Ohio. 28 p.

The 1967-68 survey determined total solids, chloride, and total phosphorus loadings from thirteen south shore tributaries to Lake Erie. The data show that large quantities of solids and nutrients from basin tributaries are being discharged to Lake Erie. Of the thirteen south shore tributaries sampled, the Maumee River contributes the largest quantities of total solids and total phosphorus. The Grand River (Ohio), because of a large industrial discharge near its mouth, had the largest chloride contribution of the south shore tributaries. It is apparent from the limited sampling program that the largest tributary loading occurs during high flow. (CCIW)

837. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie surveillance data summary 1967-1968. Federal Water Pollution Control Admin. Washington, D. C. 65 p.

This is a report on the water quality in the three basins of Lake Erie. The physical parameters used were temperature,

transparency and turbidity.

838. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie surveillance data summary 1967-1968. Proc. Prog. Evaluation Meeting, Pollution of Lake Erie and its Tributaries, June 4, 1968. Cleveland, Ohio. 65 p.

Formal data presentation dealing with the parameters of lake chemistry, sediment chemistry, temperature, transparency and turbidity. Data collected 1967-68 was compared to 1963-64 data.

839. U. S. Fish and Wildlife Service. 1963. Water levels of the Great Lakes: A special report on fish and wildlife resources. U. S. Fish and Wildlife Service. Washington, D. C. 56 p.

This report provides an appraisal of the effects on fish and wildlife of a plan to regulate the levels of the Great Lakes. The current plan will only affect Lake Erie, so the majority of the data presented pertains to Lake Erie. No evidence has been found which would indicate that the plan (57-EO-1 of Plan G, U. S. Corps of Engineers) will have any marked effect on the fishery resources of Lake Erie. (CCIW)

840. U. S. Geological Survey. 1967. Water resources data for New York. U. S. Geol. Surv. Albany, N. Y. Pt. 1. Surface Water Records. pp. 196, 198.

Discharge records for water year October 1965 to September 1966 for Cattaraugus Creek near Arcade and at Gowanda.

841. U. S. Geological Survey. 1967. Water resources data for New York. U. S. Geol. Surv. Albany, N. Y. Pt. 2. Water Quality Records. p. 95.

Data on chemical analyses of ground water in the Lake Erie-Niagara River Basin mentioning water-bearing material, depth of well, date of collection (during 1964), temperature, chemical constituents, pH and specific conductance.

842. U. S. National Oceanic and Atmospheric Administration. 1972. Great Lakes water levels, 1970; daily and monthly average water surface elevations. NOAA. National Ocean Surv. Lake Surv. Center. Detroit, Mich. 128 p.

The publication contains Lake Survey Center Great Lakes water level gauge records for 1970 and shows in tabular form daily and monthly average levels for each gauge in the network for the calendar year. It also contains, in a separate table, the highest and lowest daily average for the month. In addition, a frequency distribution table of daily average levels shows the number of times each month the recorded levels were above a specified elevation. (CA)

843. U. S. National Oceanic and Atmospheric Administration. 1973. Great Lakes water levels, 1971. NOAA. National Ocean Surv. Lake Surv. Center. Detroit, Mich. 120 p.

This publication contains Lake Survey Center Great Lakes water level gauge records showing daily and monthly average levels for each gauge in the network. The highest and lowest daily average for each month is listed in a separate table. Eight gauge stations are located on Lake Erie and four on the Detroit River.

844. U. S. Office of Water Resources Research. 1972. Lake Erie - a bibliography. Water Resources Sci. Info. Center. Springfield, Va. Info. Center Rept. WRSIC 72-209. 240 p.

This bibliography, containing 221 abstracts is one in a series of planned bibliographies in water resources produced wholly from the information base comprising Selected Water Resources Abstracts (SWRA). At the time of search for this bibliography, the data base had 41,521 abstracts covering SWRA through May 15, 1972 (Volume 5, Number 10). Abstracts with full bibliographic details are listed in ascending Accession Number order. A descriptor index is made up of a fraction of the total descriptors and identifiers by which each paper in this bibliography has been indexed. These descriptors represent weighted terms that best describe the information content and are indicated by asterisks. Through permutation, each word in a multiple-word descriptor or identifier is made to file in its normal alphabetic order, thus affording a multiple access to each abstract. Another index lists the authors alphabetically and gives page numbers for the abstracts.

845. U. S. Water Resources Council. 1968. The nation's water resources. U. S. Water Resources Council. Washington, D. C. (Parts 1-7). pp. 6, 3, 4.

This publication contains general data on the Great Lakes which includes water surface, drainage basin (sq mi), average annual precipitation, average annual outflow, mean elevation and runoff.

846. U. S. Weather Bureau (ESSA, Detroit). 1969. The Great Lakes ice season of 1969. Mariners Weather Log. 13(5):203-204.

An intensified ice observation program was carried out to support the extension of the lake shipping season. The 1969 season, with some important departures from the norm, adhered somewhat closely to the normal pattern of ice accumulation and deterioration observed over the years of record. By late January, Lake Erie was almost completely covered with ice. Late winter ice coverage on Lake Erie consisted of open water along the Canadian shore, closepack ice (70 to 90 per cent ice coverage) for the next quarter of the Lake, and, with the exception of the center of the Western Basin, solid ice with complete coverage for the U. S. shoreline. (BECPL)

847. Upchurch, Sam B. 1972. Chemical characteristics of the Great Lakes. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4:4-417 to 4-658.

This report deals with a conceptual model for inorganic and organic loads in the Lakes, based on chemical weathering in the drainage basin, known chemical loads, and chemical equilibria. Types of chemical loads discussed are inorganic and organic, runoff, precipitation and groundwater. Consideration is given to residence times in the Lakes.

848. Upchurch, Sam B. 1972. The Great Lakes Basin. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4: 4-11 to 4-50.

This paper consists of the location, geology, physiography, population and culture, climate, temperature, precipitation, winds and storms, and runoff of the Great Lakes Basin.

849. Upchurch, Sam B. 1972. Lake basin physiography. In: Limnology of Lakes and Embayments. Great Lakes Basin Comm. Ann Arbor, Mich. Great Lakes Basin Framework Study. 1(Draft 2)Appendix 4: 4-51 to 4-78.

This is a physiographic study including low water datum and drainage for the Great Lakes Basin (including Lake Erie).

850. Upchurch, Sam B. 1972. Natural weathering and chemical loads in the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 401-415.

Natural and cultural chemical loads can be estimated and differentiated for the Great Lakes Basin. Some modern loading estimates are obtained through use of U. S. and Canadian water quality data from populated drainage basin. Where insufficient data are available, loads are estimated by comparing the lithology of the surficial material and the material exposed at the pre-Pleistocene erosional surface to water quality and discharge data from streams with little cultural contamination. Extrapolation is made to unsampled basins of similar discharge and geology. Correlation studies of the Raquette and Maumee Rivers exemplify the response of chemical loads to temporal changes and to lithologic control and provide a basis for relating loading to weathering. Natural loads are based upon historical data.

Chemical constituents for which loads are estimated include: total dissolved solids (TDS), $Cl^-$, $PO_4^{-3}$, $Ca^{+2}$ and $SiO_2$ aq. The loading rates of $Ca^{+2}$ and $SiO_2$ aq reflect lithologic source materials, $Ca^{+2}$ loading from carbonate terranes in the Erie and Ontario drainage basins and $SiO_2$ aq loading in those basins where igneous and metamorphic rocks prevail. TDS, $Cl^-$ and $PO_4^{-3}$ reflect urban and agricultural loads which are important in Lakes Michigan, Erie and Ontario.

851. Upham, Warren. 1891. Glacial lakes in Canada. Geol. Soc. Am. Bull. 2:243-276.

Besides giving a definition and evidence of glacial lakes, this paper describes the lakes throughout the provinces of Canada. Lake Erie is referred to in Ontario Province in regard to its geologic history. (BL)

852. Upham, Warren. 1894. Departure of the ice sheet from the Laurentian Lakes. Geol. Soc. Am. Bull. 6:21-27.

This is an abstract that discusses the glacial lakes. Reference is made to Lake Warren which covered part of Lake Erie in terms of outflow. (BL)

853. Upham, Warren. 1895. Late glacial or Champlain subsidence and reelevation of the St. Lawrence River Basin. Am. J. Sci. 49(289):3-18.

The glacial lakes are now represented by the diminished but still large modern Great Lakes. The outlets prove that the great Pleistocene water bodies which occupied the basins were lakes, not arms of the sea. The western Erie glacial lake formed two distinct beaches: the Van Wert, 200-220 feet above Lake Erie and the Leipsic ridge, 190-210 feet above lake level, separated by a vertical interval of 15-25 feet. The various glacial lakes are described as are their beach ridges and terraces. All submergence is ascribed to ice-dammed lakes. (BECPL)

854. Upham, Warren. 1895. Stages of recession of the North American ice-sheet shown by glacial lakes. Am. Geologist. 15(6):396-399.

Description of the formation and stages of succession of the glacial lakes covering the Erie Basin is made in reference to the general discussion on the stages of recession of the North American ice-sheet. (SM)

855. Upham, Warren. 1896. Origin and age of the Laurentian Lakes and of Niagara Falls. Am. Geologist. 18:169-177.

General discussion of the glacial history of the Great Lakes Basin and reference to Lake Erie outlets in the Niagara Falls area. (SM)

856. Upham, Warren. 1896. Preglacial and postglacial valleys of the Cuyahoga and Rocky Rivers. Geol. Soc. Am. Bull. 7:327-348.

A glacial history of the Cuyahoga and Rocky Rivers is presented with reference to the geology of the area. Stratigraphic cross sections and descriptions of the beaches along Lake Erie at Cleveland, Ohio are given. (BL)

857. Upham, Warren. 1897. Cuyahoga preglacial gorge in Cleveland, Ohio. Geol. Soc. Am. Bull. 8:7-13.

Through the study of well records around Cleveland, Ohio, data was obtained for drift depth. A discussion of probable drainage conditions, epeirogenic movements, and deposition of glacial and modified drift is also presented. (BL)

Van Horn, Frank R. - See: H. P. Cushing, et al, No. 177.

858. Van Oosten, John. 1948. Turbidity as a factor in the decline of Great Lakes fishes with special reference to Lake Erie. Trans. Am. Fish. Soc. 75:281-322.

Lake Erie waters were no clearer 50 years ago than they are now. The annual average of inshore waters dropped by 44 ppm before 1930 to 32 ppm in 1930, and the April-May values decreased from 72 ppm to 46 ppm. Any decline in Lake Erie fishes cannot be attributed to turbidity. Turbidity in open waters of Lake Erie are primarily the result of wave action induced by wind. Other factors are discharge, plankton, eastward water mass movement, currents, seiches, and possibly bacteria. Reference is made to conditions relating to turbidity of the other Great Lakes. (CCIW)

859. Van Oosten, John and R. Hill. 1947. Age and growth of the lake whitefish, Coregonus clupalformis (Mitchell), in Lake Erie. Trans. Am. Fish. Soc. 77:178-249.

A correlation between meteorological-limnological conditions (temperature, precipitation, sunlight, turbidity, wind velocity) and fluctuations in the strength of the year classes of the Lake Erie whitefish was not detected though it was not ruled out that the weather at the time of spawning, embryological development, hatching, and early growth does not influence success of reproduction. (BU)

Van Tuyl, Donald W. - See: John W. Mangan, et al, No. 466.

860. Verber, James L. 1952. Nomographs for determining seiche periods. Science. 116(3003):62.

A sample computation for Lake Erie's seiche period is given. Included are two nomographs, one for a short or shallow lake, and one for long or deep lakes. The nomographs express the seiche period in minutes or hours and are based on Merian's formula. (BU)

861. Verber, James L. 1953. Surface water movement, Western Lake Erie. Ohio J. Sci. 53(1):42-46.

Drift cards show surface water movement, but no stable flow patterns can be established by using drift cards. The drift cards averaged 6.5 miles per day. There is a direct correlation between wind movement and surface flow. (SE)

862. Verber, James L. 1953. Tenative summary of studies of water movements in Lake Erie. In: Lake Erie Pollution Survey. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. p. 136.

This summary contains a description of the five principal water movements in Lake Erie and their cause and effect.

863. Verber, James L. 1955. Bibliography of physical limnology 1791-1954. Ohio Dept. Nat. Resources. Div. Geol. Surv. Lake Erie Geol. Res. Prog. Columbus, Ohio. Rept. Invest. 25. Contrib. 4. 57 p.

Contains both a bibliography and subject index of the literature relating to physical limnology with special emphasis on the Great Lakes. Lake Erie literature is cited under the subject headings dealing with the pertinent physical parameters.

864. Verber, James L. 1955. The climates of South Bass Island, Western Lake Erie. Ecology. 36(3): 388-399.

A thorough discussion of the climatology of South Bass Island and Lake Erie, covering temperature, precipitation, evaporation, frost-free periods, fog, winds, solar radiation, and water temperature for the microclimate of South Bass Island. A pronounced tempering effect of Lake Erie is noticed. (BU)

865. Verber, James L. 1966. Inertial currents in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:375-379.

The Great Lakes-Illinois River Basins Project has completed field studies on currents in Lakes Michigan, Erie, and Ontario. One of the dominant effects appears to be that the earth's rotation produces right hand acceleration to the currents. The effect of the earth's rotation on water movements in the Great Lakes has been portrayed in a film. Five patterns of flow are displayed: straight-line flow, sinusoidal or oscillatory, half moon, circular or spiral, and rotary or screw. Inertial flow is found in the Great Lakes at all depths and in all seasons as well as under ice cover. With few exceptions, such as the Straits of Mackinac and shallow inshore stations, some type of inertial flow is evident in the Lakes.

866. Verber, James L. and D. H. Stansbery. 1953. Caves in the Lake Erie Islands. Ohio J. Sci. 53(6): 358-362.

Discussion entailed in this paper covers the caves on South Bass Island and their formation. The authors uphold Kraus' theory of anhydrite into gypsum. The source of gypsum is in the Tymochtee shaly dolomite underlying the Put-in-Bay dolomite. The water seepage is well filtered and the water in the caves lag by about three hours behind primary oscillations of Lake Erie. The surface features of elliptical depressions with caves at the edges show that collapse has taken place. (SE)

Verduin, Jacob - See: Gladys L. McMillan, No. 473.

867. Verduin, Jacob. 1952. Photosynthesis and growth rates of the diatom communities in Western Lake Erie. Ecology. 33(2):163-168.

Comparison of an Asterionella-Cyclotella community with a Stephanodiscus community growing in Western Lake Erie near Pelee Island showed that the photosynthetic rate and respiration rate of the former were approximately twice those of the latter. The natural growth rate of the Asterionella-Cyclotella community was about 3 times that of the Stephanodiscus community. Although the Stephanodiscus community grew in water having a depth (18 m) about twice that of the Asterionella-Cyclotella habitat (8 m), the euphotic zone represented about one-half the water column in both communities, because the water in the Stephanodiscus community was less turbid (7ppm) than in the Asterionella-Cyclotella community (15 ppm). (BU)

868. Verduin, Jacob. 1953. The suspended silt in Western Lake Erie during the spring of 1951. In: Lake Erie Pollution Survey. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. pp. 130-133.

This is a study on the silt retained in suspension in Western Lake Erie after the spring rains had injected their silt loads.

869. Verduin, Jacob. 1954. Phytoplankton and turbidity in Western Lake Erie. Ecology. 35(4):550-561.

In conjunction with the phytoplankton studies, the turbidity of water samples has been studied. These data afford an opportunity to assess relationships between turbidity and phytoplankton abundance from the accumulated data of several years sampling over an extensive area. Determinations of the light quenching effectiveness of suspended particles in waters of the Bass Island region are also presented. Maps are presented showing horizontal distribution of turbidities in an area comprising about one half of Western Lake Erie. The highest turbidities were found consistently in the Bass Island region. (BU)

870. Verduin, Jacob. 1956. Primary production in lakes. Limnology and Oceanography. 1:85-91.

A year-round study under completely natural conditions in Western Lake Erie showed winter yields of approximately 40 millimoles per square meter per day and summer maxima of about 300. The annual curve followed the solar radiation curve closely. (CCIW)

871. Verduin, Jacob. 1960. Phytoplankton communities of Western Lake Erie and the $CO_2$ and $O_2$ changes associated with them. Limnology and Oceanography. 5(4):372-380.

The importance of turbulence in the aquatic environment necessitates some qualitative measure of it. The eddy diffusivity is such a parameter. Because the waters of Western Lake Erie show no consistent trend in temperature characteristics, the usual method of determining eddy diffusivity by solving a heat transport equation has never been applied. Eddy diffusivity in Western Lake Erie, computed from pH change in a dysphotic zone and vertical pH gradients, is about 25 sq cm/sec. (BU)

872. Verduin, Jacob. 1962. Energy flow through biotic systems of Western Lake Erie. Great Lakes Basin. Am. Assoc. Adv. Sci. Pub. 71. pp. 107-121.

Western Lake Erie has a high vertical turbulence which is created by the seiche-generated currents. The eddy diffusivity averages 25 sq cm/sec. Measurements of light penetration and concentration of suspensoids have yielded an extinction coefficient (k) relating the dry weight of suspensoids (mgm/l) to the depth associated with 1% of surface light intensity (mean k = 0.13).

873. Verduin, Jacob. 1963. Radioactivity of suspensoids in aquatic environments of Northwestern Ohio. Ohio J. Sci. 63(1):39-43.

Suspensoids in aquatic environments in Northwestern Ohio contained between 12 to 23 times more radioactivity per gram than was present in the dissolved solids of the environment. No positive correlation was observed between radioactivity of suspensoids and phytoplankton volume.

874. Verduin, Jacob. 1964. Changes in Western Lake Erie during the period 1948-1962. Verh. Internat. Verein. Limnol. 15:639-644.

A brief mention of the Maumee River and siltation processes, the homogeneity of the Western Basin due to seiche displacement, and a comparison of the Maumee and Detroit Rivers.

875. Verduin, Jacob. 1969. Man's influence on Lake Erie. Ohio J. Sci. 69(2):65-70.

Conversion of Northwestern Ohio's Great Black Swamp to farm land during the last half of the nineteenth century had a profound, but scantily documented influence on Lake Erie. Silts, once largely filtered out by the swampland vegetation, were, with the destruction of that vegetation, carried into Lake Erie, where their effect in reducing light penetration has significantly altered the lake's biota.

Ver Steeg, Karl - See: W. Stout, et al, No. 702.

876. Ver Steeg, Karl. 1933. The thickness of the glacial deposits in Ohio. Science. 78(2029):459.

Discussion of glacial drift in Northern Ohio and the shores of Lake Erie. It appears that the drift is only up to 20 feet in thickness on the shore as compared to an average of 51 feet in the buried uplands. The old Cuyahoga Valley at the bottom lays 586 feet below the present Lake Erie. It was found that the greatest thickness can be found south of Cleveland at 763 feet in the course of the preglacial or interglacial Cuyahoga River. (BL)

877. Ver Steeg, Karl. 1936. The buried topography of Western Ohio. J. Geol. 44:918-939.

Paper deals with the geologic formation, geomorphology, and the original topography of Ohio (western), prior, during,

and after the glacial periods. Reference is made to the formation of the drainage systems into the Erie Basin encompassing the major river systems flowing into the Basin in Northern Ohio. The Lake Erie depression is also discussed with its formation. Much of the paper deals with bedrock data collected and plotted on base maps and the interpretation of the data. (BL)

878. Ver Steeg, Karl and George Yunck. 1935. Geography and geology of Kelleys Island. Ohio J. Sci. 35(6):421-433.

This paper discusses much of Kelleys Island physical characteristics including its glacial history. The economics and culture of this region are also included. (SE)

879. Visher, S. S. 1941. Some climatic influences of the Great Lakes. Am. Meteor. Soc. Bull. 24(5): 205-210.

The south shore of Lake Erie, with only five dense fog days a year, has less fog than any other coastal area except for Southern Florida. (BL)

880. Wagner, R. H. 1974. Environment and Man. W. W. Norton and Company, Inc. New York, N. Y. pp. 116-119.

A general discussion of the death of a lake is given, citing Lake Erie's western portion as an example.

881. Wall, R. E. 1968. A sub-bottom reflection survey in the Central Basin of Lake Erie. Geol. Soc. Am. Bull. 79:91-106.

A geophysical survey of the Central Basin of Lake Erie was carried out in 1960. The survey track consisted of 18 lines run normally to the lake's axis at five mile intervals and two lines run parallel to the long axes of the lake. Subbottom reflection data show four reflecting horizons extensive enough to be mapped. (BL)

Walters, Lester J. - See: T. L. Kovacik, No. 409.

882. Walters, Lester J., C. E. Herdendorf, L. J. Charlesworth, H. K. Anders, W. B. Jackson, E. J. Skoch, D. K. Webb, T. L. Kovacik and C. S. Sikes. 1972. Mercury contamination and its relation to other

physico-chemical parameters in the Western Basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 306-316.

Preliminary results of a limnological cruise to collect water and sediment samples and to conduct field measurements of lake and atmospheric conditions in Western Lake Erie during an eleven-day period in June 1971 are presented. The objective of the survey was to determine the distribution of mercury in the water, sediment and benthic organisms of the Western Basin and its relationship to other physico-chemical properties of the water and sediment. Water samples, sediment cores and benthic organisms were taken at 63 stations, on a five-minute latitude-longitude grid, throughout the Basin. Six other stations were concentrated at the mouth of the Detroit River.

Water flow patterns are illustrated by chloride, conductivity and temperature contours, showing the dominating influence of Detroit River flow into the Western Basin of Lake Erie. Three water masses enter Lake Erie at the mouth, a midchannel flow low in temperature and mineralization and two contaminated edge flows. The mercury concentrations in the sediment reflect the same patterns. The highest values in Western Lake Erie occur under a stagnant water zone along the Michigan shore southwest of the river's mouth.

883. Walters, Lester J., Thomas Kovacik and Charles E. Herdendorf. 1974. Mercury occurrence in sediment cores from Western Lake Erie. Ohio J. Sci. 74(1):1-19.

The Detroit River is the major source of mercury contamination in the sediments of Western Lake Erie. Analyses of 63 sediment cores indicate that the mercury consists of two components: a high-concentration (0.5 to 4.0 ppm of dry sediment) mercury-enriched surface zone, whose concentration decreases pseudo-exponentially with depth, and a low-concentration (0.04 to 0.09 ppm of dry sediment) relatively constant-background zone. Mathematical modeling of the mercury concentration as a function of depth in these sediment cores and subsequent statistical analysis of the apparent constant-concentration levels reveals that two log-normal distributions are necessary to describe these observed constant concentrations. Any mercury concentration within the sediment in excess of the lower (natural) background level plus one standard deviation is defined as being due to pollution. Such calculations of the pollution component for these 63 cores serve as the basis for an estimate of the total mercury that has been added through pollution sources. The mercury-pollution load for bottom sediments of Western Lake Erie is estimated to be 228 metric tons.

884. Watkins, Dorothy G. 1953. Bibliography of Ohio geology. Ohio Div. Geol. Surv. Bull. 52. 103 p.

Bibliography of Ohio geology, 1819-1950, which is subject indexed of all literature pertaining to geology and mineral resources of the state. Lake Erie literature is cited and the geology of areas adjacent to the basin as well as the geologic processes are noted. (SM)

885. Watt, A. K. 1962. Surface and groundwater supplies in Ontario. In: H. J. Pincus (Ed.), Great Lakes Basin. Am. Assoc. Adv. Sci. Washington, D. C. pp. 269-276.

The surface water and groundwater supplies of Ontario are reviewed. Ontario has an area of 412,582 square and has a wide range of geologic conditions accounting for a wide range in the quality and quantity of its water supplies.

Although present water sources appear adequate, rapid residential and industrial development in several areas has contributed to water supply problems. The Water Resource Commission, which has general controls over water supply and pollution in Canada, and its recent actions are reviewed. Also the public water supply systems of the province are surveyed. Water supply conditions are poorest in those counties adjoining Lake Erie and parts of Lake Huron and Lake Ontario. A pipeline project is discussed and additional projects are under consideration. In conclusion, the high cost of piping water from the Great Lakes to inland districts in Southern Ontario is the principal deterrent at the present for many municipalities with water supply problems. (BU & SM)

Webb, D. K. - See: L. J. Walters, et al, No. 882.

886. Webb, M. S. and D. W. Phillips. 1973. An estimate of the role of lake effect snowstorms in the hydrology of the Lake Erie Basin. Water Resources Res. 9(1):103-117.

The role of lake effect snowstorms in the hydrology of the Lake Erie Basin is estimated by using climatological data. By comparing monthly snowfall over areas affected by lake effect storms off Lake Erie and Lake Huron/Georgian Bay with a nearby nonaffected area, it was possible to isolate the contribution from frontal storm systems (including their augmentation due to orography) and from lake effect storm activity. These latter storms were found to contribute only 6% of the mean seasonal snowfall over the entire basin. For the snow belt southeast of Lake Erie, lake effect snowstorms provided less than 20% of the total seasonal snowfall. This percentage is low in comparison with other Great Lake snow belts because of the diminished storm activity resulting from the freezing over of Lake Erie by midwinter. The water equivalent of all snowfall over the Lake Erie Basin is equivalent to a 1.07-foot depth over the Lake Erie area. Only 0.06 foot of this depth results from lake effect snowstorm activity.

Weeks, Owen B. - See: David C. Chandler, No. 134.

887. Weickmann, Helmut K. 1972. Man-made weather patterns in the Great Lakes Basin. In: Proceedings of the First Federal Conference on the Great Lakes. Interagency Committee on Mar. Sci. and Eng. Federal Council for Sci. and Technology. Washington, D. C. pp. 205-219.

For the past five years NOAA has studied the weather modification potential of the Great Lakes Region. Numerous observations of artificial rain and snowfall have been made in the Buffalo region of Lake Erie. Climatologically, the Great Lakes Region is peculiar in that its numerous relationships between the water surfaces and the air exert particularly strong influences in the atmospheric boundary layer. In winter the entire Great Lakes Basin has a high frequency of shallow cloud layers which, upon traveling across the still unfrozen and warm lakes, form the basic ingredient for the development of Lake storms. The Basin is the seat of many industries whose pollution potential not only affects the hydrology and ecology but also the weather. The shallow cloud layers occur with sufficient depth to present a favorable precipitation potential but they are frequently not cold enough to produce ice crystals naturally. Consequently, these cloud systems constitute a source of artificial precipitation which is so far unexploited. Seeding applications are being discussed.

888. Weiler, R. R. and V. K. Chawla. 1968. The chemical composition of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 593-608.

The major and trace element concentrations during the summer and fall of 1967 in Lake Erie are presented. The distribution and concentration of ions in the main body of the Lake and at the mouth of various rivers is discussed in the light of the 1967 and earlier information. A brief discussion of the seasonal as well as long-term changes in the composition of the Lake is given. Also included are the physical parameters that influence the Lake's homogeneous composition. The conductivity and major ion concentrations at various stations throughout Lake Erie are likewise included along with the report.

889. Weiler, R. R. and V. K. Chawla. 1969. Dissolved mineral quality of Great Lakes waters. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 801-818.

In 1968 the Canada Centre for Inland Waters (CCIW) undertook a systematic monitoring of Lakes Ontario, Erie, Huron and Superior in a study of the major (Ca, Mg, Na, K, $SO_4$, Cl, $HCO_3$ and F) and trace (Zn, Cu, Pb, Fe, Ni, Cr, Mn and Sr) elements. The data gathered on major elements during the period July to November 1968 were examined and the results compared on a lake-wide basis with earlier compilations to appraise recent trends and changes in the composition of these waters. Lake-wide comparison of the trace element compositions of the Great Lakes waters is discussed.

890. Weiss, Morris. 1970. Water surface temperature measurements using airborne infrared techniques. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. Pt. 2. pp. 978-989.

Techniques for rapidly measuring water surface temperature over large areas to an absolute accuracy of better than 0.5-1.0°C are now routine. This is accomplished with the aid of highly sensitive, rugged infrared radiometers used on airborne platforms. This paper briefly describes the infrared physics and principles of IR radiometry applied to airborne water surface temperature measurements. Examples are given of a variety of measured surface temperature patterns related to aerial surveys of the Great Lakes, thermal pollution of bodies of water from power plant water usage, and temperature patterns obtained from a satellite. Limitations of measurement accuracy and some methods for correcting the data are discussed including the use of narrow band optical filters, employing field derived altitude-air temperature corrections, and the use of slant measurements for determining the atmospheric background produced errors.

891. Welch, Paul S. 1952. Limnology. McGraw-Hill Book Co., Inc. New York, N. Y. 538 p.

General references are made, citing Lake Erie as an example, under the topics of discussion dealing with thermal stratification, seiches (computation of the period of oscillation), subsurface seiches and varves.

White, George W. - See: R. P. Goldthwaith, et al, No. 262, 263.

892. White, George W. 1926. The limestone caves and caverns of Ohio. Ohio J. Sci. 26(2):73-116.

The limestone caves of Ohio are described as to location, geological formation, type, stratigraphy, and mapping. The Put-in-Bay area contains numerous caves formed in such a way that the floor and roof at one time seem to have been in contact and not by the usual method of solution of the rock along joint planes. Anhydrite, it is hypothesized, changed to gypsum (which is soluble in water) and was removed leaving the space of the present caves. Also described are caves in Crystal Rock Park, 8 miles west of Sandusky and three-fourths of a mile south of Lake Erie. (BU)

893. White, George W. 1953. Sangamon soil and early Wisconsin loesses at Cleveland, Ohio. Am. J. Sci. 251:362-368.

This article discusses the stratigraphy of 5 feet of Sangamon soil which rests upon leached Illinoian gravel and is overlain by a Wisconsin sequence of two fossiliferous loesses, lacustrine clay, silt, and till in the vicinity of Cleveland, Ohio. The lower loess is about 3.5 feet thick and includes an upper one-foot layer weathered to an incipient soil. The upper loess is 1.5 feet thick and calcareous throughout. The role of deposition is discussed in regard to the glacial lakes. (BU)

894. White, George W. 1968. Age and correlation of Pleistocene deposits at Garfield Heights, Cleveland, Ohio. Geol. Soc. Am. Bull. 79:749-752.

Radiocarbon dates and new exposures in the Mill Creek Valley in Garfield Heights, just southeast of Cleveland, Ohio, now permit a revised correlation of the Pleistocene deposits.

Illinoian gravel is overlain by thick paleosol, Sangamonian in age. Above the paleosol is "Lower loess," 4 feet thick, fossiliferous in the lower calcareous part, and late Altonian in age; it is overlain by calcareous, fossiliferous "Upper loess," 2.5 feet thick, dated 28,195 ± 535 radiocarbon years BP and therefore early Farmdalian in age. Above this is pro-Kent lacustrine silt and clay with beetle fragments (described in the following paper by G. R. Coope); wood in the lowest part is dated as 24,600 ± 800 and 23,313 ± 391 years BP. Kent Till overlying the lacustrine material is therefore about 23,250 years BP and thus earliest Woodfordian. Hiram Till, later Woodfordian, overlies the Kent Till and is the surface material. (BL)

895. White, George W. 1971. Glacial geology of Trumbull County, Ohio. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 80. 1 map, 1 sheet.

Trumbull County, in the northern part of the Allegheny Plateau, is underlain chiefly by almost horizontal beds of sandstone and shale of Mississippian and Pennsylvanian ages. Old valleys are cut below the general bedrock surface. Only the principal ancient valleys coincide with the present valley of the Grand River. (SM)

896. White, I. C. 1881. The geology of Erie and Crawford Counties. Penn. Second Geol. Surv. Rept. Prog. (1879). Q4:1-355.

The geology and topography of Erie and Crawford Counties, Pennsylvania, includes the lakeshore of Lake Erie. Geologic formations and their lithology are discussed. Included are references to the county drainage, slopes, and their observed lake levels. (SM)

White, Walter F., Jr. - See: John W. Mangan, et al, No. 466.

897. Whiting, H. 1831. Remarks on the supposed tides and periodical rise and fall of the North American Lakes. Am. J. Sci. 20(2):205-219.

While the main part of this report deals with observations of levels of Lake Michigan, part of the discussion includes changes in the Detroit River. Easterly winds drive an increased volume of water down from Lake St. Clair which accumulates at the outlet to Lake Erie and causes an unusual elevation of the Detroit River. (BECPL)

898. Whittlesey, Charles. 1838. Mr. Whittlesey's report. In: W. W. Mather (Ed.), Second Annual Report on the Geological Survey of the State of Ohio. Medary Printer to the State. Columbus, Ohio. pp. 50-58.

Report on water levels and data collected from 1796 through 1838 is presented. Reasons for level changes and physical factors affecting the levels are presented by the author as well as information on the existence of a tide. Flooding conditions and a mechanism for a return of "normal" levels is presented. The lithology and physiography of the land adjacent to the Erie Basin is also discussed. One geological cross sectional map is included. (SM)

899. Whittlesey, Charles. 1850. On the natural terraces and ridges of the country bordering Lake Erie. Am. J. Sci. 10:31-39.

The elevations of the lake ridges at numerous points between the Pennsylvania state line and Sandusky Bay are determined by surveying. The results are thought to be fairly accurate, except for a possible discrepancy of 3 feet (an amount that points to changes in the surface of the Lake). The author believes that the ridges do not represent ancient beaches, but sub-marine deposits as they are not horizontal at their base. The composition of the ridges is essentially the same: coarse, water-washed, yellowish sand or fine.gravel, with flat and worn rock fragments. (BECPL)

900. Whittlesey, Charles. 1851. On the "superficial deposits" of the north-western part of the United States. Am. Assoc. Adv. Sci. Proc. 5:54-59.

Report covers the extent and description of the drift material, briefly citing its occurrence in the Erie Basin. The author also mentions the blue, marly clays in the Western Erie Basin and the occurrence of boulders in the Cleveland area. (SM)

901. Whittlesey, Charles. 1874. Sudden fluctuations of level in quiet waters - records of observations. Am. Assoc. Adv. Sci. Proc. 23:139-143.

Recorded are eight incidents of sudden level changes that have occurred in Lake Erie from 1811 to 1867. Most cite waves reaching heights of up to 20 feet. (SM)

902. Whittlesey, Charles. 1875. On fluctuations of level in Lake Erie. Canadian Nat. 7(7):407-414.

On the supposition that the Lake in calm weather is approximately level, readings made simultaneously at Detroit, Cleveland, and Buffalo may be regarded as representing one plane surface. It appears that the three stations had some periods of time in common, so the data could be brought together as one series of observations good for the entire Lake. The monthly averages for 1838 to 1853 are combined into one expression in the form of curves. The importance of using the mean water level (taking extreme low water into consideration) is pointed out. (BECPL)

903. Whittlesey, Charles. 1879. Ancient glacial action, Kelleys Island, Lake Erie. Am. Assoc. Adv. Sci. Proc. (1878). 27:239-245.

The glacial markings including grooves, striations, and troughs exposed during quarrying activities on the north side of Kelleys Island are examined and described in terms of direction (bearing), location, size, and profile. (SM)

904. Wiggin, B. L. 1950. Great snows of the Great Lakes. Weatherwise. 3(6):123-236.

An account of heavy snow storms from 1930 is discussed by the author. Also discussed are the factors that operate to produce heavy lake snowstorms and a summary of observations that have been noted for a long period of time of the snowstorms of the past.

Wilbert, J. L. - See: J. F. Paul, No. 561.

Williams, E. G. - See: Richard Lowright, et al, No. 461.

905. Williams, J. D. H. and Tatiana Mayer. 1972. Effects of sediment diagenesis and regeneration of phosphorus with special reference to Lakes Erie and Ontario. In: H. E. Allen and J. R. Kramer (Eds.), Nutrients in Natural Waters. John Wiley & Sons, Co. New York, N. Y. pp. 281-315.

Eutrophication reversal is discussed with consideration of possible influence of phosphorus regeneration from sediments on time required to reverse eutrophication, net phosphorus regeneration from sediment columns in idealized and actual situations, mechanisms for nutrient transfer from sediments, phosphorus forms, forms and amounts of phosphorus in Great Lakes sediment, and analysis of piston core samples. If inputs of phosphorus and nitrogen were reduced or increased to a new constant level, the concentrations of total phosphorus and nitrogen would asymptotically approach a new mean steady-state value. Provided oxic conditions are maintained, reduction in phosphorus input should result in more rapid attainment of a new mean steady-state phosphorus concentration than would be predicted if the role of sedimentation is ignored. The prevalent view is that, given a sufficient period of time and provided the rate of input of phosphorus is controlled sufficiently, even the most eutrophic lake will revert to an oligotrophic condition. If this is done, regeneration of a part of the excess of phosphorus that accumulated in the sediments during the eutrophic conditions may extend the transition period and delay the attainment of oligotrophic conditions, but the ultimate trophic state of the lake should not be affected. (SE)

906. Wilson, Alfred W. G. 1908. Shoreline studies on Lakes Ontario and Erie. Geol. Soc. Am. Bull. 19:471-500.

In 1908 Wilson wrote this paper describing two of the Great Lakes in terms of their topography, shore processes, and movements of the lake waters. (BL)

907. Wilson, Ira T. 1943. Varves in Sandusky Bay sediments. Ohio J. Sci. 43(5):195-197.

While determining the quantity and distribution of the sediment in Sandusky Bay near the western end of Lake Erie for the Division of Conservation of Ohio, the writer found the deposits to be varved. Since several nearly complete cores of sediment were secured, an estimation of the total number of varves has been possible. Estimates of three cores have been made, two in the Bay proper and one at the edge of the Bay. This last core penetrated 10 feet of deposit that lies above the level of the Bay floor that is not represented in the other two borings. Since it represents as complete a profile as is likely to be found of the lacustrine deposits of the glacial waters that covered Northwestern Ohio for a considerable part of post-glacial time, it was thought that the varve count might be of interest to glaciologists.

Wilson, M. - See: R. K. Fahnestock, et al, No. 227.

908. Winchell, N. H. 1873. The surface geology of North-

western Ohio. Am. Assoc. Adv. Sci. Proc. (1872). 21:152-186.

The glacial drift, moraine, and ridges of the western end of Lake Erie are discussed in terms of their location, external form, contents, altitude above Lake Erie, and origin. In general, the drift is found to overlay the bedrock to a height of six hundred feet above the level of Lake Erie. (SM)

909. Winchell, N. H. 1874. Report on the geology of Ottawa County. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Vol. 2, Pt. 1, Sec. 2. pp. 227-235.

This is a detailed study on the geology of Ottawa County. Reference is made to drainage and the Portage River. (BL)

910. Winchell, N. H. 1876. Vegetable remains in the drift deposits of the Northwest. Am. Assoc. Adv. Sci. Proc. 24(2):43-56.

This report traces the discovery of vegetation and woods buried along the counties that border Lake Erie. The sediment depth and types are mentioned. (SM)

911. Winchester, John W. 1969. Pollution pathways in the Great Lakes. Limnos. 2(1):20-24.

This article deals with the pollution of the Lakes with regard to cleansing by natural processes. The parameters include residence time, outflow and winds.

Winklhofer, A. R. - See: J. O. Blanton, No. 51, 52.

912. Wisner, G. Y. 1898. The rainfall and outflow of the Great Lakes. Mon. Wea. Rev. 26(5):215-216.

This report contains corrections made to water surplus calculations in Abbe (1898, 26:164-166) so correlation with measured values will be obtained. The discharge into the Niagara River for mean lake level will probably prove to be about 235,000 cu ft/sec rather than the 250,000 previously used. The runoff from the surrounding watershed is estimated at 33 per cent. For Lake St. Clair plus Lake Erie, total supply equals 27.8 feet and total discharge is 25.5, leaving 2.3 feet for evaporation and errors. (BECPL)

913. Wolfert, David R. and J. K. Hiltunen. 1968. Distri-

bution and abundance of the Japanese snail, Viviparus Japonicus, and associated macrobenthos in Sandusky Bay, Ohio. Ohio J. Sci. 68(1):32-34.

A description of the physical characteristics of Sandusky Bay is given, taking into account depth, bottom composition, turbidity, and water temperature.

914. Wood, K. G. 1963. The bottom fauna of Western Lake Erie, 1951-52. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10: 258-265.

A brief description of the organic sediments found in the dredging operations in Western Lake Erie for bottom fauna is mentioned.

915. Wright, George Frederick. 1884. The Niagara River and the glacial period. Am. J. Sci. (3rd Ser.). 28(163):32-35.

This article discusses the preglacial channel at St. Davids, an alternate outlet for Lake Erie due to the 200-foot level change below the present level next to the Niagara River. A comparison is made of the downcutting, questioning the recession of Niagara Falls with respect to other streams draining into Lake Erie in similar stratas. (SM)

916. Wright, George Frederick. 1890. The glacial boundary in Western Pennsylvania, Ohio, Kentucky, Indiana and Illinois. U. S. Geol. Surv. Bull. 58. pp. 39-110.

This report deals mainly with observations of the limits of direct glacial action of which tills and transported boulders serve as evidence. Observation of the character of the till in the vicinity of Oberlin, Ohio, was made along with reference to Lake Erie level in relation to deposition. Transport of Lake Erie sediment is also noted for the glacial advance in the vicinity under discussion. (SM)

917. Wright, George Frederick. 1890. The lake ridges of Ohio and their probable relations to the lines of glacial drainage into the valley of the Susquehanna. Am. Assoc. Adv. Sci. Proc. (1889). 38:247.

Abstract of paper read at the meeting. Drainage of the glacier that was present to supply the Erie-Niagara Basin also accounts for the loess and deposits in Chesapeake Bay, which received glacial drainage from the Erie-Ontario glacial lakes' surplus water. (SM)

918. Wright, George Frederick. 1891. The glacial grooves on Kelleys Island to be preserved. Science (1st Ser.). 17(438):358-359.

A written account of the measures taken to protect and preserve part of the glacial grooves found on Kelleys Island from mining interests operating on the island. Also included is a brief discussion of the geological formation, evidences of direction of glacial flow, and the causes and effects of the grooves. (BU)

919. Wright, George Frederick. 1892. Outlets to the Great Lakes. Nation. 55(1421):217-219.

Discussion of the outlets in glacial history of Niagara and Chicago. Mentioned are the level changes and geologic evolution of water flow through the Great Lakes. (BU)

920. Wright, George Frederick. 1898. A recently discovered cave of celestite crystals at Put-in-Bay, Ohio. Science. 8:502-503.

Brief article describing the discovery of a cavern (huge geode), lined with celestite crystals in the waterline formation of the Lower Helderberg on Put-in-Bay Island. (BL)

921. Wright, George Frederick. 1898. Supposed "corduroy Road" of late glacial age, at Amboy, Ohio. Am. Assoc. Adv. Sci. Proc. 47:298.

A report on the discovery of a series of logs, lying side by side as in a corduroy road, covered by thirty feet of gravel in which were also found a tooth and tusk of a mammoth. The logs were probably of driftwood origin, buried by accumulation of gravel along the glacial shore of Lake Erie at a level 150 feet higher than at present. (SM)

922. Wright, Stillman and Wilbur M. Tidd. 1933. Summary of limnological investigations in Western Lake Erie in 1929 and 1930. Trans. Am. Fish. Soc. 63:271-285.

This study was undertaken following claims made by fishermen that their reduced catch was caused by pollution. The parts of the Lake in which there was definite evidence of pollution, as evidenced by high albuminoid ammonia, were characterized by low nitrite and nitrate as compared with the parts of the Lake in which the evidence of pollution was less definite or lacking. Stations included the Portage, Maumee, Raisin and Detroit Rivers to determine the extent of polluting substances contributed. Conditions in the lower parts of the Maumee and Raisin Rivers and in small areas of the Lake near their mouths have been made unfavorable or prohibitive to all except the most tolerant fishes by reason of the low content of $O_2$ and high content of $CO_2$. In addition, considerable areas of the bottom near the Maumee, Raisin and Detroit Rivers have been rendered unfit for spawning purposes by the deposition of organic debris. However, it should be recognized that a large part of the polluted area probably was never suitable for spawning due to the deposition of silt. (CCIW)

923. Wykes, Colin E. 1967. A limnological study of Blue Springs Creek, the Upper Grand River, 1966-67. M. S. Thesis. Univ. Guelph. Guelph, Ont. 101 p.

Selected physical, chemical, and biological characteristics of Blue Springs Creek, Ontario, were observed for a 55-week period between June 1965 and June 1966. Twice-weekly minimum and maximum water temperatures were highly correlated with minimum and maximum air temperatures, respectively. Bi-monthly changes in the following pairs of factors were negatively correlated: pH and concentrations of free $CO_2$, stream discharge and levels of Ca hardness, stream discharge and total hardness levels, stream discharge and concentration of total dissolved solids. Positively correlated were: bi-monthly changes in levels of Ca hardness and total hardness, bi-monthly changes in levels of total hardness and concentrations of total dissolved solids. The distribution of fish was affected by different temperatures and habitats within Blue Springs Creek. The low biomass or productivity compared to other trout streams was probably a result of a thick layer of silt on the stream bed, limiting good spawning areas and suitable micro-habitat for the progeny. (CCIW)

924. Young, G. A. 1926. Geology and economic minerals of Canada. Canadian Dept. Mines. Geol. Surv. Economic Geol. Ser. 1. pp. 68-82.

This article briefly discusses the occurrence of salt, gypsum, petroleum, and natural gas in the vicinity of Southern Ontario between Lakes Erie and Ontario. (SM)

Yunck, George - See: Karl Ver Steeg, No. 878.

Zaebat, K. - See: R. M. Pfister, et al, No. 576.

925. Zubkoff, Paul L. and Walter E. Carey. 1970. Neutron activation analysis of sediments in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 319-325.

Sediment cores, 15 cm in depth, were obtained in February, May and August of 1969 from a location (long. 82°50'50"W; lat. 41°41'30"N) which has been under biological surveillance for more than 15 years (Britt, Skoch and Smith, 1968). The centers of 1 cm lateral sections of these cores were washed free of interstitial water and subjected to a 2.0 x $10^{11}$ neutron $cm^{-2}$ $sec^{-1}$ flux in the Ohio State University Research Reactor.

Analysis of the resulting gamma-ray spectra, obtained with a NaI(Tl) crystal, indicate a uniform concentration [μg/g] of Al, (61,000), V (500), Mn (478), Na (3,144), La (8.7), Cr (319), and Sc (5.1). These data indicate that V and Cr are present in quantities at least three times greater than those normally reported for soils.

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## VII. ABBREVIATIONS

| | |
|---|---|
| Acad. | Academy |
| Admin. | Administration |
| Adv. | Advancement |
| Agric. | Agriculture |
| Am. | American |
| Ann. | Annual |
| ASChE | American Society of Chemical Engineers |
| ASCE | American Society of Civil Engineers |
| ASME | American Society of Mechanical Engineers |
| Assoc. | Association |
| BECPL | Buffalo and Erie County Public Library |
| Biol. | Biology, Biological |
| BL | Bell Library - State University N.Y. at Buffalo |
| Bot. | Botany |
| BU | Butler Library - New York State University College at Buffalo |
| Bull. | Bulletin |
| CA | Calspan Corporation Library |
| Calif. | California |
| CCIW | Canada Centre for Inland Waters Library |
| CE | Corp of Engineers - Buffalo District Library |
| Chem. | Chemistry, Chemical |
| Circ. | Circular |
| Co. | Company |
| Comm. | Commission |
| Conf. | Conference |
| Conn. | Connecticut |
| Cons. | Conservation |
| Contrib. | Contribution |
| Cult. | Cultural, Culturist |
| Dept. | Department |
| Dev. | Development |
| Div. | Division |
| Ecol. | Ecological |
| Ed. | Editor |

Eng. --------------------------------Engineering
Engr. ------------------------------Engineer
Env. -------------------------------Environment, Environmental
Exp. -------------------------------Experiment, Experimental
Fish. ------------------------------Fishery
Gaz. -------------------------------Gazette
Geog. ------------------------------Geographic, Geographical,
Geography
Geol. ------------------------------Geologic, Geological,
Geology
Geophys. ---------------------------Geophysical
GLL --------------------------------Great Lakes Laboratory
Library
Ill. -------------------------------Illinois
Inc. -------------------------------Incorporated
Info. ------------------------------Information
Inst. ------------------------------Institute
Internat. --------------------------International
Invest. ----------------------------Investigation
J. ---------------------------------Journal
Lab. -------------------------------Laboratory
LO ---------------------------------Lockwood Library - State
University New York
at Buffalo
Mag. -------------------------------Magazine
Mar. -------------------------------Marine
Mass. ------------------------------Massachussetts
Memo. ------------------------------Memorandum
Meteor. ----------------------------Meteorological, Meteorology
Mich. ------------------------------Michigan
Micro. -----------------------------Microscopical
Mid. -------------------------------Midland
Mon. -------------------------------Monthly
Mono. ------------------------------Monographs
Nat. -------------------------------Natural
No. --------------------------------Number
NOAA -------------------------------National Oceanic and
Atmospheric Admin.
N.Y. -------------------------------New York
Okla. ------------------------------Oklahoma
Ont. -------------------------------Ontario
p. ---------------------------------Page
pp. --------------------------------Pages (inclusive)
_p. --------------------------------Pages (total in report)
Pt. --------------------------------Part
Penn. ------------------------------Pennsylvania
Petrol. ----------------------------Petrology
Phil. ------------------------------Philosophical

Pop. --------------------------------Popular
Proc. ------------------------------Proceedings
Prog. ------------------------------Progress, Progressive
Pub. -------------------------------Publication
Rept. ------------------------------Report
Res. -------------------------------Research
Rev. -------------------------------Review
RL ---------------------------------Ridge Lea Library - State
University New York
at Buffalo
Sci. -------------------------------Science, Scientific
SE ---------------------------------Science and Engineering
Library - State
University New York
at Buffalo
Sec. -------------------------------Section
Sed. -------------------------------Sedimentary
Ser. -------------------------------Series
SM ---------------------------------Buffalo Museum Science
Research Library
Soc. -------------------------------Society
Spec. ------------------------------Special
Surv. ------------------------------Survey
Tech. ------------------------------Technical
Trans. -----------------------------Transactions
Univ. ------------------------------University
U.S. -------------------------------United States
Vol. -------------------------------Volume
Wea. -------------------------------Weather
Wisc. ------------------------------Wisconsin