Inventory and Evaluation of Information on Delaware Bay

volume 3

Prepared Under the Direction of
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Newark, Delaware
for THE DELAWARE RIVER BASIN COMISSION

Funded by Sea Grant No. 1-35377 and the National Geographic Society

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Volume III

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Samples of zooplankton collected from 1929 to 1935 at 40 stations in the Delaware Bay. Copepods dominated. There is a wide annual temperature range (0-25 degrees C) so few organisms occur throughout year. Has 19 figures and 4 tables with detailed information.

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Delaware Bay Transportation Company is owned by four oil companies; has been joined by nine others to form and finance the feasibility study group. Their plan, presented December 1970 at Dover, consists of the following elements: Use of large supertankers; an offshore terminal located 6 1/2 miles off Big Stone Beach. Two submerged pipelines connecting this receiving terminal to the shore, offshore tank storage facilities on property owned by the above oil companies, an onshore pipeline from the storage facilities to the participating refineries. There is complete assurance that these plans are in line with concern for the preservation of the environment. The history and details of the project are discussed, map, graph, and 2 engineering drawings of proposed facility.

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The presently transgressing sea has a marginal low and intermediate energy zone of tidal marshes and lagoons, protected from the wave energy of the open ocean by barrier beaches. Peats and muds are being deposited in the tidal marshes, sands and muds in the lagoons. The sands are largely derived from the ocean and deposited as tidal deltas, which start as gaps in the barrier beaches and grow across the lagoon toward the mainland. Implications for sedimentology and stratigraphy.

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100. Geological Survey (1964) HYDROLOGIC INVESTIGATIONS ATLAS

REF: *See* U. S. Documents, Department of the Interior

101. Ghyben, B. W. (1889) NOTA IN VERBAND MET DE VOORGENOMEN PUT BORING NABIJ AMSTERDAM

REF: K. Inst. Ing. Tijdschr., The Hague, 1888-1889.

102. Goldfield, M. O., R. P. Kandle, and Sussman (1967) PROGRESS REPORT ON ARBOVIRUS STUDIES IN NEW JERSEY

*In 1966 only one case of arbovirus encephalitis was recognized in a New Jersey hospital. This was a California virus. Most of the potential host isolations have been from mammals. A natural cycle of mammals--*Aedes *mosquitoes--has been suggested. This finding makes the continued surveillance of California virus activity imperative. This study has been greatly expanded in New Jersey.*

REF: Proceedings of the 54th Annual Meeting of the New Jersey Mosquito Extermination Association, pages 15-19, Rutgers, The State University, New Brunswick, New Jersey

103. Gowanloch, N. J. (1935) POLLUTION BY OIL IN RELATION TO OYSTERS

REF: American Fisheries Society, Transactions, volume 65, page 293, 1935. Washington, D. C.

104. Graham, R., and C. A. Lesser (1970) COOPERATIVE MIGRATORY BIRD CENSUSING AND BANDING

REF: *See* U. S. Documents, Department of the Interior, U. S. Fish and Wilflife Service

105. Groot, J. J. (1955) SEDIMENTARY PETROLOGY OF THE CRETACEOUS SEDIMENTS OF NORTHERN DELAWARE IN RELATION TO PALEOGRAPHIC PROBLEMS

REF: *See* Delaware Documents, University

106. Groot, J. J. (1966) SOME OBSERVATIONS ON POLLEN GRAINS IN SUSPENSION IN THE ESTUARY OF THE DELAWARE RIVER

Pollen spectra of samples of suspended and bottom sediments in the Delaware River estuary represent the regional vegetation of the basin as a whole rather than local plant communities. There appears to be a relationship between the number of pollen grains and the quality of mineral matter in suspension suggesting that the two types of particles are transported together and in similar fashion, that is, primarily by water currents.

REF: Marine Geology, volume 4, number 6, pages 409-416, 1966.

107. Groot, J. J., D. M. Organist, and H. G. Richards (1954) MARINE UPPER CRETACEOUS FORMATION OF THE CHESAPEAKE AND DELAWARE CANAL

REF: *See* Delaware Documents, University

108. Haefner, P. A., Jr. (1964) MORPHOMETRY OF THE COMMON ATLANTIC SQUID AND THE BRIEF SQUID IN DELAWARE BAY

Growth rate, length frequency, weight-length ratios, and change of body shape are presented and discussed.

REF: Chesapeake Science, volume 5, number 3, pages 138-144, 1964. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland.

109. Haefner, P. A., Jr., and C. N. Shuster, Jr. (1964) LENGTH INCREMENTS DURING TERMINAL MOLT OF THE FEMALE BLUE CRAB IN DIFFERENT SALINITY ENVIRONMENTS

The study was initiated to determine if observed differences in the size of adult female blue crabs in the Delmarva Peninsula area were related to the salinity of the environmental waters in which the crab undergoes the terminal molt. No significant correlation was found.

REF: Chesapeake Science, volume 5, number 3, pages 114-118, 1964. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland

110. Halliday, W. B. (1967) ECONOMIC ASPECTS OF THE DELAWARE RIVER ESTUARY PROGRAM

REF: *Presented to* American Association of Cost Engineers, July 1967. University of Alabama, University, Alabama

111. Hardison, C. H., and R. O. R. Martin (1963) WATER SUPPLY CHARACTERISTICS OF STREAMS IN THE DELAWARE RIVER BASIN AND IN SOUTHERN NEW JERSEY

REF: *See* U. S. Documents, Department of the Interior

112. Harleman, D. R. (1966) TIDAL DYNAMICS IN ESTUARIES: II, REAL ESTUARIES

A mathematical model is developed for cooscillating tide in Delaware estuary. Data are given for the geometric characteristics of the Delaware estuary. Tidal amplitude ratio vs. distance from Trenton. Phase change KX vs. X for the Delaware estuary. Damping parameter, UX vs. X - for Delaware estuary maximum tidal discharge vs. distance from Trenton. Variation of tidal energy dissipation along Delaware estuary. Tidal data for Delaware estuary, and maximum tidal discharge and velocity, Delaware estuary.

REF: Chapter 10, part 2, pages 522-545, *in* Estuary and Coastline Hydrodynamics, Ippen, A. T., ed. McGraw-Hill Book Company, Inc., New York, New York

113. Harman, O., (1968) ENVIRONMENTAL CONTROL SYSTEM FOR OYSTER FARMING

REF: *See* Delaware Documents, University

114. Harmic, J. L. (1969) A PROPOSAL FOR THE CREATION OF A DIVISION OF MARINE RESOURCES

REF: *See* Delaware Documents, State

115. Harrison, W., J. J. Norcross, and E. M. Stanley (1967) CIRCULATION OF SHELF WATERS OFF THE CHESAPEAKE BIGHT

REF: *See* U. S. Documents, Environmental Science Services Administration, Washington, D. C.

116. Headlee, T. J. (1945) THE MOSQUITOES OF NEW JERSEY AND THEIR CONTROL

Structure, classification, and keys; the New Jersey mosquito fauna; mosquito biology; environmental influence; history of mosquito control in New Jersey; mosquito repellants; laws relating to mosquito control; economic effect of mosquito reduction.

REF: Rutgers University Press, Rutgers, The State University, New Brunswick, New Jersey

117. Heck, L. W. *et. al.* (1966) DELAWARE PLACE NAMES

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

118. Hely, A. G., and F. H. Olmsted (1963) SOME RELATIONS BETWEEN STREAM FLOW CHARACTERISTICS AND THE ENVIRONMENT IN THE DELAWARE RIVER REGION: CONTRIBUTIONS TO STREAM-BASIN HYDROLOGY

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

119. Henderson, C., W. Johnson, and A. Inglis (1969) ORGANOCHLORINE INSECTICIDES RESIDUES IN FISH (NATIONAL PESTICIDE MONITORING PROGRAM)

REF: Pesticide Monitoring Journal, volume 3, number 3, page 157, December 1969. Pesticides Program, Food and Drug Administration, 4770 Buford Highway, Building 29, Chamblee, Georgia

120. Henry, H. G. (1964) INTERFACES BETWEEN SALT WATER AND FRESH WATER IN COASTAL AQUIFERS

REF: *See* U. S. Documents, Department of the Interior

121. Henry, K. A., C. M. Beardon, E. B. Joseph, and J. W. Reintjes (1965) ATLANTIC MENHADEN

REF: Atlantic States Marine Fisheries Commission, Tallahassee, Florida, 1965.

122. Herzberg, B. (1901) DIE WASSERVERSORGUNG EINIGER NORDSEEBADER (THE WATER RESOURCES OF SOME RESORTS ON THE NORTH SEA)

REF: Journal Gasbeleuchtung und Wasserversorgung (Journal of Manufactured Gas and Water Resources), Jahrgang 44, Munich, 1901.

123. Hess, P. W. (1961) FOOD HABITS OF TWO DASYATID RAYS IN DELAWARE BAY

REF: *See* Delaware Documents, University

124. Hillman, R. E. (1961) FORMATION OF THE PERIOSTRACUM IN MERCENARIA

REF: Science Magazine, volume 134, number 3492, pages 1754-1755, American Association for the Advancement of Science, Washington, D. C., 1961

125. Hoak, R. D. (1961) THE THERMAL POLLUTION PROBLEM

REF: Federal Water Pollution Control Administration, Journal, volume 33, number 12, page 1267. U. S. Department of the Interior, Washington, D. C.

126. Hoeh, R. S. (1966) WATER RESOURCES ADMINISTRATION IN DELAWARE

REF: *See* Delaware Documents, University

127. Hopkins, T. L. (1965) MYSID SHRIMP ABUNDANCE IN SURFACE WATERS OF INDIAN RIVER INLET, DELAWARE

REF: Chesapeake Science, volume 1, number 2, pages 86-91, Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland

128. Humphries, E. M., and F. C. Daiber (1968) SHELLFISH SURVEY OF INDIAN RIVER BAY AND REHOBOTH BAY, DELAWARE

REF: *See* Delaware Documents, University

129. Hurlburt, E. M. (1957) DISTRIBUTION OF NEOMYSIS IN THE ESTUARY OF THE DELAWARE RIVER

REF: *See* Delaware Documents, University

130. Ippen, A. T. ed. (1966) ESTUARY AND COASTLINE HYDRODYNAMICS

Contents: (1) small amplitude wave theory, (2) finite amplitude waves, (3) wave generation by wind, deep and shallow water, (4) tides and harmonic analysis, (5) engineering aspects of hurricane surge, (6) wave refraction, diffraction, and reflection, (7) harbor resonance, (8) interaction of structures and waves, (9) coastal

processes, (10) tidal dynamics in estuaries (part 2 concerns the Delaware Estuary), (11) the mechanism of an arrested saline wedge, (12) diffusion processes in stratified flow, (13) salinity intrusion in estuaries, (14) pollution in estuaries, (15) sedimentation in estuaries, (shoals in Delaware Estuary composed largely of very fine silicon dioxide), (16) field experience in estuaries, (17) model laws for coastal and estuarine models, (18) tidal and salinity model practice, 744 pages, indexes.

REF: McGraw-Hill Book Company, Inc., New York, New York

131. Ippen, A. T. (1966) TIDAL DYNAMICS IN ESTUARIES: I, ESTUARIES OF RECTANGULAR SECTION

Mathematic descriptions of tides with and without friction; experimental results on cooscillating tides; 21 references. Passing references to Delaware River in this chapter part and to the Delaware Estuary in chapter 15, sedimentation in estuaries.

REF: Chapter 10, part 1, pages 493-522, *in* Estuary and Coastline Hydrodynamics, Ippen, A. T., ed., McGraw-Hill Book Company, Inc., New York, New York, 1966.

132. Ippen, A. T., and D. R. F. Harleman (1961) ONE-DIMENSIONAL ANALYSIS OF SALINITY INTRUSION IN ESTUARIES

REF: *See* U. S. Documents, Department of Defense, Army Corps of Engineers

133. Isard, W. (1969) ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM

REF: *See* U. S. Documents, Councils and Commissions, National Council on Marine Resources and Engineering Development

134. Jones, J. R. E. (1964) FISH AND RIVER POLLUTION

The effects on fish of pollution by: oxygen-reduction, toxic materials and metals, respiratory depressants, detergent, pesticides, phenolics, inorganic gases, acids

and alkalis, and complex effluents. Discussions of thermal pollution, inert suspended matter, and the responses of fish eggs to pollutants.

REF: Butterworths, London, 1966. Butterworth, Inc., Washington, D. C.

135. Jordan, R. R. (1962) STRATIGRAPHY OF THE SEDIMENTARY ROCKS IN DELAWARE

REF: *See* Delaware Documents, University

136. Jordan, R. R. (1964) COLUMBIA (PLEISTOCENE) SEDIMENTS OF DELAWARE

REF: *See* Delaware Documents, University

137. Jordan, R. R. (1967) GUIDEBOOK, 8TH ANNUAL FIELD CONFERENCE, DELAWARE, 1967

Conference, 7-8 October 1967 and field trip of 109 miles with descriptive notes of the places of geologic interest visited. Has 63 pages.

REF: Atlantic Coastal Plain Geological Association, Academy of Natural Sciences, Philadelphia, Pennsylvania

138. Jordan, R. R. (1969) SUSPENDED AND BOTTOM SEDIMENTS IN THE DELAWARE ESTUARY

Abstracts of papers presented in meetings in 1968. Suspended and bottom sediments in the Delaware Estuary, major clay minerals. Sediment concentration, textural parameters, and mineralogy do not show clear correlation with location, current velocities or directions, salinity or other measured variables in the estuary. Preliminary conclusions are: (1) transportation through Delaware estuary appears to have little effect on textures or mineralogy of suspended sediment; (2) upper portion of estuary is filling with stream-derived sediment, and this deposition is selective only with regard to sand sizes; (3) lower bay is filling with coarse materials probably derived from the Continental Shelf and the Ocean Shores; (4) the estuary is so agitated, mostly by tidal

currents, that the transportation of suspended sediment is not a very selective process.

REF: Special Paper number 121, page 357, 1969. Geological Society of America, Boulder, Colorado. *Also* Abstracts of 1968 meeting, Northeastern Section, Geological Society of America, pages 37-38.

139. June, F. C., and J. W. Reintjes (1957) SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY

REF: *See* U. S. Documents, Department of the Interior, U. S. Fish and Wildlife Service

140. June, F. C., and J. W. Reintjes (1962) PROGRESS REPORT ON MENHADEN STUDIES

REF: Transactions of the 21st annual meeting of the Atlantic States Marine Fisheries Commission, Tallahassee, Florida

141. Kalber, F. A., Jr. (1959) WHERE DOES THE SHORELINE BEGIN?

REF: *See* Delaware Documents, State

142. Kaplovsky, A. J. (1951) SURVEY OF POLLUTION AND ITS EFFECT UPON THE STREAMS WITHIN THE MISPILLION RIVER DRAINAGE BASIN

REF: *See* Delaware Documents, State

143. Kaplovsky, A. J. (1952) STUDY OF THE ACCUMULATION AND DISTRIBUTION OF IRON WASTE DISCHARGES WITHIN THE DELAWARE RIVER ATTRIBUTED TO DISCHARGES ORIGINATING WITHIN THE STATE OF DELAWARE

REF: *See* Delaware Documents, State

144. Kaplovsky, A. J. (1952) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT UPON THE WATERS WITHIN THE RED CLAY CREEK DRAINAGE BASIN

REF: *See* Delaware Documents, State

145. Kaplovsky, A. J. (1954) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT UPON THE WATERS WITHIN THE BRANDYWINE CREEK DRAINAGE BASIN

REF: *See* Delaware Documents, State

146. Kaplovsky, A. J. (1956) INVESTIGATION OF SANITARY WATER QUALITY IN LOWER DELAWARE RIVER *PART I* AND *PART II*

REF: *See* Delaware Documents, State

147. Kaplovsky, A. J. (1957) ESTUARINE POLLUTION SURVEYS

Seven sampling stations from Pennsylvania- Delaware line to Smyrna River at the beginning of Delaware Bay, for a distance of 35 miles. Data presented for December 1956 include: temperature, dissolved oxygen, pH, BOD, turbidity, total iron, color, coliform count, chloride, hardness, ammonia, nitrate, nitrite, odor, ash, and volatiles.

REF: Sewage and Industrial Wastes, Journal, volume 29, pages 1042-1053, September 1957. Federation of Sewage and Industrial Waste Associations, Washington, D. C.

148. Kaplovsky, A. J. (1959) TIDEWATER'S DELAWARE REFINERY: WASTE CONTROL AND TREATMENT: EVALUATION OF TREATMENT METHODS

Sampling points to 5 miles from the refinery into Delaware Bay. Sanitary and chemical data from the same area are presented for 1956 through 1958.

REF: Sewage and Industrial Wastes, Journal, volume 31, pages 432-442, 1959. Federation of Sewage and Industrial Waste Associations, Washington, D. C.

149. Kaplovsky, A. J., and D. B. Aulenbach (1956) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT ON THE WATERS WITHIN THE INDIAN RIVER DRAINAGE BASIN

REF: *See* Delaware Documents, State

150. Keighton, W. B. (1966) FRESH-WATER DISCHARGE--SALINITY RELATIONS IN THE TIDAL DELAWARE RIVER

REF: *See* U. S. Documents, Department of the Interior

151. Keighton, W. B. (1969) WATER QUALITY IN THE DELAWARE ESTUARY FOR TWO YEARS OF DROUGHT--1965 and 1966--FROM TRENTON TO REEDY ISLAND

REF: *See* U. S. Documents, Department of the Interior

152. Kent, R. E. (1958) TURBULENT DIFFUSION IN A SECTIONALLY HOMOGENEOUS ESTUARY

The U. S. Army Corps of Engineers Delaware Estuary model at Vicksburg was used to verify a theoretical development. An equation is derived which involves a variable coefficient of eddy diffusion.

REF: Technical Report 16, reference 58-1, 1958. Chesapeake Bay Institute, The Johns Hopkins University, Baltimore, Maryland

153. Kent, R. E. (1960) DIFFUSION IN A SECTIONALLY HOMOGENEOUS ESTUARY

Turbulent diffusion in a well-mixed tidal estuary is considered. A theory is presented from which quantitative predictions of mean pollutant concentration distribution may be obtained for an estuary characterized by a steady-state salinity and velocity fields which are considered to vary only in the axial direction. Flushing investigations were conducted by the Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Mississippi, on the model of the Delaware River and Bay Estuary; these data were employed in the present study. Representative data demonstrating the agreement between the model and prototype salinities are given in figure 2. There are 14 figures and 17 references.

REF: American Society of Civil Engineers, Proceedings, Sanitary Engineering Division, volume 86, pages 15-47, 1960.

154. Ketchum, B. H. (1952) DISTRIBUTION OF SALINITY IN THE ESTUARY OF THE DELAWARE RIVER

To determine the relationship between river flow and the salinity in various parts of the estuary of the Delaware River, the study included a review of data on the distribution of fresh and salt water in the coastal water immediately outisde the Delaware Capes. The salinity is inversely related to river flow; under present natural conditions the range of variation of salinity expected for the high and low river flows would be greatest near the head of the bay; the predicted changes are found farther downstream during high river flows and farther up-stream during low flows.

REF: Reference 52-103, pages 1-52, December 1952. Woods Hole Oceanographic Institute, Woods Hole, Massachusetts

155. Ketchum, B. H. (1953) PRELIMINARY EVALUATION OF THE COASTAL WATER OFF DELAWARE BAY FOR THE DISPOSAL OF INDUSTRIAL WASTES

Summary of data for 1951-1952; salinity and temperature of the waters and recent studies for the U. S. Navy Hydrographic Office. About 3000 drift bottles were released in the area immediately off Delaware Bay extending about 50 miles along the coast and 40 miles offshore. The local currents and rates of exchange have been evaluated. Enumerates general coastal conditions, conditions of circulation, distribution of salinity, and temperature off the bay, the rate of circulation, drift-bottle returns, flushing times and diluting volumes in the bay, and recommendations on waste disposal in the proposed disposal area.

REF: Reference 53-31, 1953. Woods Hole Oceanographic Institute, Woods Hole, Massachusetts

156. Ketchum, B. H., and D. J. Keen (1955) ACCUMULATION OF RIVER WATER OVER THE CONTINENTAL SHELF BETWEEN CAPE COD AND CHESAPEAKE BAY

The depth mean salinities for the waters of the Continental Shelf show a seasonal variation in the concentration of river water. The spring and the winter accumulations are about the same, but about 25% more river water is present in the summer. The total volume of fresh water in spring and winter is equivalent to that produced by the rivers in about one and a half years. The extra accumulation in summer is equal to

a half year's flow and reflects, in part, the fact that the high spring flows of two successive years are present on the shelf at this time. Drainage areas and flows from Delaware are presented, and the horizontal mixing coefficients normal to the coast have been computed.

REF: Deep-Sea Research and Oceanographic Abstracts, volume 3, supplement, pages 346-357, 1955. Pergamon Press, Elmsford, New York

157. Kinsman, G. (1965) NOTES OF TIDES, SEICHES, AND LONG WAVES

Part 1, empirical analysis of the tide, astonomical background, and data reduction processes. Part 2, tidal dynamics, solutions of motion and continuity under the assumption that friction is negligible. Part 3, the effect of friction on the tide, a necessary consideration in shallow water. Bibliography. Index.

REF: "...unpublished material.... restricted to the personal use of the individual...the Department of Oceanography, Johns Hopkins University," Baltimore, Maryland

158. Klein, W. H. (1957) PRINCIPAL TRACKS AND MEAN FREQUENCIES OF CYCLONES AND ANTICYCLONES IN THE NORTHERN HEMISPHERE

REF: *See* U. S. Documents, Department of Commerce

159. Kraft, J. C. (1968) COASTAL SEDIMENTARY ENVIRONMENTS LEWES-REHOBOTH BEACH, DELAWARE

Many varied sedimentary environments are under study. Environments include bays, inlets from open marine and tidal deltas, baymouth bars and dunes, marshes and tidal creeks, transgressive beaches and marsh fringes of Delaware Bay. Preliminary results are summarized. Has 13 pages.

REF: Guidebook, Annual Fieldtrip of the Northeastern Section, Society of Economic Paleontologists and Mineralogists, Tulsa, Oklahoma, September 1968

160. Kraft, J. C. (1968) TRANSGRESSIVE FACIES PATTERNS IN DELAWARE COASTAL AREA

Studies of recent sediments in coastal Delaware show complex sediment-distribution patterns resulting from lateral and vertical movements of successive environments of deposition over a Pleistocene unconformity. Recent sediments are infilling a drowned topography with a local relief of 70 feet and possibly up to 125 feet eroded on highly variable Pleistocene sediments. Cores of sediments taken under shallow bays (Rehoboth, Indian River and Assawoman Bays) and in fringing marsh environments show that the depositional units are thin, highly irregular in areal extent, extremely variable in thickness, and difficult to project. Sedimentary processes active in the shallow bays include shoreline marsh erosion and formation of thin, possibly ephemeral beach-dune complexes of clean well-sorted sand.

REF: Abstracts, Annual Meeting, Oklahoma City, 1968. *In* American Association of Petroleum Geologists, Bulletin, volume 52, page 537, 1968. Tulsa, Oklahoma

161. Kraft, J. C. (1969) RECENT MARINE AND NON-MARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS

REF: *See* U. S. Documents, Councils and Commissions, National Council on Marine Resources and Engineering Development

162. Kraft, J. C. (1971) SEDIMENTARY FACIES PATTERNS AND GEOLOGIC HISTORY OF A HOLOCENE TRANSGRESSION

Holocene sediments in coastal Delaware show complex sediment distribution patterns resulting from lateral and vertical movement of successive environments of deposition over a Pleistocene unconformity. These sediments are infilling a drowned topography. Larger depositional features forming around eroding Pleistocene headlands and infilling the estuaries include characteristic shoreline environments, such as dunes, spits, and baymouth barriers, a network of intertidal deltas, nearshore marine erosional-depositional sands and gravel, and lagoons or estuaries, with adjoining marshes.

REF: Geological Society of America, Bulletin, volume 82, pages 2131-2158, 1971. Boulder, Colorado

163. Kraft, J. C., and M. D. Maisano (1968) GEOLOGIC CROSS SECTION OF DELAWARE

REF: *See* Delaware Documents, University

164. Kraft, J. C., and G. Margules (1969) CORRELATION OF FORAMINIFERA DISTRIBUTION WITH SEDIMENT FACIES PATTERMS AND PHYSICAL DATA IN INDIAN RIVER BAY, COASTAL DELAWARE

The physiographic setting, bottom-sediment facies patterns, and salinity, temperature, pH, Eh, and organic content of the water mass and bottom sediments of the Indian River Estuary compared with the distribution of living benthonic foraminifera. Twelve genera, 23 facies, of foraminifera identified and separated into 6 geographically distinctive facies groups. Bottom sediment types range from dark grey mud in center and west to a well-sorted clean sand in the tidal delta to the east. No significant correlation found between patterns of foraminifera abundance and the distribution of sediment types.

REF: Special Paper number 121, page 361, 1969. Geological Society of America, Boulder, Colorado. *Also* Abstracts of the 1968 Meeting, Northeastern Section, Geological Society of America, page 41.

165. Krimgold, D. B. (1969) HYDROLOGIC, PHYSIOGRAPHIC, EDAPHIC, AND VEGETATION ASPECTS OF THE CLIMATIC WATER BALANCE, DELMARVA PENINSULA

REF: *See* Delaware Documents, University

166. La Brecque, M. (1971) THE SCIENCES

REF: Volume 2, number 2, 1971. New York Academy of Sciences, New York

167. Lack, N. (1966) BILLIONS FOR THE MILLIONS

REF: Water Research Foundation, Wilmington, Delaware

168. Lauff, G. H., ed. (1964) ESTUARIES

Papers presented at conference on estuaries held at Jekyll Island, Georgia, 31 March - 3 April 1964. Subjects: definitions, physical factors, geomorphology, sediments and sedimentations, microbiota nutrients and biological production, ecology and population, physiology and evolution, fisheries, and human influences. Much of the discussion is general, but the Delaware Estuary is mentioned a few times.

Papers on "physical factors" concern circulation and diffusion, circulation in Coastal Plain estuaries, salt balance and circulation in partially mixed estuaries, salinity measurements, and methods and devices for measuring currents.

"Sediments and sedimentation" papers deal with origin of sediments, sediment transport, rates of sediment accumulation, littoral drift and tidal inlets, sediments of Chesapeake Bay, and the compactness variability of estuarine sediments.

REF: Publication number 83, American Association for the Advancement of Science, Washington, D. C.

169. Lesser, C. A. (1966) AQUATIC VEGETATION SURVEY

REF: *See* Delaware Documents, State of Delaware, Board of Game and Fish Commissioners

170. Lesser, C. A. (1968) MARINE FISHERIES SURVEY

REF: *See* Delaware Documents, State

171. Liberman, C., J. M. Rosbrow, and H. Rubenstein (1967) DELAWARE CITIZEN: GUIDE TO ACTIVE CITIZENSHIP IN THE FIRST STATE

The contents support the title; in part they include basic law, how the members of the government are chosen, natural resources, housing, education, welfare, social security, public safety, and the operation of the state and county services.

REF: Taplinger Publishing Company, Inc., 29 East 10th Street, New York City

172. Livingstone, D. A. (1963) CHEMICAL COMPOSITION OF RIVERS AND LAKES

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

173. Luff, M. C., Jr., (1968) DELAWARE'S OVERNIGHT TOURIST INDUSTRY

REF: *from* The Annual Report of the Delaware State Development Department (1967-1968), pages 2-3, Dover, Delaware.

174. MacCreary, D. (1940) REPORT OF THE TABANIDAE OF DELAWARE

REF: *See* Delaware Documents, University

175. MacKichon, K. A., and J. C. Krammorer (1961) ESTIMATED USE OF WATER IN THE UNITED STATES

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

176. Maits, B. (1966) THE NATURAL RESOURCES OF DELAWARE

REF: *See* Delaware Documents State

177. Marine, I. W., and W. C. Rasmussen (1955) PRELIMINARY REPORT ON THE GEOLOGY AND GROUND-WATER RESOURCES OF DELAWARE

REF: *See* Delaware Documents, University

178. Mason, W. D., and W. H. Pietsh (1940) SALINITY MOVEMENT AND ITS CAUSES IN THE DELAWARE RIVER ESTUARY

The salinity characteristics of the river are cited in detail. River flows, isochlors, and averages at specific conditions are included. The fresh-water runoffs to achieve certain isochlors at different locations have been calculated.

REF: EOS, American Geophysical Union, Transactions, volume 12, pages 457-463, 1940. Washington, D. C.

179. Mather, J. R. (1968) METEOROLOGY AND AIR POLLUTION IN THE DELAWARE VALLEY

The 11-county lower Delaware Valley area was investigated with regard to availability of data, air flow, atmospheric stability conditions, varying air quality, use of meteorologic conditions to forecast pollution, and detailed interpretation of specific high pollution events. Serious, but not extreme, pollution conditions exist in the highly industrialized Delaware Valley. The potential for very serious pollution certainly exists.

REF: Publications in Climatology, volume 21, number 1, 136 pages, 1968. Laboratory of Climatology, Elmer, New Jersey

180. Mather, J. R. (1969) FACTORS OF THE CLIMATIC WATER BALANCE OVER THE DELMARVA PENINSULA

Chapters: climatic water balance; evaluation of long-term records of the water balance; geographic distribution of the factors of the water balance; influence of soil storage capacity; application of the water balance to water resources problems; computer program to determine monthly water balances.

REF: Publications in Climatology, volume 22, number 3, 129 pages, 1969. Laboratory of Climatology, Elmer, New Jersey

181. Mather, J. R., N. Adams, III, and G. A. Yoshioka (1964) COASTAL STORMS OF THE EASTERN UNITED STATES

Storms resulting in damage to the East Coast over the past 42 years have been classified into: synoptic situations; hurricanes; wave developments in the vicinity of Cuba; wave developments in Florida or the nearly coastal water; wave developments in the Gulf of Mexico; inland depressions; secondary cyclonic disturbances in the Hatteras area, intense cyclones moving northeastward, west of the coast, and strong cold fronts with associated squall lines. The seasonal and geographical distributions of these storm types were investigated. Delaware had 20 storms during this period or about 1 every two years. Of these 8 were of the hurricane type,

etc. 1 storm was severe, 13 moderate, and 6 light. Damage from coastal storms will undoubtably increase significantly in the years to come as development of the coastal area proceeds.

REF: Journal of Applied Meteorology, volume 3, number 6, pages 693-706, 1964. American Meteorological Society, Boston, Massachusetts

182. Mather, J. R., R. T. Field, and G. A. Yoshioka (1967) STORM DAMAGE HAZARD ALONG THE EAST COAST OF THE UNITED STATES

Study of damage during the past 40 years has revealed a significant increase in the past decade. Reasons for this increase are analyzed. Man's generally unrestricted development of the outer coastal margin, as well as a slight intensification of coastal cyclones, has contributed. A storm as damaging as the one in March 1962 would be expected once every 20 years. The New Jersey, Maryland, and Delaware coasts and that from South Carolina to Florida seem to have a relatively low storm damage potential.

REF: Journal of Applied Meteorology, volume 6, number 1, pages 20-30, 1967. American Meteorological Society, Boston, Massachusetts.

183. Maurer, D., and K. S. Price, Jr. (1968) HOLDING AND SPAWNING DELAWARE BAY OYSTERS OUT OF SEASON: I, LABORATORY FACILITIES FOR RETARDING SPAWNING

REF: *See* U. S. Documents, Department of the Interior,

184. McGinnes, B. S. (1955) UPLAND GAME INVESTIGATIONS IN DELAWARE

REF: *See* U. S. Documents, Department of the Interior, U. S. Fish and Wildlife Service

185. McKee, J. E., and H. W. Wolf (1963) WATER QUALITY CRITERIA

REF: Publication 3-A, second edition, 231 pages, 1963. State Water Quality Control Board, Sacramento, California

186. McKenzie, S. W. (1967) INVENTORY OF THE USE OF WATER IN 1966

REF: *See* Delaware Documents, University

187. Metcalf and Eddy, Engineers (1965) REPORT TO CITY OF WILMINGTON, DELAWARE, UPON RAW WATER SUPPLY UPDATED DECEMBER 1964

REF: *See* Delaware Documents, Cities, Counties and Organizations

188. Middleton, F. M., and J. J. Lichtenberg (1960) MEASUREMENTS OF ORGANIC CONTAMINANTS IN THE NATION'S RIVERS

The carbon-filter technique was used to determine variability of contaminant concentrations and revealed important specific contaminants in the 5 major rivers: Columbia, Colorado, Missouri, Mississippi, Ohio.

REF: Industrial and Engineering Chemistry, volume 52, number 6, 99A-102A, June 1960. American Chemical Society, Washington, D. C.

189. Miller, E. G. (1960) CHARACTERISTICS OF TIDE-AFFECTED FLOW OF THE LOWER DELAWARE RIVER

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

190. Miller, E. G. (1962) OBSERVATIONS OF TIDAL FLOW IN THE DELAWARE RIVER: HYDROLOGY OF TIDAL STREAMS

REF: *See* U. S. Documents, Department of the Interior

191. Miller, J. C. (1971) GROUND WATER GEOLOGY OF THE DELAWARE ATLANTIC SEASHORE

REF: *See* Delaware Documents, University

192. Minard, J. P., H. E. Gill, J. F. Mello, J. P. Owens, and N. F. Sohl (1969) CRETACEOUS TERTIARY BOUNDARY IN NEW JERSEY, DELAWARE AND EASTERN MARYLAND

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

193. Model Study Committee (1961) DISPERSION STUDIES ON THE DELAWARE RIVER ESTUARY MODEL AND POTENTIAL APPLICATIONS TOWARD STREAM PURIFICATION CAPACITY EVALUATION

REF: *See* Delaware Documents, State

194. Moody, D. W. (1964) COASTAL MORPHOLOGY AND PROCESSES IN RELATION TO THE DEVELOPMENT OF SUBMARINE SAND RIDGES OFF BETHANY BEACH, DELAWARE

"Offshore there are 14 sand ridges which develop contemporaneously with the westward migration of a barrier beach. These ridges are spaced 500-800 meters apart and meet the barrier beach at 5-6 meter depths below mean low water. Comparison of surveys made in the past 42 years (1919-1961) indicate the ridges have moved southeast a maximum distance of 250 meters while the shoreline has migrated 25-85 meters landward, etc.

"The distribution and stratigraphic relationships of Quaternary Sediments in eastern Sussex County, Delaware, indicate a complex history of erosion and deposition in fluvial, estuarine, and marine environments. As sea level fell during the late Wisconsin glaciation, the ancestral Delaware River probably transported sands and gravel across the coastal plain and continental shelf, etc."

REF: Doctoral dissertation, 167 pages. Dissertation Abstracts, volume 25, number 12, page 7205, 1964. The Johns Hopkins University, Baltimore, Maryland

195. Moody, D. W. (1969) DELAWARE ESTUARY SEDIMENTATION STUDY

REF: *See* U. S. Documents, Councils and Commissions, National Council on Marine Resources and Engineering Development

196. Moody, D. W., and E. D. Van Reenan (1967) HIGH RESOLUTION SUBBOTTOM SEISMIC PROFILES OF THE DELAWARE ESTUARY AND BAY MOUTH

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

197. Moyer, W. J. (1970) CLIMATOLOGICAL DATA

REF: *See* U. S. Documents, Department of Commerce

198. Murphey, F. J. (1969) MOSQUITO CONTROL BY AIRCRAFT

A report about the efforts and problems in Delaware starting in 1947 with spraying of DDT, the switching to BHC in 1954 until 1957 when this material became ineffective. In 1967 the new organophosphate ABATE™ was started after 6 years of development work. The application and results are described.

REF: Report of the Fifth Northeast Aerial Applicators Conference, pages 33-44, Cornell University, Ithaca, New York

199. National Council on Marine Resources and Engineering Development (1968) Daiber, F. C., SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA

REF: *See* U. S. Documents, Councils and Commissions

200. Nemerow, N. L. (1969) BAFFLED BIOLOGICAL BASINS FOR TREATING POULTRY PLANT WASTE

Description of poultry operations at Millsboro, Delaware, on the Indian River Bay 13 miles from the ocean. The successful handling of the effluent is also described. The quality of the intake water is described, using dissolved oxygen, and salinity, physical and chemical analyses for different periods in 1966 and 1967.

REF: Water Pollution Control Federation, Journal, volume 4, number 9, pages 1602-12, 1969, Washington, D. C.

201. O'Connor, D. J. (1960) OXYGEN BALANCE OF AN ESTUARY

The dissolved-oxygen profile depends on the concentration of the organic material, its rate of oxidation, and the resulting rate of aeration. These interrelationships are described by a differential equation under steady state conditions. The assumption of constant coefficients in

the equation is confirmed by field data from estuarine surveys of the Delaware and James Rivers. Chlorides, BOD, and dissolved oxygen values are given and the curves fitted.

REF: Proceedings of the American Society of Civil Engineers, Journal, Sanitary Engineering Division, volume 86 (SA 3), pages 35-55, May 1960. New York, New York

202. O'Connor, D. J., J. P. St. John, and D. M. DiToro (1968) WATER QUALITY ANALYSIS OF THE DELAWARE RIVER ESTUARY

A mathematical model of the Delaware River between Trenton, New Jersey, and Reedy Island was developed. This tidal part of the river was divided into four segments. A substantial amount of water quality data which had been collected by various agencies was available for study.

The 11 figures show ultimate oxygen demand, BOD loading distribution, nitrogen loading observed and calculated oxygen deficit distribution at several different times, effect of flow and loading location on the deficit response, effect of waste treatment on total deficit distribution and projected dissolved-oxygen distribution.

REF: Proceedings, American Society of Civil Engineers; Journal, Sanitary Engineering Division, volume 94 (SA6) page 1225, 1968, New York, New York

203. Odum, E. P. (1969) RELATIONSHIPS BETWEEN STRUCTURE AND FUNCTION IN THE ECOSYSTEM

A discussion on the descriptive and functional approach to nature.

REF: *in* Readings in Conservation Ecology, Cox, G. W., ed., pages 6-20, 1969. Appleton-Century-Crofts, New York, New York

204. Odum, H. T., B. J. Copeland, and E. A. MacMahay (1969) COASTAL ECOLOGICAL SYSTEMS OF THE UNITED STATES: A SOURCE BOOK FOR ESTUARINE PLANNING

A report to the Federal Water Pollution Control Administration. Volume 3 of 3: Bibliography. About 5800 references are listed in 446 pages.

REF: Educational Institute of Marine Sciences, University of North Carolina, Chapel Hill, North Carolina, 1969

205. Oostdam, B. L., and R. N. Swift (1970) VARIATIONS IN TIDAL CURRENTS, SALINITY AND TURBIDITY ACROSS THE DELAWARE BAY MOUTH

Current salinity and turbidity data were collected at five depths throughout complete cycles and used to calculate suspended-sediment transport rates. Suspended water appears to travel in "turbidity clouds". Turbidities increased from top to bottom with distinctly lower values during ebb for the upper 2/3 of the water column. Salinity increased from top to bottom with maximum difference of 2.1 percent just before a slack tide.

REF: Abstracts of the Fifth Annual Meeting, Northeastern Section, Geological Society of America, volume 2, number 1, pages 30-31, 1970.

206. Otton, E. G. (1955) GROUND WATER RESOURCES OF THE SOUTHERN MARYLAND COASTAL PLAINS

Describes the aquifers and geology of the area, the water available and used in 1951. There are chemical analyses of 275 samples.

REF: Bulletin 15, 1955. Maryland Department of Geology, Mines and Water Resources, The Johns Hopkins University, Baltimore, Maryland

207. Outdoor Recreation Resources Review Commission (ORRRC) (1962) OUTDOOR RECREATION FOR AMERICA

REF: *See* U. S. Documents, Councils and Commissions

208. Parker, G. G., *et. al.* (1964) WATER RESOURCES OF THE DELAWARE RIVER BASIN

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

209. Paulson, R. W. (1969) LONGITUDINAL DIFFUSION COEFFICIENT IN THE DELAWARE RIVER ESTUARY AS DETERMINED FROM A STEADY-STATE MODEL

An analytic solution of the one-dimensional steady-state diffusion equation for a conservative substance in an estuary of constant depth in which the half-width is related to the

longitudinal distance and may be found if the turbulent diffusion coefficient is given a general form. Data from Torresdale, Pennsylvania, to Reedy Island, Delaware, where fresh-water inflow has been measured and the channel geometry satisfies the requirements. Salinity data to test the solution were also available for the mathematical modeling. Analysis of data indicates that for low fresh water inflow Kx is of the order of 100 m/sec and that for most operational purposes, Kx may be assumed to be a constant.

REF: Water Resources Research, volume 5, number 1, pages 59-67, 1969. American Geophysical Union, Washington, D. C.

210. Paulson, R. W. (1970) EXPERIENCE WITH COMPUTER USE IN MANAGING WATER-QUALITY DATA IN THE DELAWARE RIVER BASIN

The U. S. Geological Survey--Current Record Center in Philadelphia processes data from 11 automatic water-quality monitors in the Delaware River. Digital computer techniques have been developed to process, edit, and summarize these data.

REF: National Symposium on Data and Instrumentation for Water Quality Management, 1970. Water Resources Center, University of Wisconsin, Madison, Wisconsin

211. Paulson, R. W. (1970) GRAPHICAL SUMMARY OF SPECIFIC CONDUCTANCE DATA FOR THE DELAWARE RIVER ESTUARY

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

212. Paulson, R. W. (1970) VARIATION OF THE LONGITUDINAL DISPERSION COEFFICIENT IN THE DELAWARE RIVER ESTUARY AS A FUNCTION OF FRESHWATER INFLOW

Three solutions of the one-dimensional steady-state diffusion equation for a conservative substance (ocean salinity) were derived for an estuary whose cross-sectional area increases linearly in the seaward direction. The three solutions were tested with U. S. Geological Survey water-quality-monitor data for five stations between Torresdale, Pennsylvania, and Reedy Island. The longitudinal dispersion coefficient in the estuary increased with fresh water inflow to the estuary. This is in disagreement with Harleman (Proc. 2nd

Int'l Water Pollution Res. Conf., Tokyo, 1964. Pergamon Press, N. Y., pages 279-306, 1965.) Has five figures, three tables, and six references.

REF: Water Resources Research, volume 6, number 2, page 576, 1970. American Geophysical Union, Washington, D.C.

213. Pearre, N. C., and A. V. Heyl, Jr. (1960) CHROMITE AND OTHER MINERAL DEPOSITS IN SERPENTINE ROCKS OF THE PIEDMONT UPLAND, MARYLAND, PENNSYLVANIA, AND DELAWARE

REF: *See* U. S. Documents, Department of the Interior

214. Penjerdel (1961) ANNUAL REPORT: 1960-1961

This annual report of the fact-finding and reporting non-profit and nongovernmental organization describes its programs and accomplishments. It includes a review of the Penjerdel conference on open space preservation held on 18 October 1961 at the Cherry Hill Inn in Haddonfield, New Jersey. A program of the conference is available. Among the reports sponsored by Penjerdel is one on open space by A. L. Strong.

REF: Penjerdel (Pennsylvania-New Jersey-Delaware Metropolitan Project, Inc.), 1500 Walnut Street, Philadelphia, Pennsylvania

215. Penjerdel (1961) THE PENJERDEL CONFERENCE ON OPEN SPACE PRESERVATION: NEW PROGRAMS AND PROPOSALS

Program of a conference on 18 October 1961 at the Cherry Hill Inn, Haddonfield, New Jersey

REF: Penjerdel (Pennsylvania-New Jersey-Delaware Metropolitan Project, Inc.), 1500 Walnut Street, Philadelphia, Pennsylvania

216. Peterson, R. T. (1963) FIELD GUIDE TO THE BIRDS: EASTERN LAND AND WATER BIRDS

Includes the appearance, habits and distribution of birds

which live in or migrate through Delaware. Illustrations include waterfowl in flight and at rest.

REF: Peterson Field Guide Series, Houghton Mifflin Company, Boston, Massachusetts

217. Pfitzenmeyer, H. T., and C. N. Shuster, Jr. (1960) PARTIAL BIBLIOGRAPHY OF THE SOFT SHELL CLAM

REF: *See* Delaware Documents, University

218. Pickett, T. E. (1970) NEW GEOLOGIC MAPPING IN DELAWARE

REF: *See* Delaware Documents, University

219. Pickett, T. E., J. C. Kraft, and K. Smith (1969) CRETACEOUS BURROWS--CHESAPEAKE AND DELAWARE CANAL, DELAWARE

Some of best exposures in the Atlantic Coastal Plain of networks of Cretaceous indurated, nodulese, limonitic, sandy tubes (Halymenites major Lesquereux) are found at St. Georges, Delaware, along the beach of the C & D canal. The Cretaceous tubes are morphologically similar to modern littoral zone burrows of the decapod Callianassa major. *They occur in low mound-like structures of 30-40 feet in diameter.*

REF: Special Paper number 121, page 366, 1969, Geological Society of America, Boulder, Colorado. *Also* Abstracts of 1968 meeting, Northeastern Section, GSA, pages 46-47, 1968.

220. Price, K. S., Jr. (1962) BIOLOGY OF THE SAND SHRIMP *Crangon septemspinosa* IN THE SHORE ZONE OF THE DELAWARE BAY REGION

The growth rate, spawning characteristics, and feeding habits were studied.

REF: Chesapeake Science, volume 3, number 4, pages 244-255, 1962. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland

221. Price, K. S., Jr. (1967) COPULATORY BEHAVIOR IN THE CLEARNOSE SKATE, *Raja eglanteria*, IN LOWER CHESAPEAKE BAY

Having captured several females with moles attached to the caudal margin of the female's pectoral fins their copulatory behavior was studied.

REF: COPEIA, number 4, pages 854-855, 1967. American Society of Ichthyologists and Herpetologists, National Museum, Washington, D. C.

222. Price, K. S., Jr. (1970) THE FISHES OF WHITE CREEK, SUSSEX COUNTY, DELAWARE

REF: Unpublished manuscript. College of Marine Studies, University of Delaware, Newark, Delaware

223. Price, K. S., Jr., and E. P. Creaser, Jr. (1967) FLUCTUATIONS IN TWO OSMOREGULATORY COMPONENTS, UREA AND SODIUM CHLORIDE, OF THE CLEARNOSE SKATE, *Raja eglanteria:* I, UPON LABORATORY MODIFICATION OF EXTERNAL SALINITIES: II, UPON NATURAL VARIATION OF THE SALINITY OF THE EXTERNAL MEDIUM

R. eglanteria *from lower Delaware Bay were studied. When acclimated to high salinities, they experienced loss of serum chloride and urea after exposure to lower salinities. After exposure to higher salinities, they experienced increases in serum chloride and urea. These changes produce changes in serum osmotic pressure. No definite depression of chloride values was related to dilution of sea water. Urea values were depressed at lower salinities, although urea values and the resultant serum osmotic pressures were higher at low salinities than expected.*

REF: Comparative Biochemistry and Physiology, volume 23, pages 65-82, 1967. Pergamon Press, Elmsford, New York

224. Price, K. S., Jr., and D. L. Maurer (1971) ARTIFICIAL PROPAGATION OF COMMERCIALLY VALUABLE SHELLFISH--OYSTERS

REF: *See* Delaware Documents, University

225. Pringle, B. H., *et. al.* (1968) TRACE METAL ACCUMULATION BY ESTUARINE MOLLUSCS

The selectivity for trace metals depends upon the metals available in the environment, their chemical and physical properties, the kind and number of ligands available for chelation, transport, and storage, and the stability of the complex formed. The relative toxicities of the various metals also play a prominent role. The rate of depletion of various metals are different for different species, such as the Eastern Oyster, Northern Quohaug, and soft shell crab.

The study was based on the known fact that molluscs are able to concentrate selectively chemical materials up to many times the level found in their environment.

REF: Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Ann Arbor, Michigan, volume 94, SA3, June 1968, pages 455-475

226. Pritchard, D. W. (1951) THE PHYSICAL HYDROGRAPHY OF ESTUARIES AND SOME APPLICATIONS TO BIOLOGICAL PROBLEMS

A model estuary typical of Delaware Bay, Upper Chesapeake, etc., is discussed, i.e., salinity, isohalines, velocity, tidal currents, estuarine structure, and circulation as related to biological problems, with emphasis on the oyster seed.

REF: Transactions of the 16th North American Wildlife and Natural Resources Conference, pages 368-376, March 1951. Wildlife Management Institute, Washington, D. C.

227. Pritchard, D. W. (1952) ESTUARINE HYDROGRAPHY

General discussions of estuaries--definitions, and classifications. Delaware Bay included in coastal plain estuaries. Discusses physical structures and circulation patterns in coastal-plain estuaries, specifically Chesapeake Bay and the James River. Discusses flushing of tidal estuaries; develops equations for quantitative study of salt balance in a coastal-plain estuary. Cites 10 references.

REF: *In* Advances in Geophysics, volume 1, pages 243-279, 1952. Academic Press, New York

228. Pritchard, D. W. (1954) STUDY OF FLUSHING IN THE DELAWARE MODEL

The Army Corps of Engineers model at Vicksburg was used. Tracer dyes were introduced at different locations under different conditions.

REF: Report 7, reference 54-4, April 1954. Chesapeake Bay Institute, The Johns Hopkins University, Baltimore, Maryland

229. Pritchard, D. W. (1959) COMPUTATION OF THE LONGITUDINAL SALINITY DISTRIBUTION IN THE DELAWARE ESTUARY FOR VARIOUS DEGREES OF RIVER INFLOW REGULATION

Presents the results of an evaluation of all probable longitudinal distributions of salinity as a function of time under four different seasonal flow patterns. Contents: river inflow theory; differential equation; determination of eddy diffusivity; data for salt-balance equation; numerical solution.

REF: Report 18, reference 59-3, September 1959. Chesapeake Bay Institute, The Johns Hopkins University, Baltimore, Maryland.

230. Pritchard, D. W. (1960) THE MOVEMENT AND MIXING OF CONTAMINANTS IN TIDAL ESTUARIES

The processes which control the movement and dispersion of a water layer contaminant within and through a tidal estuary are presented first in a descriptive manner and then from a mathematical standpoint. Data obtained from dye releases in the Delaware Estuary model of the Army Corps of Engineers were employed. A figure shows the computed longitudinal distribution of dye compared to the observed distribution; the agreement is quite satisfactory.

REF: *In* Proceedings of the First International Conference on Waste Disposal in the Marine Environment, Berkeley, California, July 1959, E. A. Pearson, ed., Pergamon Press, Elmsford, New York, 1960.

231. Pritchard, D. W. (1967) OBSERVATIONS OF CIRCULATION IN COASTAL PLAIN ESTUARIES

The estuarine portion of the Delaware River, but not the wider portion of the Bay, represents a moderately stratified estuary in which the dominant mixing agent is turbulence caused by tidal action. At any given location the bottom

layer is always higher in salt content than the top layer.

REF: *In* Estuaries, G. H. Lauff, ed., pages 37-44, 1967. Publication number 83, American Association for the Advancement of Science, Washington, D. C.

232. Public Service Electric and Gas Company (1968) DISPERSION AND COOLING OF WASTE HEAT RELEASED INTO THE DELAWARE RIVER ESTUARY

This report presents the results of studies made to determine the probable effect on the distribution of temperature in the Delaware River estuary of the discharge of waste heat in the condenser cooling water from the Salem Nuclear Generating Station to be built on Artificial Island. Has 58 pages; charts are included.

REF: *Prepared by* D. W. Pritchard and J. Carpenter, Chesapeake Bay Institute, The Johns Hopkins University, *for* Public Service Electric and Gas Company, Newark, New Jersey

233. Pyatt, E. E. (1964) ON DETERMINING POLLUTANT DISTRIBUTION IN TIDAL ESTUARIES

REF: *See* U. S. Documents, Department of the Interior

234. Rasmussen, W. C., J. J. Groot, R. O. R. Martin, E. F. McCarren, V. C. Behn, *et. al.* (1957) WATER RESOURCES OF NORTHERN DELAWARE

REF: *See* Delaware Documents, University

235. Rasmussen, W. C., and L. B. Haigler (1953) GROUND WATER PROBLEMS IN HIGHWAY CONSTRUCTION AND MAINTENANCE

REF: *See* U. S. Documents, Department of the Interior

236. Rasmussen, W. C., J. W. Odell, and N. H. Beamer (1966) DELAWARE WATER

REF: *See* U. S. Documents, Department of the Interior

237. Rasmussen, W. C., R. A. Wilkens, and R. M. Beall (1960) WATER RESOURCES OF SUSSEX COUNTY, DELAWARE

REF: *See* Delaware Documents, University

238. Redfield, A. C. (1967) POSTGLACIAL CHANGE IN SEA LEVEL IN THE WESTERN NORTH ATLANTIC OCEAN

Radiocarbon dating indicates that, between Cape Cod and Northern Virginia, a coastal subsidence of 13 feet occurred between 4000 and 2000 years ago and has continued at a rate of about 1 x 10^{-3} feet per year.

REF: Science, volume 157, number 3789, pages 687-692, 1967. American Association for the Advancement of Science, Washington, D. C.

239. Reimold, R. J., and F. C. Daiber (1967) EUTOPHICATION OF ESTUARINE AREAS BY RAINWATER

Total phosphorus concentrations were determined in rainwater collected at Lewes. The mean concentration of winter-spring rainwater increased thirty-fold in summer rainwater and decreased to 1 1/2 times winter-spring in fall-winter levels. This phenomenon may account for atypical phosphorus cycles noted in estuarine areas.

REF: Chesapeake Science, volume 8, number 2, pages 132-133, 1967. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland.

240. Rima, D. R., P. W. Anderson, and O. J. Coskery (1964) GROUND WATER RESOURCES OF SOUTHERN NEW CASTLE COUNTY, DELAWARE

REF: *See* Delaware Documents, University

241. Ritchie, T. P., and C. N. Shuster, Jr. (1963) THE 1962 STATUS OF OYSTER SURVIVAL IN DELAWARE WATERS

REF: Report presented at the Fifth Annual Oyster Mortality Conference held January 1963 at the Biological Laboratories, Bureau of Commercial Fisheries, Oxford, Maryland

242. Rumer, R. R., Jr., and J. C. Shiau (1968) SALT WATER INTERFACE IN A LAYERED COASTAL AQUIFER

The investigation tried to determine the shape and the position of the interface between the seaward flowing fresh water and the underlying salt water in the coastal aquifers. Under certain idealized concentrations, a mathematical expression for the interface between the salt water and the fresh water has been solved. An immiscible theory appears to give a first approximation to the location of the zone diffusion.

REF: Water Resources Research, volume 4, number 6, American Geophysical Union, Washington, D. C., 1968

243. Scharf, J. T., ed. (1888) HISTORY OF DELAWARE 1609-1888

A comprehensive history in two volumes and 1358 pages, illustrated with many prints of people prominent in the affairs of the locations described, and other points of interest.

REF: History of Delaware, L. J. Richards and Company, Philadelphia, Pennsylvania

244. Schneider, E. (1962) TEXTURE AND MINERALOGY OF DELAWARE'S ATLANTIC BEACHES

REF: *See* Delaware Documents, University

245. Seidenstat, P. (1966) THE MARKET FOR WATER BASED OUTDOOR RECREATION SERVICES IN NEW CASTLE COUNTY, DELAWARE

REF: *See* Delaware Documents, University

246. Setzler, E. M. (1969) EFFECTS OF TRICAINE AND ADRENALINE ON THE HEART RATE OF THE HOGCHOKER

REF: *See* Delaware Documents, University

247. Shepard, F. P., and G. V. Cohee (1926) CONTINENTAL SHELF SEDIMENTS OFF THE MID-ATLANTIC STATES

Mechanical analysis of the sediment divides the shelf off the Mid-Atlantic states into two zones: the southern zone from Delaware Bay to Block Island contains sediments composed almost entirely of sand with subordinate amounts of gravel, but with sediment almost as coarse at the seaward edge of the shelf. The Northern zone to Martha's Vineyard has decidedly finer sediment in the same patchy arrangement of coarse and fine material found further south. Most common mineral is quartz, with feldspar next; 2 dozen heavy minerals were found. Biotite occurred in samples near the shore south of Delaware Bay. Cretaceous formations were found in a belt 12-15 miles wide across New Jersey and along the lower Delaware River. Sediment for most part was quite out of harmony with present-day conditions and was evidently deposited during the Pleistocene stages of lowest sea level.

REF: Geological Society of America, Bulletin, volume 47, pages 441-458, 1926. Boulder, Colorado

248. Shuster, C. N., Jr. (1955) FISHERY STATISTICS OF DELAWARE

REF: *See* Delaware Documents, University

249. Shuster, C. N., Jr. (1956) COMMENTS ON ESTUARINE FLORA

REF: *See* Delaware Documents, University

250. Shuster, C. N., Jr. (1957) ON THE SHELL OF BIVALVE MOLLUSKS

REF: *See* U. S. Documents, Department of the Interior, U. S. Fish and Wildlife Service

251. Shuster, C. N., Jr. (1957) UNIVERSITY OF DELAWARE MARINE LABORATORIES

A description of the history, facilities, programs, and courses at the Lewes laboratories.

REF: American Institute of Biological Sciences, Bulletin, volume 7, number 1, pages 23-24, 1957. Washington, D. C.

252. Shuster, C. N., Jr. (1958) CURRENT ESTUARINE RESEARCH AT THE UNIVERSITY OF DELAWARE MARINE LABORATORIES

REF: *See* Delaware Documents, University

253. Shuster, C. N., Jr. (1958) PUBLICATIONS OF THE UNIVERSITY OF DELAWARE MARINE LABORATORIES 1952-1958

REF: *See* Delaware Documents, University

254. Shuster, C. N., Jr. (1959) BIOLOGICAL EVALUATION OF THE DELAWARE RIVER ESTUARY

REF: *See* Delaware Documents, University

255. Shuster, C. N., Jr. (1963) OUR EVER-CHANGING COASTLINE

REF: *See* Delaware Documents, University

256. Shuster, C. N., Jr., F. C. Daiber, and K. P. H. Frey (1961) SHALLOW WATER RESEARCH AT THE UNIVERSITY OF DELAWARE

REF: *See* Delaware Documents, University

257. Shuster, C. N., Jr., and A. F. Eble (1961) TECHNIQUES IN VISUALIZATION OF ORGAN SYSTEMS IN BIVALVE MOLLUSKS

REF: *See* U. S. Documents, Department of the Interior

258. Shuster, C. N., Jr., and A. F. Eble (1963) TECHNIQUES IN VISUALIZATION OF ORGAN SYSTEMS IN BIVALVE MOLLUSKS

The techniques utilized at the University of Delaware and at Rutgers are described.

REF: *See* U. S. Documents, Department of the Interior

259. Shuster, C. N., Jr., and R. E. Hillman (1963) COMMENTS ON "MICROECOLOGICAL FACTORS IN OYSTER EPIZOOTICS" BY MARSHALL LAIRD

Some of the conclusions by Laird are questioned. Laird's microenvironmental concept has possible applications in connection with the recent MSX-linked oyster mortalities in Delaware and Chesapeake Bays.

REF: Chesapeake Science, volume 4, number 2, pages 101-103, 1963. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland

260. Simmons, U. B., and W. H. Bobbs (1964) DELAWARE RIVER MODEL STUDY: DIKE REHABILITATION HYDRAULIC MODEL INVESTIGATION, TECHNOLOGY

REF: *See* U. S. Documents, Department of Defense, Army Corps of Engineers

261. Slaughter, T. H. (1962) BEACH-AREA WATER SUPPLIES BETWEEN OCEAN CITY, MARYLAND, AND REHOBOTH BEACH, DELAWARE

REF: *See* U. S. Documents, Department of the Interior

262. Smith, E. T., and E. Mehr (1968) COST ALLOCATION MODEL FOR ZONED OPTIMIZATION OF WASTE TREATMENT REQUIREMENTS

Three cost allocation models have been developed for achieving desired water quality: (1) a uniform-treatment model; each source must remove a uniform percentage of its raw waste load. (2) a cost-minimization model; it requires construction of a cost function relating dollars spent on waste-treatment facilities to amount of waste removed. This method will be difficult to implement. (3) Zoned-optimization model; it combines elements of (1) and (2) in that it seeks treatment levels which are uniform for various groups of sources, but not necessarily uniform for the whole estuary; it also seeks a combination of such zone removals which yields a minimum overall cost. This is the model selected by the DRBC for implementation on the estuary.

REF: Paper presented at Second Mid-Atlantic Industrial Waste Conference, Drexel Institute of Technology, Philadelphia, Pennsylvania, November 18-20, 1968

263. Smith, E. T., and A. R. Morris (1969) SYSTEMS ANALYSIS FOR OPTIMAL WATER QUALITY MANAGEMENT

Since 1961, the objectives of the Delaware Estuary Comprehensive Study have been to (1) develop methods of water-quality management (2) determine the relationships between pollution and the present deteriorated quality of water, and (3) prepare a program for improvement and maintenance of water quality. An objective set was selected and is now being carried out to 30 sections (geographical areas essentially homogeneous in water quality) between Trenton and location below Wilmington. This set has resulted in load allocations for individual firms and municipalities, so that water quality in the estuary will be maintained at an enhanced level. The set is based on the use of systems analysis methods. The mathematical model for pollution control is based on the relationship between BOD and DO (dissolved oxygen). The limitation and the mathematics are discussed.

REF: Water Pollution Control Federation, Journal, volume 41, number 9, pages 1635-1646, 1969. Washington, D. C.

264. Smith, R. C. (1970) DELAWARE'S FARM INCOME: CROP AND LIVESTOCK PRODUCTION IN 1969

REF: *See* Delaware Documents, University

265. Smith, R. C., and D. F. Crossan (1969) ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

REF: *See* Delaware Documents, University

266. Spoljaric, N. (1967) PLEISTOCENE CHANNELS OF NEW CASTLE COUNTY, DELAWARE

REF: *See* Delaware Documents, University

267. Spoljaric, N., and R. R. Jordan (1966) GENERALIZED GEOLOGIC MAP OF DELAWARE

REF: *See* Delaware Documents, University

268. Stachecki, C. J., Jr., and A. W. Wheatley (1969) SALT-MARSH WATER MANAGEMENT IN DELAWARE ACCOMPLISHED UNDER SENATE BILL 75, 1965-68

A report from the Mosquito Control Division of the State Highway Department, Milford, Delaware. Describes the ditching and impoundment started under Bill 75. The permanent control measures initiated, performed beyond all expectations.

REF: Proceedings of the 56th Annual Meeting of the New Jersey Mosquito Extermination Association, pages 225-227, 1969. Rutgers State University, New Brunswick, New Jersey

269. Stanley, D. J. (1969) ATLANTIC CONTINENTAL SHELF AND SLOPE OF THE UNITED STATES: COLOR OF MARINE SEDIMENTS

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

270. Stauber, L. A. (1943) GRAPHIC REPRESENTATION OF SALINITY IN A TIDAL ESTUARY

A graphic method of plotting salinity data that shows points where samples are taken, with the recorded salinity of the samples, and also shows the position of such samples with reference to the total range of salinity as it varies with the tide or the depth. Data are based on hourly samples over a complete tidal cycle (12-13 hours) on 20 April in Delaware Bay.

REF: Journal of Marine Research, volume 5, pages 165-167, 1943. Osborn Memorial Laboratory, Yale University, New Haven, Connecticut

271. Steenis, J. H., N. G. Wilder, H. P. Cofer, and R. A. Beck (1954) MARSHES OF DELAWARE, THEIR IMPROVEMENT AND PRESERVATION

REF: *See* Delaware Documents, State

272. Stetson, H. C. (1938) SEDIMENTS OF THE CONTINENTAL SHELF OFF THE EASTERN COAST OF THE UNITED STATES

A dredge made eight traverses across the Continental Shelf between Cape Cod and Cape Canaveral beginning at the beach and going over the break in the slope. The central section off New Jersey and Maryland show fairly well sorted sands

out to the slope, with little diminution of the median diameters. Detailed tables and graphs are presented for mechanical analyses, size fractions and profiles.

REF: Papers in physical oceanography and meteorology, volume 5, number 4, 1938. Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, Cambridge and Woods Hole, Massachusetts.

273. Stewart, J. Q. (1962) GREAT ATLANTIC WEST TIDES OF 5-8 MARCH 1962

The storm did unprecedented damage, more than most hurricanes, because the huge slow-moving windstorm coincided exactly not only with the occurrence of a new moon, but with the moon at perigee, i.e., at its nearest. Perigee gravitational effects produce astronomical tides.

REF: Weather Wise, volume 15, pages 117-120, 1962. American Meteorological Society, Boston, Massachusetts

274. Strong, A. L. (1961) OPEN SPACE FOR THE PENJERDEL REGION

Working papers and source meterial for the Penjerdel conference on open space; several hundred pages.

REF: Penjerdel (Pennsylvania-New Jersey-Delaware Metropolitan Project, Inc.), 1500 Walnut Street, Philadelphia, Pennsylvania

275. Strong, A. L., J. C. Keene, and J. Hillsberg (1971) THE NEXT TEN YEARS: SOME RECOMMENDATIONS TO THE DELAWARE RIVER BASIN COMMISSION

REF: *See* Delaware Documents, Cities, Counties, and Organizations

276. Strong, A. L., J. C. Keene, J. Hillsberg, F. Uthman, and M. Aspin (1971) DELAWARE RIVER BASIN COMPACT: A REVIEW WITH RESPECT TO ENVIRONMENTAL QUALITY

REF: *See* Delaware Documents, Cities, Counties, and Organizations

277. Strong, A. L., and S. K. Slade (1971) LEGAL SURVEY FOR GOVERNOR'S TASK FORCE ON MARINE AND COASTAL AFFAIRS

This report concerns itself with the legal issues of the physiographic subareas of the Coastal Zone and the major threats to their ecological health. Because environmental impacts cross the boundaries of the Coastal Zone, some attention is given to issues which arise from these external interrelationships.

REF: Institute for Environmental Studies, University of Pennsylvania, Philadelphia, Pennsylvania

278. Sundstrom, R. W., *et. al.* (1967) THE AVAILABILITY OF GROUND WATER FROM THE POTOMAC FORMATION IN THE CHESAPEAKE AND DELAWARE CANAL AREA, DELAWARE

REF: *See* Delaware Documents, University

279. Sundstrom, R. W., and T. E. Pickett (1968) THE AVAILABILITY OF GROUND WATER IN KENT COUNTY, DELAWARE, WITH SPECIAL REFERENCE TO THE DOVER AREA

REF: *See* Delaware Documents, University

280. Sundstrom, R. W., and T. E. Pickett (1969) THE AVAILABILITY OF GROUND WATER IN EASTERN SUSSEX COUNTY, DELAWARE

REF: *See* Delaware Documents, University

281. Sundstrom, R. W., and T. E. Pickett (1969) THE AVAILABILITY OF GROUND WATER IN WESTERN SUSSEX COUNTY, DELAWARE

REF: *See* Delaware Documents, University

282. Sundstrom, R. W., and T. E. Pickett (1971) THE AVAILABILITY OF GROUND WATER IN NEW CASTLE COUNTY, DELAWARE

REF: *See* Delaware Documents, University

283. Sundstrom, R. W., and R. D. Varrin (1971) WATER SUPPLY AND USE IN THE DRAINAGE BASINS OF THE DELAWARE RIVER SYSTEM AND ATLANTIC COASTAL DRAINAGE BASINS IN DELAWARE

REF: *See* Delaware Documents, University

284. Tannian, F. X. (1968) PORT OF WILMINGTON

REF: *See* Delaware Documents, University

285. Tannian, F. X., C. Chandler, N. Wilson (1967) CITY OF WILMINGTON WATER SYSTEM

REF: *See* Delaware Documents, University

286. Thomann, R. V. (1963) MATHEMATICAL MODEL FOR DISSOLVED OXYGEN

A mathematical model is presented for describing the time variations of dissolved oxygen in a finite number of sections in a body of water; an analytical model is given for dissolved oxygen variation in an estuary. It was applied to a part of the Delaware Estuary.

REF: Proceedings, American Society of Civil Engineers: Journal, Sanitary Engineering Division, volume 89 (SA5), pages 1-30, October 1963.

287. Thomann, R. V. (1964) USE OF SYSTEMS ANALYSIS IN ESTUARINE WATER POLLUTION CONTROL

The various cause and effect relationships existing between the man-made environment and water quality can be satisfactorily described using the techniques of systems analysis. The Delaware Estuary is used as one example.

REF: Pages 47-59 *in* Selected Papers from the Western Resources Conference on New Horizons for Resources Research, July 1964, at Colorado State University, Fort Collins, Colorado. University of Colorado Press, Boulder, Colorado.

288. Thomann, R. V. (1965) RECENT RESULTS FROM A MATHEMATICAL MODEL OF WATER POLLUTION CONTROL IN THE DELAWARE ESTUARY

The paper presents the basic principles involved in the construction of a mathematical model of dissolved oxygen in the Delaware Estuary. The basic motivation was the development of a comprehensive water-pollution-control plan for water-quality improvement in the Delaware Estuary.

REF: Water Resources Research of Water Pollution Control in the Delaware Estuary, volume 1, number 3, pages 349-359, 1965. American Geophysical Union, Washington, D. C.

289. Thomann, R. V., and M. J. Sobel (1964) ESTUARINE WATER QUALITY MANAGEMENT AND FORECASTING

The results of systems analysis applied to the Delaware Estuary are given, including the variation of dissolved oxygen with water temperature and the effect of wind speed on water conductivity.

REF: Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Ann Arbor, Michigan, volume 90, SA5, 1964, pages 9-36.

290. Turner, P. A. (1968) SHORELINE HISTORY OF THE ATLANTIC COAST, DELMARVA PENINSULA

REF: Abstracts of papers presented to the 1968 Annual Meeting, Northeastern Section, Society of Economic Paleontologists and Mineralogists at Washington, D. C., 1968

291. Tyler, D. B. (1955) THE BAY AND RIVER, DELAWARE

Photographs, maps, and history in 244 pages.

REF: Cornell Maritime Press, Inc., Cambridge, Maryland, 1955

292. University of Delaware (1968) GEOLOGY AND EARTH RESOURCES OF DELAWARE

REF: *See* Delaware Documents, University

293. University of Pennsylvania (1966) DELAWARE RIVER BASIN STUDY

The quality of the water of the Delaware River Basin is analyzed by starting at the upper basin and following the conditions affecting the quality of the River through the sub-basin, estuaries, and down to the lower estuary and bay. Includes a table of typical water quality analysis of summer conditions in selected locations in the Delaware sub-basin (1962-64) and unpublished maps.

REF: Department of Landscape Architecture and Regional Planning, The Graduate School of Fine Arts, University of Pennsylvania, Philadelphia, Pennsylvania

294. University of Pennsylvania (1967) AN ECOLOGICAL APPROACH TO REGIONAL PLANNING

Summarizes graduate program at University of Pennsylvania, Department of Landscape Architecture and Regional Planning. Mentions as an initial case study the Delaware River Basin which had been carried out in two successive years. 16 small maps of the Delaware River Basin, with specific details shown, e.g., geology, physiographic regions, stream flows and withdrawals along Delaware River, ground water, surface water, soil depth, soil drainage, slope and others.

REF: Department of Landscape Architecture and Regional Planning, The Graduate School of Fine Arts, University of Pennsylvania, Philadelphia, Pennsylvania

295. Upson, J. E. (1966) RELATIONSHIPS OF FRESH AND SALTY GROUND WATER IN THE NORTHERN ATLANTIC COASTAL PLAIN OF THE UNITED STATES

REF: *See* U. S. Documents, Department of the Interior, Geological Survey

296. Vasuki, N. C. (1970) WATER QUALITY LIMITATIONS IN DELAWARE ESTUARY

The seriousness of the situation and need for action. "Delaware is a dirty river." There are certain limitations to what can be done under present political and technological conditions: Delaware will remain a muddy estuary below Marcus Hook. The upper estuary will experience algal blooms. The appearance of color, addition of flotsam, and

sewage overflows will continue to pose problems. Continued discharge of heavy metals will adversely affect aquatic life. Continued dredging and filling will constantly upset benthal communities. Oil slicks, spills, increasing. Irreversible changes may have already reduced the capacity of the estuary to act as a nursery for many fish species. We must reverse the thinking of allowing land-use classification without regard to water quality or use. Out of the 133.4 miles of estuarine water, 38.4 miles are already lost for fish propagation. Between 1954 and 1964 more than 45,000 acres of marshland were destroyed between Maine and Delaware. Unless we drastically reduce the amount of heavy metals discharged, the remaining aquatic life will be harmed. Yet, statistics show that sport fishing is increasing. 60 million anglers harvest 1.5 billion pounds of fish per year. Of these, 843 million pounds were caught in salt water and about 630 million pounds of these were estuary dependent.

REF: Address at the fourth Mid-Atlantic Industrial Waste Conference, November 18-20, 1970. Department of Civil Engineering, University of Delaware, Newark, Delaware

297. Vaughn, G. F. (1968) AGRIBUSINESS IN DELAWARE'S ECONOMY

REF: *See* Delaware Documents, University

298. Vaughn, G. F. (1968) AGRICULTURAL LAND: DELAWARE'S RETREATING OPEN SPACE

REF: *See* Delaware Documents, University

299. Ward, R. F. (1958) GEOLOGY OF THE DELAWARE RIVER

REF: *See* Delaware Documents, University

300. Wastler, T. A., and L. C. deGuerrero (1968) NATIONAL ESTUARINE INVENTORY: HANDBOOK OF DESCRIPTORS

REF: *See* U. S. Documents, Department of the Interior, Federal Water Pollution Control Administration

301. Watts, E. (1957) SURVEY OF THE BRYOZOA IN DELAWARE BAY WITH SPECIAL REFERENCE TO THE SPECIES OCCURRING ON THE BLUE CRAB

REF: *See* Delaware Documents, University

302. Wells, H. W. (1970) *Saballaria* REEF MASSES IN DELAWARE BAY

Along the western shore of Delaware Bay the polychaetous annelid Saballaria vulgaris *builds reefs which are formed of sand grains cemented together in rounded masses of dwelling tubes. The reefs have important geological and biological effects on the immediate environment, modifying and stabilizing beach sediments, and supporting a distinct community of associated organisms.*

REF: Chesapeake Science, volume 11, number 4, pages 255-261, 1970. Natural Resources Institute of the University of Maryland, Chesapeake Biological Laboratory, Solomons, Maryland

303. Weston, R. F. (1970) ENGINEER'S EVALUATION REPORT, PORTABLE WATER SUPPLIES, NEW CASTLE COUNTY, DELAWARE

REF: *See* Delaware Documents, Cities, Counties, and Organizations

304. Witkin, L. D. (1965) WIDENING AND DEEPENING THE WORLD'S BUSIEST CANAL

REF: The Constructioneer, November 15, 1965. Reports Corporation, Chatham, New Jersey

305. Woodruff, K. D. (1969) THE OCCURRENCE OF SALINE GROUND WATER IN DELAWARE AQUIFERS

REF: *See* Delaware Documents, University

306. Woodruff, K. D. (1970) GENERAL GROUND-WATER QUALITY IN FRESH-WATER AQUIFERS OF DELAWARE

REF: *See* Delaware Documents, University

307. Woodruff, K. D. (1970) MONTHLY REPORT ON WATER CONDITIONS IN DELAWARE

REF: *See* Delaware Documents, University

308. Wright, J. F. (1969) DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT

REF: *See* Delaware Documents, Cities, Counties, and Organizations

309. Young, C. M. (1960) OYSTERS

Gives history of oyster banks with timely quotes; reviews damage by predators; surveys oyster culture. Discusses oystering from Long Island to Chesapeake Bay. Good list of references.

REF: Collins Press, St. James Place, London, England, 1960.

310. Zaneveld, J. S. (1966) BENTHIC MARINE ALGAE OF DELAWARE

A preliminary list of 66 marine algae has been compiled giving area and conditions at selected collecting points in Delaware. More than half of these algae belong to the Phaeophyta (brown), Rhodophyta (red). Nineteen Chlorophyta (green), 11 Cyanophyta (blue-green), Xanthophyta (yellow-green) are listed.

REF: Scientific series number 2, Institute of Oceanography, Old Dominion College, Norfolk, Virginia, 1966

311. Zapata Bulk Systems, Inc. (1971) DELAWARE TRANSFER TERMINAL: A CURRENT ASSESSMENT PREPARED FOR THE DELAWARE TASK FORCE

REF: Zapata Bulk Systems, Inc. Houston, Texas, February 1971.

312. Zesking, L. M., and E. A. Le Lacheur (1926) TIDES AND CURRENTS IN DELAWARE BAY AND RIVER

REF: *See* U. S. Documents, Department of Commerce, Coast and Geodetic Survey

DELAWARE DOCUMENTS

CITIES, COUNTIES, AND ORGANIZATIONS

313. City of Wilmington (1965) REPORT TO CITY OF WILMINGTON, DELAWARE UPON RAW WATER SUPPLY UPDATED DECEMBER 1964

To survey the water supply available to the City of Wilmington and to confirm the possibility of the use of Hoopes Reservoir; Brandywine Creek is included.

REF: *Prepared by* Metcalf and Eddy, Engineers, Boston, Massachusetts for City of Wilmington, Wilmington, Delaware

314. City of Wilmington (1968) FUTURE DEVELOPMENT OF THE PORT TERMINAL: I, ECONOMIC AND ADMINISTRATIVE CONSIDERATIONS

REF: *Prepared by* **Cresap**, McCormick and Paget, *for* City of Wilmington, Wilmington, Delaware

315. City of Wilmington (1968) FUTURE DEVELOPMENT OF THE PORT TERMINAL: II, PHYSICAL FACILITY ANALYSIS

Existing facilities; recommendations for existing facilities, new facilities; construction cost estimates (total $18,808,000).

REF: *Prepared* December 1968 *by* Lockwood Greene Engineers, Inc., Spartanburg, South Carolina, *for* City of Wilmington, Wilmington, Delaware

316. DRBC (1964) ANSWERS TO QUESTIONS

The nation's most heavily populated region, with more than 22,000,000, expects 30,000,000 by 1980 and 42,000,000 by 2010. The basin occupies 12,757 square miles (including the Bay). The compact with the federal government is similar to an international treaty. A commission is needed, among other reasons: (1) Water respects its own boundaries and not manmade. (2) Government in the basin is not organized to control and develop water resources. (3) Water can be used more economically and beneficially through unified planning. We are not running out of water, but are managing it poorly, such as the 50% unused flow into the ocean.

REF: Delaware River Basin Commission, Trenton, New Jersey

317. DRBC (1964) DELAWARE RIVER BASIN COMPACT

The legal compact entered into in 1961 between Delaware, New Jersey, New York, Pennsylvania, and the United States is presented in detail in 51 pages.

REF: Delaware River Basin Commission, Trenton, New Jersey

318. DRBC (1965) SECOND WATER RESOURCES PROGRAM, 1964-1969

Comprehensive report on the prospective supply of, and demand for water and related goods and services in the Delaware River basin during six calendar years (1964-1969). Has 26 tables on water quality; streams, runoff, flood, and storage volumes; water demands and withdrawals, export, etc. Has 16 figures on dissolved oxygen, chlorides, temperature, geohydrologic sections, maps, etc.

REF: Delaware River Basin Commission, Trenton, New Jersey

319. DRBC (1966) REVIEW OF ACTIVITIES IN 1965-1966

Considerable discussions of flood control and water diversion during the previous year's drought. Federal authorities bringing to a close a 5-year effort known as the Delaware Estuary Comprehensive Study, which used computerized techniques to determine cause and effect of pollution. The study offered 5 alternative proposals for clearing up pollution with different costs and different treatments. The total carbonaceous oxygen-demanding waste load produced daily in the basin was found to be 1.9 million pounds daily, nearly half (900,000 pounds) being removed by treatment, and 1 million pounds being discharged daily into the estuary.

REF: 4th Annual Report. Delaware River Basin Commission, Trenton, New Jersey

320. DRBC (1967) REVIEW OF ACTIVITIES IN 1966-1967

Adopted estuary and nontidal water standards keyed to water uses which are summarized. Standards vary within the basin, with higher oxygen requirements in certain parts of the

estuary. Other requirements for water temperature, alkalinity-acidity balance, phenols, odor, detergents, fluorides, radioactivity, and turbidity.

REF: 5th Annual Report. Delaware River Basin Commission, Trenton, New Jersey

321. DRBC (1968) REVIEW OF ACTIVITIES IN 1967-1968

Adopted comprehensive pollution control standards in 1967. These standards approved by Washington in 1968 for compliance with federal law. Delaware Estuary divided into 4 zones. All wastes must be treated to the same minimum degree of removal of pollutants, in order to reduce the oxygen consumption of pollutants. Federal scientists (department of government not specified) devised a mathematical formulation of the Delaware Estuary.

REF: 6th Annual Report. Delaware River Basin Commission, Trenton, New Jersey

322. DRBC (1969) REVIEW OF ACTIVITIES IN 1968-1969

Expanded efforts on assuring sound future surface and ground water supply management gave attention to protection of the rich estuarine qualities of lower Delaware Bay. Entered into regional efforts for disposal of wastes on both sides of the river. Organized a pollution surveillance program throughout the estuary. Began a 3-year study of Salem and Gloucester regional waste disposal. Began engineering study of regional facility for sewage disposal of wastes from part of Delaware County, Pennsylvania south of Philadelphia and from New Castle, Delaware and treating them near Marcus Hook, Pennsylvania below the Delaware-Pennsylvania boundary. The City of Wilmington waste discharge program (to be in full operation by 1973) has been approved. Several other sewerage schedules above Wilmington have also been approved. Development of a mathematical model of major Delaware River reservoirs planned. State of Delaware is collecting and analyzing water samples in the Delaware Estuary below Trenton for 32 pollution indicators, e.g., dissolved O_2, acidity, bacteria, toxics, and radioactivity.

REF: 7th Annual Report. Delaware River Basin Commission, Trenton, New Jersey.

323. DRBC (1970) DEEPWATER REGIONAL SEWERAGE SYSTEM: PRELIMINARY ENGINEERING AND FEASIBILITY STUDY

The estuary is defined as the 86-mile portion of the river between Trenton, New Jersey, and Liston Point. The service area of the river comprises less than 1% of the area of the continental USA but has 13% of population, 16.6% of personal income. This study is concerned with Gloucester and Salem counties, New Jersey. Has 14 chapters.

Table of Contents: 1. Pollution of estuary. 2. The study area. 3. Projected population, land use, industry. 4. Sewerage. 5. Waste water. 6. Water quality. 7. Pretreatment requirements. 8. Alternative methods. 9. Design, cost. 10.-Alternative waste water management. 11. Preliminary design and cost. 12. Financing. 13. Cost. 14. Summary, conclusions.

REF: *Prepared* February 1970 *by* Engineering, Inc., Washington, D. C., *for the* Delaware River Basin Commission, Trenton, New Jersey

324. DRBC Strong, A. L., J. C. Keene, and J. Hillsberg (1971) THE NEXT TEN YEARS: SOME RECOMMENDATIONS TO THE DELAWARE RIVER BASIN COMMISSION

Programs and procedural recommendations to the Delaware River Basin Commission for preservation of wetlands, allocation of water resources, financing of programs, and enforcement of water quality standards. Has 23 pages.

REF: Institute for Environmental Studies, University of Pennsylvania, Philadelphia, Pennsylvania. *Reprinted by the* Delaware River Basin Commission, Trenton, New Jersey

325. DRBC Strong, A. L., J. C. Keene, J. Hillsberg, F. Uthman, and M. Aspin (1971) DELAWARE RIVER BASIN COMPACT: A REVIEW WITH RESPECT TO ENVIRONMENTAL QUALITY

Findings of Delaware River Basin Commission on legal and governmental status of wetlands, water resources, development of land; actions of state and federal agencies; and programs planned for regulation and acquisition of property. 5 tables, 94 pages. Delaware River Basin Compact.

REF: Institute for Environmental Studies, University of Pennsylvania, Philadelphia, Pennsylvania. *Reprinted by the* Delaware River Basin Commission, Trenton, New Jersey

326. DRBC Wright, J. F. (1969) DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT

Construction of a mathematical model of the Delaware Estuary by conducting a series of sampling runs in the estuary over a period of years for use in an estuary pollution - abatement program.

Catalog of Marine Research Activities for 1968 (July 1969)

REF: Delaware River Basin Commission, Trenton, New Jersey

327. Delaware River Port Authority (1968) AMERIPORT, PORTS OF PHILADELPHIA: FOREIGN TRADE CARGO, IMPORTS AND EXPORTS

Comprises ports of Philadelphia, Camden, Chester, Gloucester, Trenton, Paulsboro, Marcus Hook, and Wilmington. World's largest freshwater port. Third busiest port in the world. In U.S.A., No. 1 importing port, handles over 11% of the nation's foreign waterborne commerce, etc. Statistics are given in tables and graphs.

REF: Delaware River Port Authority of Pennsylvania and New Jersey, Philadelphia, Pennsylvania, and Trenton, New Jersey

328. Delaware Water Resources Study Committee (1954) WATER IN DELAWARE: PRELIMINARY REPORT OF THE STATE'S WATER RESOURCES

Detailed discussions of the water resources of Delaware. Specific sections of report deal with surface water; ground water; quality of water; beneficial use of water; existing water problems, e.g., shortages, salt-water encroachment, pollution, drainage, soil erosion, chemical quality, economies of salt water; basic principles and history of water-right doctrine; and water-right laws in Delaware (also federal water-right laws affecting Delaware). Use of water in all three counties discussed in terms of muncipal, industrial, commercial, domestic, irrigation and farms.

REF: Delaware Water Resources Study Committee, Worrilow, G. M., Chairman, University of Delaware, Newark, Delaware

329. INCODEL (1961) INTERSTATE-FEDERAL COMPACT FOR THE DELAWARE RIVER BASIN

The Delaware River Basin Advisory Commission, a temporary body consisting of the governors of the four states and the mayors of New York and Philadelphia, prepared the draft for the interstate-federal compact.
Article 1-Definitions, purpose, limitations
Article 2-Organization and area. *The Commission consists of the governors of Delaware, New York, New Jersey, and Pennsylvania and one commissioner appointed by the President of the United States. Each member appoints an alternate with full power, etc.*
Article 3-Powers and duties of commission
Article 4-Water supply
Article 5-Pollution Control
Article 6-Flood protection
Article 7-Water shed management
Article 8-Recreation
Article 9-Hydroelectric power
Article 10-Regulation of withdrawals and diversions
Article 11-Intergovernmental relations
Article 12-Capital financing
Article 13-Plan, program and budgets
Article 14-General provisions

Note: In general the Commission has very broad powers to research, initiate, control, execute, enforce, etc.

REF: Interstate Commission on the Delaware River, Trenton, New Jersey

330. Interstate Commission on the Delaware River (INCODEL) (1957-1959) BIOLOGICAL STUDIES OF THE DELAWARE RIVER

Diatom studies, biological surveys, fish survey, chemical studies. Has 29 tables, 12 figures, 18 pages; Appendix I species lists, 18 pages; Appendix II fish list, 11 pages.

REF: *Prepared by the* Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, *for the* Interstate Commission on the Delaware River

331. Interstate Commission on the Delaware River (INCODEL) (1959-1960) BIOLOGICAL STUDIES OF THE DELAWARE RIVER

Diatom and fish studies at Burlington, New Jersey, Marcus Hook, and Pea Patch Island. Has 8 tables and two fish lists, 9 and 8 pages.

REF: *Prepared by the* Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, *for the* Interstate Commission on the Delaware River

332. Model Study Committee (1961) DISPERSION STUDIES ON THE DELAWARE RIVER ESTUARY MODEL AND POTENTIAL APPLICATIONS TOWARD STREAM PURIFICATION CAPACITY EVALUATION

A series of experiments specifically designed to supplement existing studies performed by the Corps of Engineers and other private interests with regard to dispersion and distribution of contaminants in the Delaware River Estuary. Contains tables and charts. Has 223 pages.

REF: Model Study Committee, Library, Department of Natural Resources and Environmental Control, Dover, Delaware

333. New Castle County (1967) WHITE CLAY CREEK DAM AND RESERVOIR

Preliminary or feasibility phase of comprehensive report. Purpose and scope: population projections, water use and water sources, geology and soils, stages of construction, design load relocations, recreation, land acquisition, estimated cost, financing.

REF: *Prepared by* Whitman, Requardt and Associates, Baltimore, Maryland, *for* New Castle County, Wilmington, Delaware

334. Water Resources Association of the Delaware River Basin (1959) WATER FOR RECREATION: TODAY AND TOMORROW

Popular discussion of recreational uses of the water of the Delaware River basin. Has 25 pages.

REF: Water REsources Association of the Delaware River Basin, 21 South 12th Street, Philadelphia, Pennsylvania

335. Water Resources Association of the Delaware River Basin (1966)
DELAWARE BASIN BULLETIN

Summarizes the Delaware Estuary Comprehensive Study (DECS); a preliminary report and findings of the 6-year study of pollution in the Delaware estuary. The organic waste load to the estuary found to be 1 million pounds of organic waste per day: municipalities 65%, industries 35%. Water quality evaluation made by mathematical modeling and use of new techniques of systems analysis, etc. Five objective sets of different water quality standards proposed with different achievements and costs.

REF: Volume 7, number 1. Water Resources Association of the Delaware River Basin, 21 South 12th Street, Philadelphia, Pennsylvania

336. Water Resources Association of the Delaware River Basin (1968)
DELAWARE BASIN BULLETIN

Water quality regulations adopted March 7, 1968 by the DRBC provides control of river with respect to: (1) Oxygen consumption by carbonaceous material (carb. O.D.) to be reduced from present daily waste load of 1 million pounds to 322,000 pounds through various waste treatment methods. 4 zones established--zone 5 (Pennsylvania-Delaware border to Liston Point, Delaware 30 miles-67,000 pounds per day carb. D.O. (2) Bacteria--human waste must be chlorinated (3) Thermal Pollution--in tidal waters, the induced temperature increase shall not exceed 5°F. above the average daily temperature gradient or a maximum of 86°F. whichever is less (4) Load allocations assimilative capacity of the streams to be apportioned equitably between dischargers. (Other details given for zones 2, 3, and 4 which are above the Pennsylvania-Delaware line.)

REF: Volume 9, number 1. Water Resources Association of the Delaware River Basin, 21 South 12th Street Philadelphia, Pennsylvania

337. Water Resources Association of the Delaware River Basin (1969)
TENTH ANNUAL REPORT

Summarizes accomplishments of the WRA/DRB for the period 1959-1969; includes information to basin residents; encouraged creation of the Delaware River Basin Commission; supports establishment of the Tock's Island National Recreation Area (now Delaware Water Gap National Recreation Area;

worked for adoption of adequate and equitable standards of water quality in Delaware River estuary; monitoring the Delaware River Basin Commission's activities; and presently urging preparation of a comprehensive plan for the development of the Delaware Bay area. The WRA/DRB is now setting water quality standards for Delaware Bay.

REF: Water Resources Association of the Delaware River Basin, 21 South 12th Street, Philadelphia, Pennsylvania

STATE

338. DBG&FC (1955) WHAT'S AHEAD FOR DELAWARE'S COASTAL AREAS

Summary of transactions of conference, December 8, 1955. Has no tables, no graphs, good discussion, 53 pages.

Income for 1953:	*mengaden catch*	*$4,000,000*
	oysters	*1,500,000*
	crabs and clams	*500,000*
	commercial food fish	*100,000*
	sport fishing	*1,000,000*
	Total	*$7,100,000*

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

339. DBG&FC (1969) GUIDE TO DELAWARE'S NATURAL ENVIRONMENT

Purposes: to recommend published materials relating to Delaware's natural resources; to list organizations which specialize in natural resource studies, management, and/or interpretation; and to list places to go and best times to observe Delaware's wildlife and natural landscapes.

REF: Delaware Conservationist, volume 13, number 1, 1969. Office of Information and Education, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

340. DBG&FC Chamberlain, E. B. (1950) WATERFOWL MANAGEMENT

Discusses management of waterfowl from point of view of control. Has no tables, no graphs, 8 pages.

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

341. DBG&FC Chamberlain, E. B. (1951) SURVEY OF THE MARSHES OF DELAWARE

Systematic study of principal marshlands. History of Delaware marshes since 1638. Description of 21 work units including area, water (salinity, pH); populations and frequency counts; waterfowl, furbearers, plants lists; management possibility. Has 8 graphs, 11 tables, 3 maps, photos, 76 pages.

REF: Final report of Pittman-Robertson Project 7R. Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

342. DBG&FC Chamberlain, E. B. (1952) WATERFOWL IN DELAWARE BAY

Has diagrams and 12 tables, 21 pages. Examples: Waterfowl population in Delaware by aerial count, percentage of 4 leading waterfowl killed in Delaware, total population by salinity zones, waterfowl population per square mile, etc.

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

343. DBG&FC Florio, A. J. (1950) SALT MARSHES: NOTES ON THEIR ORIGIN AND MANAGEMENT

Discusses effect of mosquito control and ditching on marshes; stresses the adverse effect. Has no table, no graphs, 10 pages.

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

344. DBG&FC Kalber, F. A., Jr. (1959) WHERE DOES THE SHORELINE BEGIN?

Two types of shoreline: the sandy beach and the tidemarsh; changes with the tides; nutrient materials in the tidemarsh.

REF: Delaware Conservationist, Summer 1959. Office of Information and Education, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

345. DBG&FC Lesser, C. A. (1966) AQUATIC VEGETATION SURVEY

Verifies changes in characteristics of vegetation growth which are potentially detrimental to desirable fish production and to fishing. Recommends remedial action before irreparable damage done to sport fishing.

REF: Federal Aid in Fish Restoration Project No. F-21-R, 1966. Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

346. DBG&FC Lesser, C. A. (1968) MARINE FISHERIES SURVEY

Survey of the marine fisheries harvest; the effort in taking this harvest, and the utilization of public access areas and waters by other outdoor recreation seekers. The survey was conducted in five sectors: (1) Delaware River and its tributaries, (2) Delaware Bay, (3) Atlantic Ocean from Cape Henlopen to Fenwick Island, (4) Rehoboth Bay and Indian River and Bay, and (5) Nanticoke River. The results are presented in a series of tables.

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

347. DBG&FC Steenis, J. H., R. A. Beck, H. P. Cofer, and N. G. Wilder (1954) THE MARSHES OF DELAWARE, THIER IMPROVEMENT AND PRESERVATION

Popular dicussion (with illustrations) of the Delaware marshes as a great natural resource. Includes briefly use of marshes as source of muskrats, for duck hunting, for fish and crabs. Tidal marshes of Delaware and their fresh water tributaries occupy 8% of the state's area. Methods of management to maintain the marshes in a form that will maintain wildlife.

REF: Pittman-Robertson Bulletin No. 2, Project 16R, June 1954. Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

348. DBSCC Delaware Basin Survey Coordinating Committee (1959) INTRA-STATE WATER RESOURCES SURVEY (Coordinators: J. Gordon Smith, Richard A. Haber, A. Joel Kaplovsky, Chauncey O. Simpson)

Section I General Introduction
Section II Synopsis
Section III Summary Observation
Section IV Recommendations
Section V Topography of Delaware
Section VI Summary Review of Water Resources Planning
Section VII State Coordination Organization
Section VIII Statements Made at Various Coordinating Meetings
Section IX Public Archives Commission Conservation of Cultural Resources
Section X Growth and Development Projections
Section XI State Highway Department Planning Division Effect of Transportation on Population Growth in Delaware
Section XII Unemployment Compensation Commission--With the Establishment of New Industries in the State What Will be the Availability of Labor in the Future?
Section XIII Delaware Chamber of Commerce
Section XIV Civil Engineering Department University of Delaware Surface Water Supplies of Northern Delaware
Section XV Delaware Geological Survey
Section XVI Delaware State Board of Health
Section XVII State Soil Conservation Commission
Section XVIII Water Pollution Commission
Section XIX Water Quality in the Lower Delaware River with Special Emphasis upon Pollution Aspects
Section XX Board of Game and Fish Commissioners
Section XXI University of Delaware Marine Laboratories
Section XXII State Highway Department Beach Areas as Future Population Generators
Section XXIII Status of Salt Water Barrier Evaluation
Section XXIV Review of Factors Affecting Saline Water Conversion
Section XXV State Park Commission
Section XXVI Projected Water Needs for the State of Delaware
Section XXVI Projected Water Needs for the State of Delaware
Section XXVII State Forestry Department
Section XXVIII Legal Aspects
Section XXIX Discussion

REF: State of Delaware, Dover, Delaware. *Published as* Appendix O, Volume 8, COMPREHENSIVE SURVEY OF THE WATER RESOURCES OF THE DELAWARE RIVER BASIN, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania. *Also published as* House Document 522, August 16, 1962, 87th Congress, 2nd session

349. DNREC (1970) ANNUAL REPORT

Highlights the reorganization under the cabinet form of government. Reorganization. Division of Environmental Control, Division of Fish and Wildlife, Division of Parks, Recreation and Forestry, Division of Soil and Water Conservation. Financial Report. History and activities of the above divisions, Water and Air Resources Commission retained to advise Division of Environmental Control

REF: Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

350. DNREC, DF&W Alexander, H. L., Jr. (1971) HUNTER SUCCESS EVALUATION ON PUBLIC HUNTING AREAS

REF: Wildlife Investigation W-16-R-20 Annual Report on Job 1-2, Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

351. DNREC, DF&W Harmic, J. L. (1969) A PROPOSAL FOR THE CREATION OF A DIVISION OF MARINE RESOURCES

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control (formerly Board of Game and Fish Commissioners), State of Delaware, Dover, Delaware

352. DSBH Eastman, A. S., and R. C. Beckett (1931) PUBLIC WATER SUPPLIES OF DELAWARE 1931

Reports the chemical and bacteriological analyses of 30 cities and towns in Delaware. Short description of the geology of Delaware given at end of the report.

REF: Division of Physical Health, Department of Health and Social Services, State of Delaware, Dover, Delaware

353. DSHD (1945,... 1969) ANNUAL REPORTS OF THE MOSQUITO CONTROL DIVISION

A series covering description of mosquito control research and evaluation of the severity of the mosquito problem on an annual basis.

REF: Department of Highways and Transportation, State of Delaware, Dover, Delaware

354. DSPO (1966) EVALUATION OF THE WATER RESOURCES OF DELAWARE

At present, Delaware has an abundance of water for the foreseeable future, but is already faced with water problems in some municipalities. These problems can only be resolved by a complete evaluation of the state's water resources and by studies of broad answers to water management. A master plan for the development of Delaware's water resources is recommended.

REF: *Prepared by the* Delaware Geological Survey *for* Delaware State Planning Office, Dover, Delaware

355. DSPO (1966) SHORELINE PLAN

REF: Delaware State Planning Office, Dover, Delaware

356. DSPO (1967) PRELIMINARY COMPREHENSIVE DEVELOPMENT PLAN

Purpose: as guide for the growth of the state. Background: State has a viable economic base, has a very favorable location relative to N.E. U.S. metropolitan area; is well suited to agriculture; sizable wildlife areas of great value; the Atlantic Ocean beaches are a significant asset. Potential problems: water supply and sewage disposal; highway system inadequate for anticipated growth; rapid urbanization is encroaching on farm land; wildlife threatened by industrialization. Population is expected to increase by 389,000 over 1960 to 835,000 in 1980. The goals are: Concentrate urban development; preserve agricultural and open land; maximize utility of major highways; encourage mass transportation (RR); health, welfare, education; encourage industrial growth. Recommend: preserve all marsh areas south of C and D Canal. Several new highways are proposed. State facilities are proposed to implement the plan, also for legislation and administrative policy. Has 93 pages.

REF: Delaware State Planning Office, Dover, Delaware

357. DSPO (1968) BETHANY BEACH COMPREHENSIVE DEVELOPMENT PLAN

The plan is intended to serve as a policy-making guide for the future development. The program consisted of (1) background studies, (2) plan preparation and (3) effectuation of plan. Under (1): History, existing land use, population, community facilities, housing, resident survey, transportation, economic base, financial analysis. Under (2): Goals, land use, community facilities, transportation. Under (3): Zoning, subdivision regulations, capital improvement, administrative procedures. Has 64 pages.

REF: Delaware State Planning Office, Dover, Delaware

358. DSPO (1968) DELAWARE POPULATION AND ECONOMY: A SUMMARY REPORT

From a study of 41 tables of statistical data, the report concludes that the state is divided into an industrialized metropolitan region in the north and a rural-urban region in the south; the economy is heterogenous, but with a heavy concentration of chemical industry in New Castle County. Delaware is undergoing considerable structural change in its economy. The size of the manufacturing sector has remained relatively constant in employment, but has increased in output as shown by wage and salary income. There is evidence that the economy of the two lower counties will become more industrialized and urbanized. Has 47 pages.

REF: Delaware State Planning Office, Dover, Delaware, and the Division of Urban Affairs, University of Delaware, Newark, Delaware

359. DSPO (1968) OUTDOOR RECREATION FOR DELAWARE-INVENTORY

This report is designed to be an inventory of the areas and facilities, both public and private, presently available in the State of Delaware.

REF: Delaware State Planning Office, Dover, Delaware

360. DSPO (1968) REHOBOTH COMPREHENSIVE DEVELOPMENT PLAN

Has 42 pages.

REF: Delaware State Planning Office, Dover, Delaware

361. DSPO (1969) ENVIRONMENTAL STUDY OF REHOBOTH, INDIAN RIVER AND ASSAWOMAN BAYS

Report to Governor Peterson of the unified effort by Delaware's natural resources and planning agencies to document the need for preserving Delaware's inland bay areas, and to outline a specific program for achieving that goal. Participating agencies: Delaware Geological Survey; University of Delaware Marine Laboratories; State Park Commission; State Game and Fish Commission, Water & Air Resources Commission; and State Planning Office. Conclusions: The inland bays of Sussex County, while still prime recreational areas, are in danger of being despoiled through increasing and uncontrolled development. Such further development would disrupt the bottom mud and sand, destroy the marshland and decrease fish populations, increase pollution, contaminate ground water, and destroy woodlands, to further intensify erosion. Has 35 pages.

REF: Delaware State Planning Office, Dover, Delaware

362. DSPO (1969) LAND USE IN SUSSEX COUNTY, DELAWARE: AN INVENTORY AND ANALYSIS

Factual and analytical basis for estimating land requirements for development. Environmental factors, including natural drainage systems, tidal and inland wetlands, and soil drainage characteristics. Has appendix, 5 tables, 3 maps; coded to punchcards in statewide data bank.

REF: *Prepared for* Sussex County Planning and Zoning Commission, Georgetown, *by* Delaware State Planning Office, Dover, Delaware

363. DSPO (1969) TRENDS IN HOUSING CONDITIONS AND CONSTRUCTION FOR SUSSEX COUNTY: 1960-1968

REF: *Prepared for* Sussex County Planning and Zoning Commission, Georgetown, *by* Delaware State Planning Office, Dover, Delaware

364. DSPO (1970) DELAWARE COMPREHENSIVE OUTDOOR RECREATION PLAN

An updated and expanded version of the 1966 report. It includes the findings of detailed studies on inventory, demand and needs, as well as details regarding the uses of existing property and potential acquisitions. The

Delaware Outdoor Recreation Plan is discussed in detail. Has 35 tables, 35 figures, 21 budget schedules, bibliography, 239 pages.

REF: Delaware State Planning Office, Dover, Delaware

365. DSPO (1970) LEWES COMPREHENSIVE DEVELOPMENT PLAN

Includes detailed plans for the region and the city. Sussex County population was 73,200 in 1960, 80,900 in 1970, and is projected to 91,780 in 1980 and 101,930 in 1990. The planning is geared to this population growth. Statistical tables, maps and photographs of the area are included in 28 pages.

REF: Delaware State Planning Office, Dover, Delaware

366. DSPO (1970) NATURAL RESOURCES INVENTORY

Climate. Weather Stations, data. Agricultural land. Changes in acreage of farms. Forests. Distribution, 1957. Forest types. Geology. Rock types. Mineral resources. Soils. Associations types. Soil map. Water resources. Streams, drainage, discharges. Ponds. Analysis of ground water. Wetlands. Types. Has 72 pages.

REF: Delaware State Planning Office, Dover, Delaware

367. DSPO (1970) SUSSEX COUNTY COMPREHENSIVE DEVELOPMENT PLAN

Intended to serve as guideline for the county's future growth to 1990. Proposes a feasible relationship between the needs of the people and the provision of essential public facilities. Has 47 pages.

REF: Delaware State Planning Office, Dover, Delaware

368. SCP&ZC (1969) ANALYSIS OF HOUSING PROBLEMS AND OBSTACLES TO PROBLEM SOLUTION, SUSSEX COUNTY

REF: *Prepared for* Sussex County Planning and Zoning Commission, Georgetown, *by* Delaware State Planning Office, Dover, Delaware

369. DW&ARC (1968) SECOND ANNUAL REPORT, 1967-1968

Water Resources and Subaqueous Lands Division spent the year primarily in collection of data and writing regulations; emphasized underground water supplies; regulations being drafted for well-drilling practices. Subaqueous Lands Division acted on 40 applications; guidelines adopted for procedures to be followed; commission policy relative to certain land reclamation projects. Water Pollution Control Division submitted water quality standards to Department of the Interior in June 1967 which were approved; the adopted standards are compatible with those of the Delaware River Basin Commission.

REF: Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

370. DWPC (1951) SURVEY OF POLLUTION AND ITS EFFECT UPON THE STREAMS WITHIN THE MISPILLION RIVER DRAINAGE BASIN

Detailed analyses as affected by the pollution were made and suggestions for improvement deducted.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

371. DWPC Aulenbach, D. B., and A. J. Kaplovsky (1958) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT ON THE WATERS WITHIN THE NANTICOKE RIVER DRAINAGE BASIN

Detailed field and laboratory measurements were made of the existing water quality in both the Nanticoke River proper and the Broad Creek to determine the effects of pollutional material. The effluent at the nylon plant was studied.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

372. DWPC Aulenbach, D. B., and A. J. Kaplovsky (1961) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECTS ON THE WATERS WITHIN THE ST. JONES RIVER DRAINAGE BASIN

Detailed field and laboratory measurements of the existing water quality and the waste discharges at the Dover Sewage Treatment Plant and two International Latex Plants, as well as at Dover Air Force Base to determine effects of pollutional discharges.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

373. DWPC Kaplovsky, A. J. (1952) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT UPON WATERS WITHIN THE RED CLAY CREEK DRAINAGE BASIN

Chemical, physical, bacteriological and biological determinations were made in a study of the pollution entering the Red Clay Creek and its effect upon the quality of the receiving waters. Recommendations are made for decreasing the existing pollution.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

374. DWPC Kaplovsky, A. J. (1954) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT UPON THE WATERS WITHIN THE BRANDYWINE CREEK DRAINAGE BASIN

Its sources of pollution and their effect upon the water supply of the City of Wilmington was studied. Detailed conclusions are drawn and recommendations made.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

375. DWPC Kaplovsky, A. J., and D. B. Aulenbach (1956) COMPREHENSIVE STUDY OF POLLUTION AND ITS EFFECT ON THE WATERS WITHIN THE INDIAN RIVER DRAINAGE BASIN

Chemical, physical, bacteriological and biological determinations were made in a study of the pollution entering the Indian River and its effect upon the quality of the receiving waters.

REF: *Report by the* State Board of Health *to the* Water Pollution Commission, Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

376. Graham, R. L. (1969) PLANNING-PROGRAMMING-BUDGETING REPORT 1967-1969

One of a series of reports under the same name compiled for the division.

REF: Division of Fish and Wildlife, Department of Natural Resources and Environmental Control, State of Delaware, Delaware Documents

377. Kaplovsky, A. J. (1952) STUDY OF THE ACCUMULATION AND DISTRIBUTION OF IRON WASTE DISCHARGES WITHIN THE DELAWARE RIVER ATTRIBUTED TO DISCHARGES ORIGINATING WITHIN THE STATE OF DELAWARE

REF: *Report by the* State Board of Health *to the* Water Pollution Commission, Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

378. Kaplovsky A. J. (1956) INVESTIGATION OF SANTITARY WATER QUALITY IN LOWER DELAWARE RIVER, *PART I* AND *PART II*

REF: Technical Report 2 *by the* State Board of Health *to the* Water Pollution Commission. Division of Environmental Control, Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

379. Maits, B. (1966) THE NATURAL RESOURCES OF DELAWARE

Starting with the history of earth itself, this is the story of how Delaware and the eastern North American Continent evolved from the barren lifelessness of primordial time over the last two billion years to affect the climate and natural resources of the present. Has 39 pages.

REF: Soil and Water Conservation Commission, State of Delaware, Dover, Delaware

UNIVERSITY

380. Alls, R. T. (1969) KILLIFISH PREDATION OF MOSQUITOES IN LOW-LEVEL IMPOUNDED DELAWARE SALT-MARSHES

REF: Master's thesis in the Department of Entomology and Applied Ecology, Hugh M. Morris Library, University of Delaware, Newark, Delaware

381. Baker, W. W., R. D. Varrin, J. J. Groot, and R. R. Jordan (1966) EVALUATION OF THE WATER RESOURCES OF DELAWARE

At present, Delaware has an abundance of water for the foreseeable future. However, the studies of water use are far too narrow to provide the broad answers needed for water management. It is recommended that a master plan for the development of Delaware's water resources be prepared to assure an adequate supply of high-quality water as the state's economy continues to expand.

REF: Report of Investigation No. 8, March 1966. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

382. Brams, M. R., C. Chandler, and N. Wilson (1969) ECONOMIC AND ENGINEERING FEASIBILITY OF A UNIFIED WATER SYSTEM FOR NORTHERN NEW CASTLE COUNTY, DELAWARE

Discusses an area of 232 square miles, with a population of 355,447 and an average daily water use of 51 gallons. The sources of the water and their operating costs are described. Unification promises greater efficiency, wholly or partially, physically and administratively, under county ownership. The proposal for building White Clay Creek Dam is a first step in the direction of county involvement with the problem of water supply and distribution. Has 166 pages.

REF: Division of Urban Affairs, University of Delaware, Newark, Delaware

383. Coskery, O. J. (1956) WATER LEVELS AND ARTESIAN PRESSURES IN DELAWARE 1955

Recording gages were maintained in municipal well fields at New Castle, Newark, and Lewes, and at Governor Bacon Health Center. Water levels varied from 4.8 to 9.0 feet below land

surface datum for 1950 to 1955. Precipitation in 1955 was less than normal (40.04 inches).

REF: Water Level Report number 4, 1956. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

384. Coskery, O. J. (1961) WATER LEVELS IN DELAWARE 1957

Similar to previous reports. Precipitation in 1957 was less than normal. Withdrawal of water from aquifers in Delaware City area was 10 times that for 1953 because of industrial development. Decline in 1957 in the four wells surveyed ranged from 12 to 50 feet from levels in earliest records (1954 and 1955).

REF: Water Level Report number 6, 1961. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

385. Coskery, O. J. (1961) WATER LEVELS IN DELAWARE 1958

Similar to previous reports in this series. Precipitation in 1958 was greater than normal (54.5 inches). The data are brought up to date.

REF: Water Level Report number 7, 1961. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

386. Coskery, O. J., and W. C. Rasmussen (1958) WATER LEVELS IN DELAWARE 1956

Similar to previous reports. Preciptation in 1956 was greater than normal (47.35 inches). Results from 4 continuous water level records at New Castle, Newark, Lewes, and Governor Bacon Health Center from 1950 to 1956.

REF: Water Level Report number 5, 1958. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

387. Crosswhite, W. M. (1968) USE OF WATER FOR SUPPLEMENTAL IRRIGATION IN DELAWARE

Compared with the present use, Delaware has a large physical

supply of water. Undetermined amounts of water are held in 12 major ground reservoirs. In addition there is an average stream flow of 1.5 billion gallons per day. Short periods of drought are common. Irrigation through sprinkler systems is used to supplement rainfall and the amount used varies accordingly. The investment and costs of irrigation systems are discussed, as are the economic benefits derived. Has 24 pages.

REF: Bulletin number 375, Agricultural Experiment Station, University of Delaware, Newark, Delaware

388. Delaware Geological Survey (1961) THE STORY OF YOUR STATE GEOLOGICAL SURVEY'S SEARCH FOR WATER

A brief story about water and the ways in which the Delaware Geological Survey helps insure that you will always have a plentiful supply.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

389. Gaither, W. S., ed. (1968) OCEAN ENGINEERING EDUCATION: PROCEEDINGS OF A WORKSHOP AT THE UNIVERSITY OF DELAWARE IN OCTOBER 1968

The workshop brought together individuals from industrial, government, and academic organizations to examine and discuss programs which are available now, or are being developed, to educate engineers and technicians for ocean-oriented careers.

REF: Department of Civil Engineering, College of Engineering, University of Delaware, Newark, Delaware

390. Governor's Task Force on Marine and Coastal Affairs (1971) COASTAL ZONE MANAGEMENT

A preliminary report of Governor Peterson's Task Force containing some recommendations toward the forming of policy guidelines and certain key recommendations for the management and conduct of marine and coastal affairs for the State of Delaware.

REF: College of Marine Studies, University of Delaware, Newark, Delaware

391. Groot, J. J. (1955) SEDIMENTARY PETROLOGY OF THE CRETACEOUS SEDIMENTS OF NORTHERN DELAWARE IN RELATION TO PALEOGRAPHIC PROBLEMS

Because of lack of identifiable fossils in nonmarine sediments in northern New Castle County and presence of only a few in the Pleistocene and Wenonal formations, study of sediments in coastal plains were made by modern methods of mechanical and heavy mineral analyses. Most samples were obtained from outcrops, which do not permit use of systematic grids to provide an even geographic distribution of sampling sites.

REF: Bulletin number 5, 1955. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

392. Groot, J. J., D. M. Organist, and H. G. Richards (1954) MARINE UPPER CRETACEOUS FORMATION OF THE CHESAPEAKE AND DELAWARE CANAL

The marine Upper Cretaceous formations were studied at 8 stations along the canal using fossils and sedimentary characteristics. Formations of the Matawan Group (Merchantville and Wenonah) [sic] *and Monmouth Group (Mount Laurel Sand, Navesink, and Red Bank Sand) were identified. Has 37 references, 64 pages; historical record on pages 11-29; outcrop description on pages 31-38.*

REF: Bulletin number 3, 1954. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

393. Harman, O. (1968) ENVIRONMENTAL CONTROL SYSTEM FOR OYSTER FARMING

Progress report on design, development and analysis of system for oyster culture. Defines approach, enumerates procedures and equipment used for work in progress at Lewes and Newark, describes diet.

REF: Department of Agricultural Engineering, College of Agricultural Sciences, University of Delaware, Newark, Delaware

394. Hoeh, R. S. (1966) WATER RESOURCES ADMINISTRATION IN DELAWARE

Discusses primarily the legal doctrines that were operating in Delaware in 1965-66 to determine the allocation and use of water and what governmental agencies influence, by statute

and administrational action, the use and development of water resources in the state. Chapters (1) The Legal Framework; (2) Administration Organization; (3) Intergovermental Relations; (4) Conclusions and Recommendations, Figures A, B, &C summarize the organization of water-related agencies and recommended organization. Appendix (1968) discusses local agencies related to water resources. Has 43 references, 175 pages.

REF: Division of Urban Affairs, University of Delaware, Newark, Delaware

395. Humphries, E. M. and F. C. Daiber (1968) SHELLFISH SURVEY OF INDIAN RIVER BAY AND REHOBOTH BAY, DELAWARE

REF: Marine Laboratory, Department of Biological Science, University of Delaware, Newark, Delaware

396. Jordan, R. R. (1962) STRATIGRAPHY OF THE SEDIMENTARY ROCKS IN DELAWARE

The stratigraphy of the coastal plain of Delaware is described and a revised stratigraphic column for Delaware is proposed and compared with similar columns for New Jersey and Maryland. The rock units of the coastal plain of all three states are an interrelated mass; however, profound facies changes do occur, particularly in the dip direction. Has 4 plates, 3 figures, 101 references.

REF: Bulletin number 9, 1962. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

397. Jordan, R. R. (1964) COLUMBIA (PLEISTOCENE) SEDIMENTS OF DELAWARE

The Columbia deposits of Delaware form a sheet of sand with maximum thickness of 150 feet which covers most of the coastal-plain portion of the state. Columbia sediment is essentially medium sand, but coarser admixtures are typical in the north and finer admixtures, in the south. Geographical distribution used of a sampling grid based on meridians and parallels spaced 5 minutes apart; quadrangles measured 4.5 to 6.0 miles; 75 quadrangles were studied with 2 outcrops in each. Samples were tested for texture, mineralogy, lithology, and heavy mineral content. Has 9 plates, 17 figures, 3 tables, 79 references.

REF: Bulletin number 12, 1964. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

398. Krimgold, D. B. (1969) HYDROLOGIC, PHYSIOGRAPHIC, EDAPHIC, AND VEGETATION ASPECTS OF THE CLIMATIC WATER BALANCE, DELMARVA PENINSULA

Notes the severe deficiencies of data on the determinable elements of the hydrologic balance in the peninsula. Presents ways of deriving essential data from existing information. Recommends data-collecting scheme for future and intermediate procedures until complete format is available. Information obtained is essential to planning use of available water resources.

REF: OWRR Project No. A-004-Del, November 1969, The Ground Water Flow System in the Delmarva Peninsula. Water Resources Center, University of Delaware, Newark, Delaware

399. Kraft, J. C., and M. D. Maisano (1968) GEOLOGIC CROSS SECTION OF DELAWARE

A chart 31 inches by 55 inches showing stratigraphic correlations, aquifer distribution, and geologic setting within the Atlantic Coastal Plain/Continental Shelf geosyncline.

REF: Water Resources Center, University of Delaware, Newark, Delaware

400. MacCreary, D. (1940) REPORT ON THE TABANIDAE OF DELAWARE

The large marshland area (8% of the total area of the state) provides favorable conditions for the development of large numbers of horseflies. The horseflies are of considerable economic importance both for their actual feeding and potential vectors of livestock diseases. In Delaware 55 species were collected and their habits and life cycles studied. Has 41 pages.

REF: Bulletin 226, May 1940, Agricultural Experiment Station. College of Agricultural Sciences, University of Delaware, Newark, Delaware

401. Malcolm, J. W., and J. L. Harmic (1967) AMERICAN SHAD

An illustrated nostalgic history of shad fishing in Delaware.

REF: Delaware Conservationist, volume 11, number 2, 1967. Department of Natural Resources and Environmental Control, State of Delaware, Dover, Delaware

402. Marine, I. W., and W. C. Rasmussen (1955) PRELIMINARY REPORT ON THE GEOLOGY AND GROUND-WATER RESOURCES OF DELAWARE

The Agricultural Experiment Station and the U.S. Geological Survey. Extensive study of the geology and ground-water resources of Delaware. Discusses Piedmont and Coastal Plains Provinces of Delaware, geologic history, ground-water hydrology; recovery by wells; chemical quality; utilization; water supplies in northern suburbs of Wilmington, (surface water) and south of Wilmington (ground water). Has 26 tables, 30 figures, 10 plates, 94 references. Maps give well locations, geologic structure, specific aquifers forming principal ground-water sources and water use. Tables include location of wells, logs of wells published previously, records of wells, wells for which records have been published in previous reports.

REF: Bulletin number 4, 1955. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

403. Mather, J. R. (1969) FACTORS OF THE CLIMATIC WATER BALANCE OVER THE DELMARVA PENINSULA

The major direction of the present study has been to assemble and analyze the available climatic water balance, and surface hydrologic data over the Delmarva peninsula and to present the results in both a geographic and time framework. Has 129 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

404. McKenzie, S. W. (1967) INVENTORY OF THE USE OF WATER IN 1966

Data for this inventory are stored on magnetic tape in the Computing Center of the University.

REF: Water Resources Center, University of Delaware, Newark, Delaware

405. Miller, John C. (1971) GROUND WATER GEOLOGY OF THE DELAWARE ATLANTIC SEASHORE

Present water use in the shore area between Philadelphia and Washington is about 4 million gallons per day and will reach 9.3 MGD by 2000, showing the need for locating additional sources of ground-water for the Delaware Atlantic seashore.

This report provides a new geologic interpretation of the occurence of deep aquifers beneath the beach areas between Lewes and Fenwick Island. Test holes are needed along the entire Delaware seashore. Has 31 pages.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

406. Pickett, T. E. (1970) NEW GEOLOGIC MAPPING IN DELAWARE

The Cretaceous Formations present in the Chesapeake and Delaware Canal area are the Potomac, Magothy, Merchantville, Englishtown, Marshalltown and Mount Laurel. Structural contour and isopach maps of lower Delaware reveal the following subsurface configuration of Paleocene, Eocene and Miocene units; Rancocas and Piney Point Formations and Cheswold, Frederica, Manokin and Pocomoke Aquifers. Pleistocene (Columbia Group) fluvial and marine deposits in Delaware cover all older units as a veneer about 50 feet thick in northern Delaware and usually 80-100 feet thick in southern Delaware.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

407. Rasmussen, W. C., J. J. Groot, R. O. R. Martin, E. F. McCarren, V. C. Behn, *et al.* (1957) WATER RESOURCES OF NORTHERN DELAWARE

The surface and ground-water resources of northern Delaware (north of the Chesapeake and Delaware Canal) are evaluated. There are 10 principal aquifers capable of sustained yields of several million gallons per day. Chemical contamination and pollution are discussed. Hydrologic evaluation is necessary from outpost wells to adjust pumping to restrain salt-water encroachment.

REF: Bulletin number 6, Delaware Geological Survey, University of Delaware, Newark, Delaware

408. Rasmussen, W. C., and L. B. Haigler (1953) GROUND-WATER PROBLEMS IN HIGHWAY CONSTRUCTION AND MAINTENANCE

Includes maps and figures locating quicksand deposits, sub-drainage problems, tide marshes, etc.

REF: Bulletin number 1, Delaware Geological Survey, University of Delaware, Newark, Delaware

409. Rasmussen, W. C., R. A. Wilkens, R. M. Beall (1960) WATER RESOURCES OF SUSSEX COUNTY, DELAWARE--A PROGRESS REPORT

Geology of Sussex County; the most important aquifers, chemical analyses, and stream flows of surface water; analyses, yields, and consumption of ground water.

REF: Bulletin number 8, Delaware Geological Survey, University of Delaware, Newark, Delaware

410. Rima, D. R., O. J. Coskery, and P. W. Anderson (1964) GROUNDWATER RESOURCES OF SOUTHERN NEW CASTLE COUNTY, DELAWARE

The geologic formations and water resources of the 190-square-mile area are described, and the chemical and physical properties of waters from representative wells are given. If large-scale pumping near the shoreline of bay is necessary, they suggest placing a line of "injection wells" between the shoreline and the area of withdrawal. Has 2 plates, 18 figures, 6 tables, 30 references.

REF: Bulletin number 11, 1964. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

411. Seidenstat, P. (1966) THE MARKET FOR WATER BASED OUTDOOR RECREATION SERVICES IN NEW CASTLE COUNTY, DELAWARE

An attempt to explore the demand for water-related recreation in an outdoor setting. The chapters cover: Recreation as a use for water; Present market for water-based recreation; Future market; Procedures used in estimating water-based recreation demand and capacity.

REF: Water Resources Center, University of Delaware, Newark, Delaware

412. Smith, R. C. (1970) DELAWARE'S FARM INCOME: CROP AND LIVESTOCK PRODUCTION IN 1969

Delaware agricultural statistics taken from publications of the U.S. Department of Agriculture are assembled and reproduced.

REF: Pamphlet No. 48, November 1970, Department of Agriculture and Food Economics. College of Agricultural Sciences, University of Delaware, Newark, Delaware

413. Smith, R. C., and D. R. Crossan (1969) ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST IN 1968

Analytical objectives enumerated; the approach used, especially in compiling information on menhaden for animal feeds. Detailed evaluation of value of fish meal in broiler production. Many statistical procedures employed, some less successfully than others.

REF: Department of Agriculture and Food Economics, College of Agricultural Sciences, University of Delaware, Newark, Delaware

414. Spoljaric, N. (1967) PLEISTOCENE CHANNELS OF NEW CASTLE COUNTY, DELAWARE

Two Pleistocene channel systems are recognized; a system of straight channels north of the Chesapeake and Delaware Canal, and a braided system south of the canal. During high stream flow, most of the area was submerged. Primary sources were melt-water streams originating from glaciers which at times advanced to within 100 miles north of the county. Thus, the age of the channels is thought to be glacial. Has 15 pages.

REF: Report Investigation number 10, 1967. Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

415. Spoljaric, N. and R. R. Jordan (1966) GENERALIZED GEOLOGIC MAP OF DELAWARE

A one-page spread giving the major types and location of rocks throughout the state.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

416. Sundstrom, R. W. and T. E. Pickett (1968) THE AVAILABILITY OF GROUND WATER IN KENT COUNTY, DELAWARE, WITH SPECIAL REFERENCE TO THE DOVER AREA

Ground water is available from several sources or aquifers. The quantities have been determined by methods of applied hydrology described and illustrated in this report. The combined use of all of the aquifers in the county in 1966

amounted to an average of 17,856,000 gallons per day. Has 123 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

417. Sundstrom, R. W. and T. E. Pickett (1969) THE AVAILABILITY OF GROUND WATER IN EASTERN SUSSEX COUNTY, DELAWARE

This report is concerned with the ground water in the 485 square miles of Eastern Sussex County that drains eastward toward the Delaware Bay and the Atlantic Ocean. The amount of water used in this area for all purposes in 1966 averaged about 18 million gallons per day. This was computed to be less than 13% of the available supply of the area of more than 140 million gallons per day. Salt-water problems occur in the coastal area where the altitude of the water table is less than 5 feet above sea level. Problems have occurred at Lewes, Rehoboth Beach and other areas. Has 136 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

418. Sundstrom, R. W., and T. E. Pickett (1970) AVAILABILITY OF GROUND WATER IN WESTERN SUSSEX COUNTY, DELAWARE

The geology and ground-water hydrology of eight ground-water reservoirs were studied in detail. The ground-water drained by all streams in the area is estimated to average about 280 million gallons per day. The area receives an average of 46.75 inches of rainfall a year. Of this an estimated average of 460 million gallons per day is available for recharge to the water table aquifer and an estimated average of 70 million gallons per day is overland runoff. Has 118 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

419. Sundstrom, R. W., and T. E. Pickett (1971) THE AVAILABILITY OF GROUND WATER IN NEW CASTLE COUNTY, DELAWARE

The county encompasses partitions of two geological provinces whose ground-water reservoirs vary widely in water yielding properties. The ground-water reservoirs in the northern Piedmont region are contained in very old rocks

in yields of small quantities in wells throughout the area, supplying 67% of the base flow of the Brandywine, Red Clay, and White Clay creeks. The ground-water reservoirs of the Coastal plain of much younger sedimentary rocks, are important for supplying up to large quantities of water. The important aquifers are described and their present and potential yields are detailed. Has 156 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

420. Sundstrom, R. W., and R. D. Varrin (1971) WATER SUPPLY AND USE IN THE DRAINAGE BASINS OF THE DELAWARE RIVER SYSTEM AND ATLANTIC COASTAL DRAINAGE BASINS IN DELAWARE

The available waters of the area, the trends of development, the anticipated needs for water to the year 2000, and potential problems of keeping the area adequately supplied with water. South of the Chesapeake and Delaware Canal most areas either have adequate water or their problems are not grave. In the northern part of New Castle County there could be a potential deficiency of 28 million gallons per day in 1980 and 68 million gallons per day in 2000. Has 90 pages.

REF: Water Resources Center, University of Delaware, Newark, Delaware

421. Sundstrom, R. W., *et al.* (1967) THE AVAILABILITY OF GROUND WATER FROM THE POTOMAC FORMATION IN THE CHESAPEAKE AND DELAWARE CANAL AREA, DELAWARE

Drawdown quantitative curves for the two aquifers were constructed. Several hypothetical plans of pumping centers in the canal area are demonstrated. There appears to be no danger of salt water contamination in the foreseeable future. The Magothy Formation in the western section of the canal crops out in the canal and is protected by the hydraulic gradient toward the canal. Geology section prepared by J. J. Groot et al. *of the Office of the Delaware Geological Survey. Has 95 pages.*

REF: Water Resources Center, University of Delaware, Newark, Delaware

422. Tannian, F. X. (1968) PORT OF WILMINGTON

Contents: History. Staff. Organization. Physical plant. Financial overview. Physical and financial performance. Shipment related functions. Real estate functions. Recommendations. Has 59 pages.

REF: Division of Urban Affairs, University of Delaware, Newark, Delaware

423. Tannian, F. X., C. Chandler, N. Wilson (1967) CITY OF WILMINGTON WATER SYSTEM

Detailed discussions of early and recent history, organization and staffing. Riparian rights, land, water storage, water purification, pumping, and distribution system, and cost and revenue analysis. It is concluded that the demand for water is increasing; the raw water sources appear to be adequate for the near future; the treated water system is being expanded and improved to meet future demands. Possibilities for future improvements are recommended. Has 53 pages.

REF: Division of Urban Affairs, University of Delaware, Newark, Delaware

424. University of Delaware (1968) GEOLOGY AND EARTH RESOURCES OF DELAWARE

A 4 page bookley briefly describes the geological history of Delaware and the earth resources of the state.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

425. University of Delaware Geological Survey (1956) Coskery, O. J. WATER LEVELS AND ARTESIAN PRESSURES IN DELAWARE 1955

During 1955, 363 individual water level measurement made in 21 wells. Recording gages maintained on 3 wells in municipal well fields at New Castle, Newark, and Lewes. Recording gages also at Governor Bacon Health Center. Figure 2 shows average water level based on 13 wells, and average monthly statewide precipitation September 1950 to December 1955. Water level varied from 4.8 to 9.0 feet below land surface datum. Data given for each well approximately monthly. Precipitation for year below normal (40.04).

REF: Delaware Geological Survey, Water Level Report number 4, University of Delaware, Newark, Delaware

426. University of Delaware Geological Survey (1958) Coskery, O. J., and W. C. Rasmussen WATER LEVELS IN DELAWARE 1956

Similar to previous reports. Precipitation in 1956 was greater than normal (47.35"). Results from 4 continuous water level records at New Castle, Newark, Lewes, and Governor Bacon Health Center from 1950 to 1956.

REF: Delaware Geological Survey, Water Level Report number 5, University of Delaware, Newark, Delaware

427. Vaughn, G. F. (1968) AGRIBUSINESS IN DELAWARE'S ECONOMY

"Agribusiness" comprises the sum total of all operations involved in the manufacture and distribution of farm supplies. Agribusiness in Delaware in 1967 was $293,000,000, or 26.7% of all production and manufacturing in the state, $273,000,000 sales in wholesale trade, or 19.1% of all business and $292,000,000 or 31.8% of all retail sales in the state. Delaware agribusiness is growing. The variety of emerging problems, such as the industry's efficiency and the state's future land use, are mentioned.

REF: Extension Bulletin 98, 1968, Agricultural Extension Service. College of Agricultural Sciences, University of Delaware, Newark, Delaware

428. Vaughn, G. F. (1968) AGRICULTURAL LAND: DELAWARE'S RETREATING OPEN SPACE

A comprehensive series of tables detailing the acreages of open land for every section of the state in 1930 and in 1964.

REF: Extension Circular 128, May 1968 Delaware Cooperative Extension Service. College of Agricultural Sciences, University of Delaware, Newark, Delaware

429. Ward, R. F. (1958) GEOLOGY OF THE DELAWARE RIVER

REF: Estuarine Bulletin, volume 3, number 3, pages 4-9, 1958. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

430. Woodruff, K. D. (1969) THE OCCURRENCE OF SALINE GROUND WATER IN DELAWARE AQUIFERS

The location of fresh-salt-water boundary in the deeper aquifers of Delaware is related mainly to head values. Heavy pumping near sources of brackish water should be avoided for the present. Proper location of monitoring wells is necessary for detection of chloride movement. Has 43 pages.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

431. Woodruff, K. D. (1970) GENERAL GROUND-WATER QUALITY IN FRESH-WATER AQUIFERS OF DELAWARE

Analyses of about 150 water quality samples from wells show that Delaware's fresh ground waters are suitable for most purposes. However, high iron content may occur in wells tapping the Columbia and Potomac formations and high nitrates were found in a few wells. Has 22 pages.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

432. Woodruff, K. D. (1970) MONTHLY REPORT ON WATER CONDITIONS IN DELAWARE

Monthly summary of precipitation, stream flows at Wilmington, Dover, and Georgetown (Brandywine). Ground-water levels in water-table wells (4) in the Pleistocene aquifer, artesian wells in Potomac, Mormouth, Mogothy and Piney Point aquifer given for the month. Chloride concentration at Delaware Memorial Bridge is also given. In May report values given for October-December 1969 and January-April 1970.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

433. Woodruff, K. D. (1970) SUMMARY OF WATER CONDITIONS IN DELAWARE: A MONTHLY REPORT

Monthly summary of precipitation, stream flows at Wilmington, Dover and Georgetown (Bridgeville); the ground-water levels in four water-table wells in the Pleistocene aquifer; and artesian well flows in the Potomac, Mormouth, Magothy and Piney Point aquifers. Chloride concentrations at Delaware Memorial Bridge are also included.

REF: Office of the Delaware Geological Survey, University of Delaware, Newark, Delaware

434. UDCMS Daiber, F. C., and R. W. Smith (1971) AMALYSIS OF THE WEAKFISH POPULATION IN DELAWARE BAY

The weakfish is the most abundant of all species of fish sampled by a trawl survey 1966-1970 in Delaware Bay. There is a peak abundance in June due to mature fish entering the bay to spawn, and a second higher peak in September or October, due to young fish on their southward migration down the Atlantic Coast. Their growth and food habits were studied.

REF: College of Marine Studies, University of Delaware, Newark, Delaware

435. UDCMS Price, K. S., Jr., and D. L. Maurer (1971) ARTIFICIAL PROPAGATION OF COMMERCIALLY VALUABLE SHELLFISH--OYSTERS

Proceedings of a conference at the university of October 22-23, 1969. The 21 papers submitted represent a progress report by industry and federal and state scientists on the work undertaken to rectify the catastrophic collapse of the oyster industry in the Delaware Bay region due to a parasitic protozoan, known as MSX, when the value of oyster landings declined in a few years from about $3 million to less than $40,000.

The papers covered the following subjects: Development of culture techniques, nutritional requirements, hatching operations, oyster diseases, selective breeding feasibility of oyster hatcheries in Delaware, Environmental Controls for culturing oysters, systems analysis of oyster production, systems engineering, technical training and extension services.

REF: College of Marine Studies, University of Delaware, Newark, Delaware

436. UDML (1952) ANNUAL REPORT: SUMMARIZATION OF FIRST YEAR'S WORK

Chapters on hydrography and plankton, marine and estuarine fauna of Delaware from approximately 20 places in Delaware Bay and Indian River Bay, e.g., salinity, dissolved oxygen, temperature, pH, transparency, current flow.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

437. UDML (1954) BIENNIAL REPORT 1953-1954

Chapter Hydrography by L. E. Cronin on pages 6-15 describes the salinity of the estuary by tables and graphs. Other tables follow temperature and oxygen variations. Estimates and averages of river flow and flushing times are included. Other chapters deal with plankton, biological survey fisheries statistics, blue crab and oyster studies.

REF: Information Series, Publication number 2. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

438. UDML (1956) BIENNIAL REPORT: DISCUSSION OF VARIOUS TYPES OF RESEARCH DURING 1955-1956

In addition to discussion of biological research of various types, mentions continuation of studies of channel and physical characterization of the estuary, routine sampling during field studies, seasonal hydrographic survey of the Delaware River estuary shared with New Jersey Oyster Research Laboratory. Water samples taken at 45 stations from Overfalls Lightship to Philadelphia. Collection of hydrographic data in Indian River Inlet continual since 1952.

REF: Biennial Report number 3, 1955-1956. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

439. UDML (1958) ANNUAL REPORT: MISCELLANEA

Collection of 25 letters, reports, research proposals, minutes of meetings, primarily on biological subjects. C. N. Shuster's suggestions for a National Program in Estuaries Research; education and conservation advisement; statements on ecological considerations (Reference 88-18); minutes of the 17th meeting of Middle Atlantic Section of Atlantic States Marine Fisheries Commission, September 25, 1958. Summaries of discussions of estuaries, research, proposed salt-water barrier in the Delaware River.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

440. UDML (1958) BIENNIAL REPORT: SUMMARY OF ACCOMPLISHMENTS DURING 1957-1958

Primarily discussion of biological aspects: fishes, mollusks, zooplankton, estuarine productivity.

REF: Biennial Report number 4, 1957-1958. Marine Laboratories, Department of Biological Science, University of Delaware, Newark, Delaware

441. UDML (1970) SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE REGION: FINAL REPORT OF THE SEA GRANT PROJECT, 1968-1970

The major goal of this Sea Grant project was revival of the state's shellfish industry. It proposed to do this through systems engineering techniques for artificial shellfish culture, including breeding, holding brood stock, spawning them on command, rearing larvae, and cultivating the progeny in the field. The primary emphasis was on oysters. Progress is reported in all these fields, also evidenced by six papers submitted for publication. Has 126 pages.

REF: College of Marine Studies, University of Delaware, Newark, Delaware

442. UDML Amos, W. H. (1957) SELECTIVE BIBLIOGRAPHY CONCERNING THE HYDROGRAPHY AND BIOLOGY OF THE DELAWARE RIVER ESTUARY

Lists maps from 1616 to 1824 and approximately 100 literature references. All are available in the libraries at the Marine Laboratories, the University, Wilmington, or the Delaware State Historical Society.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

443. UDML Curtis, L. (1969) THREE YEAR SURVEY OF THE PESTICIDE CONTENT OF SHELLFISH IN DELAWARE'S TIDAL WATERS

The American oyster, the ribbed mussel, and the hard clam were studied from 1966-1969. It was shown that shellfish are able to concentrate pesticides in their tissues at levels much higher than are found in the environment.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

444. UDML Daiber, F. C. (1955) TRAWL FISHERY INVESTIGATIONS

The trawlers disturb only the upper layers of mud and sand, but not vegetation. The trawlers have also been accused of the declines in Croaker and the Squeteague catches. The records do not bear this out. Various other accusations have been leveled against the trawlers, but the report concludes that their use is beneficial. Has 44 pages.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

445. UDML Daiber, F. C. (1959) TIDAL MARSH: CONFLICTS AND INTERACTIONS

General discussion about the important functions of marshes with a particular description of the Canary Creek Marsh which empties into the Broadkill River at Roosevelt Inlet in Lewes. Hydrographic features, detritus and chemical analyses, animal life; the marsh cycle, involving decay and the supply of nutrients.

REF: Estuarine Bulletin, volume 4, number 4. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

446. UDML Daiber, F. C. (1969) ACADEMIC COMMUNITY DESIGN

Discussion about objectives to
1. Develop a science program with emphasis on marine sciences
2. Train undergraduates
3. Initiate educational programming
4. Acquire and strengthen faculty and staff
5. Develop appropriate facilities for above objectives
6. Develop adequate budgetary support.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

447. UDML Daiber, F. C., D. Aurand, F. L. Gooch, and R. Reimold (1969) FURTHER STUDIES IN TIDAL MARSH ECOLOGY IN DELAWARE

A paper presented at American Fisheries Society meeting, February 1969. Evaluates the role of the salt marsh in estuarine productivity and the effects of man-made changes in the wetlands areas of Delaware.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

448. UDML Daiber, F. C., C. W. Beattie, and W. de Witt, III (1970) FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE

The Murderkill River has a residence time of 140 hours during a high-runoff period. The discharge is not linear. It resembles the Broadkill in that salinity and temperature vary longitudinally and are influenced by tides and runoff. Zooplankton populations appear to be distributed on the basis of salinity in both rivers, with low oxygen and pH levels further influencing zooplankton distribution and relative abundance.
There are very great differnces in concentrations of dissolved oxygen, soluble phosphorous, and nitrate. The Broadkill is overenriched with phosphorus and contains an oxygen-deficient water zone. The Murderkill is overenriched with nitrate.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

449. UDML Daiber, F. C., J. Gallagher, and M. J. Sullivan (1971) TIDE MARSH ECOLOGY AND WILDLIFE

The kinds of diatoms associated with the Marsh Surface and the productivity patterns of the edaphrie algae were studied. The report is based on the M.S. thesis by Sullivan on diatoms and the Ph.D. thesis by Gallagher on algae.

REF: College of Marine Studies, University of Delaware, Newark, Delaware

450. UDML (1968) Daiber, F. C. and G. W. Schmelz AN ANALYSIS OF TEMPERATURE AND SALINITY LEVELS ON GROWTH AND SURVIVAL OF THE STRIPED KILLIFISH

The study was carried out (1) by determining the death point of different life history stages at different temperatures and salinities, (2) by ascertaining the oxygen uptake at the above stages and conditions, and (3) by observing the hatching time under the above conditions.

REF: Project F-13-R-10, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

451. UDML Daiber, F. C., and R. W. Smith (1969) ANALYSIS OF FISH POPULATIONS IN THE DELAWARE BAY AREA 1968-1969

REF: Project F-13-R-11, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

452. UDML Daiber, F. C., and R. W. Smith (1970) ANALYSIS OF FISH POPULATIONS IN THE DELAWARE BAY AREA 1969-1970

Incidental to report on fish population the following physical parameters were determined and are reported for a cross-section of the Delaware Bay: Temperature (range 1.9-23.7°C)--Salinity (range 27.6-30.48 0/00) Dissolved oxygen (range 4.57-12 ppm)--for each of the twelve months.

REF: Project F-13-R-12, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

453. UDML Daiber, F. C., and R. W. Smith (1970) AN ANALYSIS OF THE WINDOWPANE FLOUNDER POPULATION IN THE DELAWARE BAY AREA

The windowpane flounder is the fifth most abundant fish in Delaware Bay as sampled by other trawl, and the most abundant of the edible flatfish. This paper reports on a continuing study of the biology of this fish.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

454. UDML Daiber, F. C., and R. C. Wockley (1968) ANALYSIS OF THE FISH POPULATIONS IN DELAWARE BAY AREA 1967-1968

A study of the distribution of the bottom fish populations of the Delaware River estuary with regard to temperature, salinity, depth, and other physical factors for 57 fish species.

REF: Project F-13-R-10, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

455. UDML De Sylva, D. P., F. A. Kalber, Jr., and C. N. Shuster, Jr. (1962) FISHES IN THE SHORE ZONE AND OTHER AREAS OF THE DELAWARE RIVER ESTUARY. *Also published as* FISHES AND

ECOLOGICAL CONDITIONS IN THE SHORE ZONE OF THE DELAWARE RIVER ESTUARY, WITH NOTES ON OTHER SPECIES COLLECTED IN DEEPER WATER

Information was collected during 1958-1960 at 16 sites within Delaware River estuary and adjacent areas of the Atlantic Coast, comprising 66 species caught as well as 72 species not caught in the beach zone area. Measurements of salinity, temperature, oxygen saturation, and turbidity of the water were taken at the time of fish collection. The paramenters of the conditions under which the various species were found, were delineated. Spawning activity was studied in the various areas and stomach analyses showed the feeding habits. Has 41 figures, 50 tables, 73 references, 164 pages.

REF: Information Series, Publication number 5. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

456. UDML de Witt, W. III (1971) WATER QUALITY VARIATIONS IN THE BROAD-KILL RIVER ESTUARY

Ammonia, inorganic phosphorus, and chlorophyll attained their highest mean concentrations during the summer; while the maximum mean concentrations of dissolved oxygen and nitrate appeared during the winter. The highest mean concentrations of nitrite and organic phosphorus were found during the autumn. The interreactions of the changes in nutrients and their effects were studied.

REF: Doctoral dissertation in the Department of Biological Sciences, Hugh M. Morris Library, University of Delaware, Newark, Delaware

457. UDML Hess, P. W. (1961) FOOD HABITS OF TWO DASYATID RAYS IN DELAWARE BAY

The digestive tracts of two species were removed and inspected for food items.

REF: COPEIA, number 2, pages 239-241, American Society of Ichthyologists and Herpetologists, National Museum, Washington, D.C., June 1961.

458. UDML Hurlburt, E. M. (1957) DISTRIBUTION OF *Neomysis americana* IN THE ESTUARY OF THE DELAWARE RIVER

Observations on the planktonic shrimp in the Delaware River estuary were made over a period of two years. It was far more abundant in the deep water of the estuary than in the near surface or shallow water. The size increased from the ocean towards the river end of the estuary due to their becoming older during their "up-estuary" drift in deep water.

REF: Limnology and Oceanography, volume 2, number 1, pages 1-11, January 1957, Lawrence, Kansas. Contribution 4, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

459. UDML Pfitzenmeyer, H. T., and C. N. Shuster, Jr. (1960) PARTIAL BIBLIOGRAPHY OF THE SOFT SHELL CLAM

Maryland Department of Research and Education and the University of Delaware Marine Laboratories. January 1960.

REF: Maryland Department of Research and Education, and the Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

460. UDML Setzler, E. M. (1969) EFFECTS OF TRICAINE AND ADRENALINE ON THE HEART RATE OF THE HOGCHOKER

Concentrations of 1 x 10^{-7} adrenaline produce a significant increase in rates of hearts isolated from nonanesthesized fish, but not in hearts from previously anesthesized fish. The reasons for the conflicting results with tricaine are discussed.

REF: Master's Thesis in the Department of Biological Sciences, Hugh M. Morris Library, University of Delaware, Newark, Delaware

461. UDML Schneider, E. (1962) TEXTURE AND MINERALOGY OF DELAWARE'S ATLANTIC BEACHES

Twenty-three sand samples were collected at 1-mile intervals along Delaware's Atlantic beach coast and analyzed for texture and mineralogy. Beaches consisted of medium- to coarse-grained sands. There is a great variety of minerals in the beach sands, of which hornblende, zircon, staurolite, garnet,

sillimanite, and black opaques are most abundant. Thirty-two different minerals are identified.

REF: Bachelor's Thesis in the Department of Geology, Hugh M. Morris Library, University of Delaware, Newark, Delaware

462. UDML Shuster, C. N., Jr. (1955) FISHERY STATISTICS OF DELAWARE

REF: Information Leaflet 1, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

463. UDML (1956) Shuster, C. N., Jr. COMMENTS ON ESTUARINE FLORA

A review of studies upon plant life related to Delaware River estuary. 64 species of marsh plants, exclusive of trees and shrubs, have been identified in Delaware. These plants and their incidence in relation to salinity are tabulated.

REF: Reference 56-9, Marine Laboratory, Department of Biological Sciences, University of Delaware, Newark, Delaware

464. UDML Shuster, C. N., Jr. (1958) CURRENT ESTUARINE RESEARCH AT THE UNIVERSITY OF DELAWARE MARINE LABORATORIES

Briefly, discusses research being carried out by various members of the faculty. Research is primarilty devoted to biological and fish studies. One project is devoted to obtaining basic information on the great Cape Henlopen sand dune. Quarterly hydrographic survey of the Delaware River estuary from the continental shelf to Philadelphia is conducted jointly with the New Jersey Oyster Research Laboratory.

REF: Reference 58-15, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

465. UDML Shuster, C. N., Jr. (1958) PUBLICATIONS OF THE UNIVERSITY OF DELAWARE MARINE LABORATORIES 1952-1958

Lists all publications, contributions, information leaflets, biennial reports, theses and dissertations, those in preparation, and 29 references.

REF: Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

466. UDML Shuster, C. N., Jr. (1959) BIOLOGICAL EVALUATION OF THE DELAWARE RIVER ESTUARY

Morphometry, extent, role of tidemarshes, shore-zone fishes, ecology of invertebrates, evaluation of fisheries. Tidemarsh productivity due to (1) "Nutrient buildup" and (2) organic breakdown and storage in rooted aquatics. Has 13 figures, 29 tables, 76 typed pages.

REF: Information Series, Publication number 3, Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware, September 1959. *In* State of Delaware, Intrastate Water Resources Survey, as section 21, pages 1-73.

467. UDML Shuster, C. N., Jr. (1963) OUR EVER-CHANGING COASTLINE

The average rate of shoreline erosion at Delaware Coast is about 1 yard per year. Carbon-14 analysis of wood stumps found 300 yards from the present shoreline gave a value of about 3,000 years. It is also quite possible that the coast of Delaware is gradually being flooded by a rising sea level; it is estimated to be as much as 1 foot per century. There is a large counterclockwise eddy off the mouth of Delaware Bay. A smaller whirl of water usually rotates just off Cape Henlopen and Rehoboth Beach. Small colored plastic pellets were released and simultaneous observations were made at three locations. The transport mechanism was revealed by the distribution of the pellets at different time intervals.

REF: Estuarine Bulletin, volume 7, number 1, pages 3-12. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

468. UDML Shuster, C. N., Jr., F. C. Daiber, and K. P. H. Frey (1961) SHALLOW WATER RESEARCH AT THE UNIVERSITY OF DELAWARE

Review of organization and programs on pages 211-221 of the proceedings.

REF: Presented at the First Coastal and Shallow Water Research Conference. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

469. UDML Watts, E. (1957) A SURVEY OF THE BRYOZOA IN DELAWARE BAY WITH SPECIAL REFERENCE TO THE SPECIES OCCURRING ON THE BLUE CRAB

These "moss animals" were studied in the southwest portion of Delaware Bay during August 1957.

REF: Reference 57-7. Marine Laboratories, Department of Biological Sciences, University of Delaware, Newark, Delaware

UNITED STATES GOVERNMENT DOCUMENTS

470. EPA (1971) BIBLIOGRAPHY OF WATER QUALITY RESEARCH REPORTS

Project Reports System assembles and furnishes reports of EPA-sponsored research and development grant, contract, and inhouse projects. Biblio lists. Publications on results and progress in control and abatement of pollution in our national waters with source and price.

REF: Water Pollution Control Research Series, Research Information Division, Environmental Protection Agency

471. USDA Bishopp, F. C. (1939) THE STABLE-FLY: HOW TO PREVENT ITS ANNOYANCE AND LOSSES TO LIVESTOCK

Description-distribution; character of injury and losses; life history; agricultural practice for control; natural control; artificial control. Has 18 pages.

REF: Farmers Bulletin, number 1097

472. USDA (1970) REPORT OF PRELIMINARY STUDIES OF SEDIMENTATION IN DELAWARE

REF: Soil Conservation Service

473. USDHEW (1969) REPORT OF THE SECRETARY'S COMMISSION ON PESTICIDES AND THEIR RELATIONSHIP TO ENVIRONMENTAL HEALTH (MRAK REPORT)

A 675-page report which includes chapters on uses and benefits of pesticides; contamination; effects of pesticides on nontarget organisms other than man; carcinogenicity of pesticides; interaction; mutagenicity of pesticides; teratogenicity of pesticides.

REF: Secretary of Health, Education, and Welfare

474. U. S. Supreme Court (1931) DECREE IN CASE OF NEW JERSEY vs. NEW YORK *et al.*

Decree: New York City may divert 440 million gallons of water daily from the Delaware River, but not in excess.
Port Jervis, N. Y., must treat its sewage and prevent its entering the Delaware River. At any time the Delaware River falls below 0.50 c.s.m. at Port Jervis, N. Y., or Trenton, N. J., water shall be released from the impounding reservoirs of New York City to restore the flow at Port Jervis to 0.50 c.s.m.
Right to inspect the dams, reservoirs, etc., etc.

REF: United States Report 1930, volume 283, pages 805-807, Library of Congress, Washington, D. C.

DEPARTMENT OF COMMERCE

475. USDC (1952) DELAWARE BAY APPROACHES

Data presented include hydrographic stations and profiles, density, oxygen, salinity, sound velocity, temperature, topography & transparency.

REF: U. S. Coast and Geodetic Survey

476. USDC (1954) DELAWARE BAY TIDE SURVEY 1952-1953: INTRODUCTION VOLUME 1:

Eleven tide stations were included in the report area: Trenton, Philadelphia, Wilmington (in volume 1), New Castle, Lewes (in volume 2), Cape May, Bowers, Fortescue, Woodland Beach, Bayside, Port Penn. Mean values are tabulated in volume 1 for the 6 stations in the bay for the period 1924-1942 and for 1940-1948 for 5 stations: Port Penn, New Castle, Wilmington, Philadelphia, and Trenton.

REF: Coast and Geodetic Survey

477. USDC (1960) TIDAL CURRENT TABLES 1960, ATLANTIC COAST OF NORTH AMERICA

REF: U. S. Coast and Geodetic Survey

478. USDC (1967) TOURISM AND RECREATION: A STATE-OF-THE-ART STUDY

REF: *Prepared by* Arthur D. Little, Inc., *for the* Office of Regional Development Planning, Economic Development Administration

479. USDC (1968) SURFACE WATER TEMPERATURE AND DENSITY: ATLANTIC COAST, NORTH AND SOUTH AMERICA

Includes result for Breakwater Harbor at the entrance to Delaware Bay from 1919 to 1966. A table is given to convert temperature and density to salinities.

REF: Publication 31-1, 1968, Coast and Geodetic Survey

480. USDC (1969) STATISTICAL ABSTRACTS OF THE UNITED STATES

Population, vital statistics, health, and nutrition, immigration and naturalization, education, law enforcement and prisons, area geography and climate, public lands, employment, national defense, social insurance and welfare, income, prices, elections, federal government, state and local government finances and employment, banking finance and insurance, business, communications power, science, transportation, agriculture, forests, fisheries, mining, construction, manufacture, distribution, foreign commerce and aid, outlying areas, comparative international statistics, metropolitan area.

REF: Bureau of Census

481. USDC Harrison, W., J. J. Norcross, and E. M. Stanley (1967) CIRCULATION OF SHELF WATERS OFF THE CHESAPEAKE BIGHT

Surface and bottom drift of continental shelf waters between Cape Henlopen and Cape Hatteras, N. C. Earlier research on the continental shelf waters is summarized. Beginning in June 1963, drift bottles and seabed drifters were released by aircraft and then drift and temperature and salinity variations were determined in 15 monthly shipboard surveys. The effects of winds, run-off, and characteristics of the thermal structure of the shelf waters are offered as explanations for variations in surface flow. Predictor equations are presented based on a computerized screening procedure.

REF: Professional Paper 3, 82 pages, Environmental Science Services Administration, Washington, D. C.

482. USDC Klein, W. H. (1957) PRINCIPAL TRACKS AND MEAN FREQUENCIES OF CYCLONES AND ANTICYCLONES IN THE NORTHERN HEMISPHERE

Charts are presented summarizing by months the frequency of occurrence and regions of genesis of cyclones and anticyclones. The mean meridional distribution and annual march of cyclone and anticyclone occurrence and genesis are summarized and related to the mean zonal circulation of the northern hemisphere at the 700-mb level. Statistics are presented on the relative frequency, average speed, and life span of pressure centers.

REF: Research Paper 40, 1957, Weather Bureau

483. USDC Moyer, W. J. (1970) CLIMATOLOGICAL DATA

Includes statistics for Maryland & Delaware:
(1) Temperature average and minimum-maximum by day and month;
(2) Precipitation as total rain, snow or sleet and number of days;
(3) Wind speed, direction, with average and fastest speeds;
(4) Realtive humidity;
(5) Number of days with precipitation;
(6) Percent possible sunshine;
(7) Average sky cover (sunrise to sunset);
(8) Special weather summary (storms).
Temperature and precipitation were recorded at the University of Delaware farm (Middletown), Wilmington (weather at New Castle), Wilmington (Porter Reservoir), Bridgeville, Dover, Georgetown, Lewes, Milford, Selbyville.

REF: Weather Bureau, Environmental Science Services Administration

DEPARTMENT OF DEFENSE

485. U. S. Navy Hydrographic Office (1951) A PRELIMINARY REPORT: DELAWARE BAY AND ITS APPROACHES

A compilation of published and unpublished material including surface temperatures and salinities in Delaware Bay and in the approaches to the bay; sea level, tides, tidal currents and nontidal currents in the approaches to the bay; discharge

into the bay, flushing time, transparency, fouling. A large chart of bottom contours in the approaches to the Delaware Bay (1:80,000 scale; intervals of 1 fathom.)

REF: Inshore Survey Project, Division of Oceanography, U. S. Navy Hydrographic Office, Washington, D. C.

486. USACE (1940) MODEL STUDY OF PLANS FOR ELIMINATION OF SHOALING IN THE DELAWARE RIVER ENTRANCE TO THE CHESAPEAKE AND DELAWARE CANAL

REF: Technical Memorandum number 93-3, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi

487. USACE (1952) DELAWARE RIVER MODEL STUDY: REPORT 3, EFFECTS OF PROPOSED CHANNEL ENLARGEMENT BETWEEN PHILADELPHIA AND TRENTON

Conclusions from all model tests are that the enlarged channel (from 25' deep and 300' wide to 40' deep and 400' wide) would not increase salinity concentrations in any portion of the estuary for either normal or very low fresh-water discharge. There are 35 plates which summarize data obtained in the tests.

REF: Technical Memorandum number 2-337, Department of the Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi

488. USACE (1954) DELAWARE RIVER MODEL STUDY: REPORT 2, SALINITY TESTS OF EXISTING CHANNEL

Studies on the model at Vicksburg concerning the salinity intrusion in the Delaware Estuary for the channel existing in 1942. Determined (a) relation between fresh-water discharge at Schuylkill River (6 values of fresh water discharge ranging from 5000 to 16,475 cfs) and salinity distribution throughout the estuary for mean tide conditions, (b) relation between tidal range and salinity distribution for conditions of mean fresh-water discharge (c) relation between sea level and salinity distribution for mean conditions

of tide and fresh-water discharge, and (d) effects of varying fresh-water discharges on salinity concentration at the Delaware-Pennsylvania state line. Has 2 tables and 16 plates summarizing test data.

REF: Technical Memorandum number 2-337, Department of the Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi

489. USACE (1955) WATER RESOURCES DEVELOPMENT IN DELAWARE

Lists projects compiled or underway in 1955 by the Corps of Engineers, most of which involve improvement of navigation. There are some projects on shore protection (Kitts Hummock to Fenwick Island) and on flood control. Tables give the tonnage carried each year in the C & D Canal from 1831 through 1953 and the tonnage of foreign and domestic commerce for each year in the Delaware River from 1925 through 1953.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

490. USACE (1956) BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF THE DELAWARE COAST FROM KITTS HUMMOCK TO FENWICK ISLAND

State comprises a frontage of 32 miles to Cape Henlopen--Contents: Description of study area. The problem factors pertinent to problem: (1) Geomorphology (2) Littoral material (3) Littoral forces (4) Shore history--plans of protection-Analysis of problem costs, etc.
Appendices: (A) Geomorphology of Delaware shoreline, (B) Littoral forces, etc.
Plates: Maps--comparative profiles, shoreline and offshore depth changes, storm, wind and wave data.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

491. USACE (1956) DELAWARE RIVER MODEL STUDY: REPORT 1, HYDRAULIC AND SALINITY VERIFICATION

The Delaware River model reproduces the entire estuarine portion of Delaware Bay and River from the Capes to Trenton, New Jersey. It is equipped to reproduce and measure tides, tidal

currents, salinity intrusion, channel shoaling and other significant phenomena of the prototype. The report presents complete data showing the degree of accuracy obtained in the hydraulic and salinity verification of the model, i.e., excellent agreement of the model with the prototype. Prototype parameters discussed are area, channel dimensions, tides, current velocities, salinity intrusion, etc. The model is described in detail, and maps show locations of channel stations. Plates 3 to 74 give data on tides, velocities at various stations along the entire model, and surface current directions.

REF: Technical Memorandum number 2-337, Department of the Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi

492. USACE (1959) WATER RESOURCES DEVELOPMENT IN DELAWARE

Discusses projects completely underway in Delaware by the Corps of Engineers. The projects primarily concern river and harbor improvements for benefit of commercial navigation, sea food production, and recreation. There are few projects on shore protection (Rehoboth Beach to Indian River Inlet). Tables give annual tonnage of foreign and domestic commerce in Delaware River from 1925 to 1957; tonnage in C & D Canal 1831 to 1957; tonnage of commerce in Wilmington Harbor 1930 to 1957. Flood control projects are under way in Delaware River near New Castle and Delaware City and in the Nanticoke River.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

493. USACE (1960) BEACH EROSION CONTROL REPORT ON SURVEY OF THE NEW JERSEY COAST ALONG DELAWARE BAY BETWEEN THE ENTRANCE TO CAPE MAY CANAL AND MAURICE RIVER

The report develops plans for restoration and protection of the problem areas.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

494. USACE (1960) BRIEF SUMMARY OF WATER NEEDS AND TENTATIVE PLAN OF DEVELOPMENT

REF: Information Bulletin, Delaware River Basin Study, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

495. USACE (1960) REPORT ON THE COMPREHENSIVE SURVEY OF THE WATER RESOURCES OF THE DELAWARE RIVER BASIN

Volume 1 Main Report (revised 1961)
Comprehensive study in response to several resolutions by Congress, carried out in cooperation with various U. S. Government agencies, states, and cities. Discussion and summaries of results are given in this volume. Details of studies are given in 24 appendices in volumes 2-11. A total of 193 major reservoir potentials in the basin were considered. A basic plan of 19 major control projects were recommended and a timetable for their completion by 2010. Estimated costs of such projects are also given. There are 45 tables and 32 plates.
Volume 2 Appendix A History of Investigation
Appendix B Economic base survey
Volume 3 Appendix C Municipal and industrial water use and stream quality
Many tables and figures give data on annual water use by industry and municipalities, stream quality, low-flow conditions, dissolved oxygen, effect of algae concentration on dissolved oxygen, turbidity, hardness and alkalinity.
Appendix D Flood damages
Appendix E Navigation
Appendix F Power market and evaluation of power
Volume 4 Appendix G Water for irrigation and rural use
Appendix H Fluvial sediment
Most of the sediment is transported as "suspended load". Only 10% of the total load is estimated to be moved as "bed load". During water-years 1950-1957 the average annual suspended load at Trenton was 148 tons per square mile (ranging from 59 tons per square mile in 1957 to 342 tons in 1955.) Table 1 includes data for the annual suspended sediment load in Brandywine Creek at Wilmington from 1948 to 1957. Table 3 gives the computed annual sediment load as 135 tons per square mile for Brandywine Creek.
Appendix I Recreation resources
Volume 5 Appendix J Fish and wildlife resources
Appendix K Use and management of land and cover resources
There are about 30,000 acres of tidal marshes in the coastal plains section of the Delaware River Basin (page 59).

Volume 6 Appendix L Insects of public health importance in the Delaware Basin

Appendix M Hydrology

There are many tables and figures showing various hydrological data: precipitation (seasonal, annual, and storm); runoff data (stream gaging at 108 stations, at Trenton since 1911, and at Brandywine Creek, Wilmington, since 1911, and major floods since 1839); evaporation and infiltration losses; basic hydrology studies involving mass curves, flow duration curves, frequency analyses of peak flows; generalized flood-frequency studies; unit hydrographs; surface-water-availibility studies. There are sections on hypothetical floods and design capacities and sections on effects of the proposed water-control plan.

Volume 7 Appendix N General geology and ground water

The potential ground water supply in the coastal plain section of the basin is considered equal to the ground water discharge to streams, about 1,600 m.g.d. in an area of 2,750 square miles; it is estimated that 800 m.g.d. can be developed. Present use (1951-1956) average is 210 m.g.d. Ground water suitable for most uses may be developed, at least in small quantities, almost anywhere in the basin except near the ocean and the Delaware Bay. In the coastal plain area some wells have become salty; for the most part this represents encroachment from the sea. Encroachment is due in part to the slow world-wide rise in sea level (6 in. in this area since 1930), but mostly it is due to pumping too near a body of salt ground or surface water (pages 50-62). In some cases salt water has been introduced to a former fresh-water domain through dredging operations. Along bays and estuaries the marsh deposits may serve as portals for salt-water encroachment into underlying shallow aquifers. Table 5 consists of chemical analyses of ground water in the coastal plains at various locations at various times from 1931 to 1957. Aquifer management is discussed on pages 136-147. There is also a discussion of the geology and hydrology of other areas of the Basin.

Volume 8 Appendix O State of Delaware, intrastate water resources survey

See DELAWARE DOCUMENTS, State, DBSCC

Volume 9 Appendix P Gross and net water needs

Appendix Q Formation of the plan of development

Appendix R Water control at intermediate upstream levels

Appendix S Salt water barrier

Volume 10 Appendix T Hydroelectric power

Appendix U Project designs and cost estimates

There are projects for Newark and the Christiana River dams

on pages 81 and 101.
Volume 11 Appendix V Benefits and cost allocation
Appendix W Recreation needs and appraisals
Appendix X Operating organization

REF: Department of the Army, Philadelphia District, Corps of Engineers, Philadelphia, Pennsylvania. *Also published as* House Document 522, August 16, 1962, 87th Congress, 2nd session.

496. USACE (1964) Simmons, U. B., and W. H. Bobbs. DELAWARE RIVER MODEL STUDY: REPORT 4, DIKE REHABILITATION HYDRAULIC MODEL INVESTIGATION

Tests on existing Delaware River Model to determine the effects of various degrees of rehabilitation of Reedy Island and Pea Patch Island dikes.

REF: Technical Memorandum number 2-337, Department of the Army, Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi

497. USACE (1966) BEACH EROSION CONTROL AND HURRICANE PROTECTION ALONG THE DELAWARE COAST

A revision of the 1956 report.

REF: Beach Erosion Control Board, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

498. USACE (1966) THE PORT OF WILMINGTON, DELAWARE, AND PORTS ON DELAWARE RIVER BELOW AND ABOVE PHILADELPHIA, PENNSYLVANIA

Detailed reports on port and harbor conditions; port administration and federal services; port and terminal services and charges; facilities; and transportation services. Part 2 has 72 pages and detailed maps.

REF: Port Series, number 8, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

499. USACE (1968) DELAWARE COAST: BEACH EROSION CONTROL AND HURRICANE PROTECTION

The study area consists of the Delaware coast extending 34 miles from Pickering Beach to Cape Henlopen and 34 1/2 miles along the Atlantic Ocean to the state line at Fenwick Island. All public and private beaches have been damaged by erosion. Plans for improvement are presented for control, which consists of the placement of beach fill, periodic nourishment of beaches, etc. Sufficient justification exists to warrant federal participation at Broadkill Beach, South Bowers, and Lewes, only. Plans are also provided for the entire Atlantic coast of Delaware. Has 110 pages.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania. *Also published as* Senate Document 90, 90th Congress, 2nd session, Library of Congress, Washington, D. C.

500. USACE (1968) REPORT ON THE DELAWARE COAST FROM CAPE HENLOPEN TO FENWICK ISLAND

Report on the Delaware Coast from Cape Henlopen to Fenwick Island.

REF: Senate Document 90, 90th Congress, Library of Congress, Washington, D. C.

501. USACE (1968) REPORT ON NAVIGATION STUDY: DELAWARE BAY-CHESAPEAKE BAY WATERWAY IN DELAWARE, MARYLAND, AND VIRGINIA

This is the report of a study to determine the feasibility, method, and cost of providing a navigable sheltered waterway from Roosevelt Inlet, Delaware, on the Delaware Bay, along the Atlantic Coast to the Chesapeake Bay near Cape Charles, Virginia. Also, the construction of a canal from the Chincoteague Bay, Maryland, to connect with the existing federal project on the Pocomoke River near Snow Hill, Maryland.

The continuous waterway is economically feasible. It would be known as the DelMarVa Intracoastal waterway, and have a channel generally 6 feet deep and 100 feet wide. The estimated cost would be $10,203,000 of which 67.5% would be borne by the federal government.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

502. USACE (1968) WATERBORNE COMMERCE OF THE UNITED STATES: CALENDAR YEAR 1968: PART 1, WATERWAYS AND HARBORS, ATLANTIC COAST

Detailed tables of foreign and domestic commerce are given for the Delaware River from Trenton to the sea, for individual ports and harbors, and for the Chesapeake and Delaware Canal.

REF: Department of the Army, Corps of Engineers, Washington, D. C.

503. USACE (1969) FEASIBILITY REPORT: OFFSHORE TERMINAL

Local interests have requested information on the possibility that the Corps of Engineers will provide a channel 72 feet deep to a proposed deep water terminal to be located in Delaware Bay. This terminal would be used to offload super tankers up to 250,000 d.w.t. Preliminary investigations indicate that the terminal is a feasible alternative to further deepening of the Delaware River. The most desirable project would provide for the terminal an access channel 72 feet deep and 1000 feet wide and no further deepening of the Delaware River. The annual transportation benefits would be $34,955,000. The annual cost would be $13,010,000. The District Engineer intends to proceed with a detailed study of the terminal.

REF: Delaware River--Philadelphia to the Sea, Department of the Army, Philadelphia District Corps of Engineers, Custom House, Philadelphia, Pennsylvania

504. USACE (1969) WATER RESOURCES DEVELOPMENT IN DELAWARE

Summary of projects completed, underway, and authorized but not yet started by the Corps of Engineers in Delaware on 1 January 1969. Mentions work on navigation channels and harbors, beach erosion control, Delaware River Basin projects; no major projects are authorized in Delaware. North Atlantic Regional and Water Resources (NAR) study is one of 20 regional comprehensive water and related land resources studies being conducted throughout the nation.

Surveys underway are Delaware River & Bay navigation, including a study of measures necessary to provide relief from oil pollution in Philadelphia's port area; flood control in Little Mill Creek, New Castle County; and beach erosion

control along the Atlantic Ocean, Broadkill Beach, South Bowers Beach, and Lewes Beach. Some of these surveys are to be completed in 1969 and 1971.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

505. USACE (1970) DEEPWATER TERMINAL IN DELAWARE BAY: PROCEEDINGS OF PUBLIC MEETING 31 MARCH 1970

A complete transcript of the meeting in Dover on 31 March 1970 with about 30 speakers and copies of 75 letters, statements, and maps. Has 309 pages.

REF: Channel Dimensions and Anchorages Study, Delaware River--Philadelphia to the Sea, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

506. USACE (1970) DEEPWATER TERMINAL IN DELAWARE BAY: PROCEEDINGS OF PUBLIC MEETING 1 APRIL 1970

A transcript of the meeting held 1 April 1970 in Philadelphia with 18 speakers and 81 exhibits. Has 293 pages.

REF: Channel Dimensions and Anchorages Study, Delaware River--Philadelphia to the Sea, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

507. USACE (1970) MINUTES OF THE 70TH MEETING

J. F. Phillips (Corps) gave a description of the present status of the C & D Canal with respect to dredging operations and possible damaging effects. At present, there is an average net transfer towards the Delaware end of 900-1,000 c.f.s. After completing the widening, the net transfer is expected to increase by three times the present. H. B. Simmons (Waterways Experiment Station) reported that the existing model of the Delaware Estuary has been modified to comply with the changes in the canal. D. W. Pritchard (Johns Hopkins)pointed out that in this case the cost of hydraulic modeling may be less than a mathematical model. J. Cosentino (Corps) said the amount of shoaling between May 1969 and May 1970 amounted to 600,000 cubic yards at

the Chesapeake approach to the C & D Canal. Dr. Pritchard described the work undertaken by parties other than the Corps at the Chesapeake Bay entrance to the C & D Canal. He compared the salinity distributions as a result of the old and new canal dimensions. The effects of these changes on biota are not fully known or understood. The diversion to the Delaware is a seasonable phenomenon. The ecological impact may not be severe, but it could be cumulative over a long period of time. T. S. Y. Koo (U. Maryland) discussed the biological significance of the upper Chesapeake Bay and the C & D Canal, the theoretical effects of flow and salinity on organisms, and the means of determining these effects. L. Coccese (Corps) summarized the completed studies of the spoil disposal problem along the Delaware Estuary. D. Hartzell (Corps) described the work to determine the nature and cause of shoaling in the Delaware Estuary. J. Neibeisel (Corps) spoke on the source of shoaling materials in the Delaware Estuary. R. B. Krone (U. California) reported on his studies of the flocculation phenomenon in the Savannah Estuary. These observations taken at 30-minute intervals measured current velocities, suspended solids and salinities. At 1 to 4 feet above the bottom, the density gradient stabilizes flows so that they are slow and uniform. Colligative flocs are due to thermal conditions, settling, and internal shear which tend to make the flocs denser. It was important to reduce the concentration of shoaling by minimizing the amount of suspended sediment and maintaining high shear stresses through avoidance of piles and other structures. Flocculation is an important factor in shoaling.

508. USACE (1970) NORTH ATLANTIC DIVISION STATUS REPORT: NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY, TYPE 1 FRAMEWORK

Summary of accomplishments by cooperating government departments and agencies during fiscal year 1970. Final report to be completed in FY 1971.

REF: Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

509. USACE Bretschneider, C. L. (1959) HURRICANE SURGE PREDICTIONS FOR DELAWARE BAY AND RIVER

Surge heights have been computed for various locations for Delaware Bay and River for two hypothetical hurricanes.

REF: Miscellaneous Paper number 4-59, Beach Erosion Control Board, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

510. USACE Ippen, A. T., and D. R. F. Harleman (1961) ONE-DIMENSIONAL ANALYSIS OF SALINITY INTRUSION IN ESTUARIES

(1) Introduction and previous investigation and present program, (2) theoretical considerations, (3) analysis of experimental results, (4) correlation of diffusion parameters, (5) conclusion.
Prior to 1950, the analysis of longitudinal salinity distributions was based on the concept of the tidal prism. This method is only applicable to an estuary with a fully mixed condition. As an example, even though the Delaware Estuary has a tidal prism/fresh-water discharge ratio of the order of 100, it still exhibits characteristics of a partially mixed estuary in that the salinity transfer by gravitational convection current is quite strong. It is recommended that the one-dimensional approach of this study be broadened to include a study of the longitudinal distribution of salinity. Test data from the Delaware Estuary model could be utilized to advantage.

REF: Technical Bulletin number 5, 56 pages, 1961. Committee on Tidal Hydraulics, Department of the Army, Philadelphia District, Corps of Engineers, Custom House, Philadelphia, Pennsylvania

DEPARTMENT OF THE INTERIOR

511. F&WS (1944,...1968) FISHERIES STATISTICS OF THE U. S.

A series of large annual volumes giving statistics on fisheries.

REF: Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service

512. F&WS (1953) WETLANDS OF DELAWARE

Of the 20 nationwide types of wetlands listed, only six are important to Delaware waterfowl; all types found in Delaware are described. Tables summarize wetland classifications and evaluations for waterfowl and other wildlife. There are 3 detailed county summaries of wetland type, acreage by waterfowl value, land capability, plants and agricultural use. A list of common and scientific names of the plants mentioned is included. The report is typescript and includes a colored map.

REF: Office of River Basin Studies, Region V (Boston, Massachusetts), U. S. Fish and Wildlife Service, *in cooperation with* the Delaware Fish and Game Commission, Dover, Delaware

513. F&WS (1970) NATIONAL ESTUARY STUDY: VOLUME I

A continuing series published by both the Bureau of Sport Fisheries and Wildlife and the Bureau of Commercial Fisheries.

REF: U. S. Fish and Wildlife Service

514. F&WS Carriker, M. R. (1955) CRITICAL REVIEW OF BIOLOGY AND CONTROL OF OYSTER DRILLS *Urosalpinx* and *Eupleara*

Taxonomy, distribution, abundance, form and function of two genera. Ecology, environmental factors, other animals affected, control.

REF: Special Scientific Report, Fisheries number 148, U. S. Fish and Wildlife Service

515. F&WS Chamberlain, E. B., R. K. Martinson, and S. L. Clark (1971) WATERFOWL STATUS REPORT, 1970

REF: Wildlife number 138, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, U. S. Department of the Interior

516. F&WS Chipman, W. A., and P. S. Galtsoff (1949) EFFECTS OF OIL MIXED WITH CARBONIZED SAND ON AQUATIC ANIMALS

REF: Special Scientific Report, Fisheries number 1, U. S. Fish and Wildlife Service

517. F&WS Graham, R., and C. A. Lesser (1970) COOPERATIVE MIGRATORY BIRD CENSUSING AND BANDING

REF: Progress Report 1964-1969, Federal Aid to Wildlife Restoration, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, U. S. Department of the Interior

518. F&WS June, F. C., and J. W. Reintjes (1957) SURVEY OF THE OCEAN FISHERIES OFF DELAWARE BAY

Has 55 pages.

REF: Special Scientific Report, Fisheries number 222, U. S. Fish and Wildlife Service

519. F&WS Maurer, D., and K. S. Price, Jr. (1968) HOLDING AND SPAWNING DELAWARE BAY OYSTERS OUT OF SEASON: I, LABORATORY FACILITIES FOR RETARDING SPAWNING

Laboratory facilities and techniques for retarding the natural spawning of Crassostrea virginica *from Delaware Bay are described.*

REF: National Shellfisheries Association, Proceedings, volume 58, pages 71-77, 1968. U. S. Fish and Wildlife Service

520. F&WS McGinnes, B. S. (1955) UPLAND GAME INVESTIGATIONS IN DELAWARE

REF: Report number 3, Federal Aid to Wildlife Restoration, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, Department of the Interior

521. F&WS Shuster, C. N., Jr. (1957) ON THE SHELL OF BIVALVE MOLLUSKS

Part of a continuing study of mollusk shell growth, age determination, and relation of shell growth to environmental conditions.

REF: National Shellfisheries Association, Proceedings, volume 47, pages 34-42, U. S. Fish and Wildlife Service

521a. F&WS Shuster, C. N., Jr., and A. F. Eble (1963) TECHNIQUES IN VISUALIZATION OF ORGAN SYSTEMS IN BIVALVE MOLLUSKS

The techniques utilized at the University of Delaware and at Rutgers are described.

REF: National Shellfisheries Association, 1961 Proceedings, volume 52, pages 13-24.

522. USDI (1962) QUALITY OF SURFACE WATERS OF THE UNITED STATES

Chemical analysis of the water and the flow at the Delaware Memorial Bridge from October 1961 to August 1962 are included among much other data.

REF: U. S. Department of the Interior, Geological Survey, Water Supply Paper, 1941

523. USDI (1969) FLOODS OF AUGUST 1967, IN MARYLAND AND DELAWARE

REF: Water Resources Division, Geological Survey

524. USDI (1970) SURFACE WATER SUPPLY OF THE UNITED STATES 1961-1965: PART I, NORTH ATLANTIC SLOPE BASINS: VOLUME 2, BASINS FROM NEW YORK TO DELAWARE

Data for Delaware River basins are given for Murderkill, St. Jones, Mispillion, Broadkill, and Indian River, including discharge of streams, daily, monthly, and annually for water years 1961-1965. Water years begin 1 October, end 30 September. Gives data on daily discharge of streams in cubic feet/second, average discharge for 7 years, maximum and minimum discharge for water years 1961-1965. Monthly totals and yearly summaries are included. At some gaging stations water-quality records are collected; chemical analysis, temperature of water, suspended sediment concen-

tration, and particule size distribution of suspended sediment and bed material.
The numbers of Water Supply Papers containing results of stream measurement in the North Atlantic Slope Basin for years 1899 to 1960 are listed on page 9. The last 5 years are: 1956--1432; 1957--1526; 1958--1552; 1959--1622; 1960--1702.

REF: Water Supply Paper 1902, Geological Survey

525. USDI Adams, J. K., and D. H. Boggess (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE WILMINGTON AREA, DELAWARE

The specific locations of 19 soil types are mapped.

REF: Hydrologic Investigations Atlas HA-79, Geological Survey

526. USDI Adams, J. K., and D. H. Boggess (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE ELLENDALE QUADRANGLE, DELAWARE

Specific locations of 16 soil types are mapped. There is a small amount of marine tidal-marsh deposits, but a considerable amount of swamp deposits which are underlain by various types of soil.

REF: Hydrologic Investigations Atlas HA-101, Geological Survey

527. USDI Adams, J. K., and D. H. Boggess (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE TAYLOR'S BRIDGE AREA, DELAWARE

The specific locations of 8 soil types are mapped. Figure 2 shows the water levels in 13 Delaware wells during 12 years. Tables 2, 3, and 4 give soil classifications, laboratory analyses, and characteristics of engineering soil types in the area. Water-table contours, wells, perennial streams, and intermittent streams are shown on the map.

REF: Hydrologic Investigations Atlas HA-80, Geological Survey

528. USDI Adams, J. K., D. H. Boggess, and O. J. Coskery (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE FRANKFORD AREA, DELAWARE

There are 13 soil types identified and located on the map, which shows only a small amount of tidal-marsh area.

REF: Hydrologic Investigations Atlas HA-119, Geological Survey

529. USDI Adams, J. K., D. H. Boggess, and C. F. Davis (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE LEWES AREA, DELAWARE

The 19 types of soil identified are located specifically on the map. Extensive marine tidal-marsh deposits are indicated.

REF: Hydrologic Investigations Atlas HA-103, Geological Survey

530. USDI Adams, J. K., D. H. Boggess, and C. F. Davis (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE DOVER QUADRANGLE, DELAWARE

There are 19 soil types identified and located on the map.

REF: Hydrologic Investigations Atlas HA-139, Geological Survey

531. USDI Anderson, P. W., and J. R. George (1963) WATER QUALITY CHARACTERISTICS OF NEW JERSEY STREAMS

Water discharge and dissolved solids are given in figure 1 for the Delaware River at Trenton and in figure 2 for 4 stations in the Delaware River in 1957-58 (Trenton, Easton, Port Jervis, and Barryville). Variations in dissolved solids with the tidal stage at Philadelphia, and at the Delaware Memorial Bridge for April 19-20, 1963. Figure 8 gives synthetic detergent concentration (ABS) in streams in New Jersey during low flow condition in 1962 at 50 gaging stations. Figure 12 shows the annual fluctuations in stream flow and dissolved solids concentration in the Delaware River at Trenton from 1946 to 1962 and shows the 15 year

average of these for comparison. Water temperatures at Trenton and at other rivers are given in Figure 14. Other comparisons are also made.

REF: Water-Supply Paper 1819-G, Geological Survey

532. USDI Barkdale, H. C., and J. B. Graham (1952) PROGRESS OF THE INVESTIGATION OF THE GROUND WATER RESOURCES OF THE LOWER DELAWARE RIVER BASIN

Study of ground water resources in Pennsylvania (5 counties), New Jersey (5 counties) and Delaware (New Castle County). Within the lower Delaware area, there are a dozen important water-bearing formations. Figure 1 shows water-yielding components of important aquifers. Figure 2 shows present use of ground water by industry, municipalities, and others. Table 1 gives estimated ground water use in each of the 11 counties. Problems of water quality, geology, and lowered water levels are discussed.

REF: Professional Paper 381, Geological Survey

533. USDI Bascom, F. (1904) WATER RESOURCES OF THE PHILADELPHIA DISTRICT, FLORENCE

A very small part of northeast New Castle County, Delaware, is included in this Philadelphia district. The report discusses physiography and stratigraphy of the district and also discusses rainfall, runoff, and river flow.

REF: Water-Supply Paper 106, Geological Survey

534. USDI Bock, William (1966) HYDROCHEMICAL FACIES AND GROUND WATER FLOW PATTERNS IN NORTHERN PART OF ATLANTIC COASTAL PLAIN HYDROLOGY OF AQUIFER SYSTEMS

Studies made principally in New Jersey, Maryland, and Virginia. One figure shows information for Delaware; that is the general pattern of ground-water flow in the Cretaceous sediments in New Castle County.

REF: Professional Paper 498-A, Geological Survey

535. USDI Boggess, D. H., and J. K. Adams (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE BETHANY BEACH AREA, DELAWARE

The 10 soil types are identified and located on the map, which shows a considerable amount of tidal-marsh area.

REF: Hydrologic Investigations Atlas HA-122, Geological Survey

536. USDI Boggess, D. H., and J. K. Adams (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE MIDDLETOWN AREA, DELAWARE

There is some marsh land on the eastern edge of the area.

REF: Hydrologic Investigations Atlas HA-82, Geological Survey

537. USDI Boggess, D. H., and J. K. Adams (1965) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE LITTLE CREEK QUADRANGLE, DELAWARE

The 10 soil types are identified and located, showing the very large extent of tidal-marsh areas.

REF: Hydrologic Investigations Atlas HA-134, Geological Survey

538. USDI Boggess, D. H., and J. K. Adams (1965) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE MILLSBORO AREA, DELAWARE

The map locates and identifies 15 soil types and shows considerable tidal-marsh and swamp area.

REF: Hydrological Investigations Atlas HA-121, Geological Survey

539. USDI Boggess, D. H., J. K. Adams, and O. J. Coskery (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE MILTON QUADRANGLE, DELAWARE

The map locates 18 soil types and extensive marine tidal-marsh deposits.

REF: Hydrologic Investigations Atlas HA-102, Geological Survey

540. USDI Boggess, D. H., J. K. Adams, and C. F. Davis (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE SMYRNA AREA, DELAWARE

There are maps locating the 24 soil samples tested.

REF: Hydrologic Investigations Atlas HA-81, Geological Survey

541. USDI Boggess, D. H., J. K. Adams, and C. F. Davis (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE REHOBOTH BEACH AREA, DELAWARE

The map identifies and locates 19 soil types. There are extensive marine tidal-marsh deposits.

REF: Hydrologic Investigations Atlas HA-109, Geological Survey

542. USDI Boggess, D. H., O. J. Coskery, and C. F. Davis (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE MILFORD QUADRANGLE, DELAWARE

The 19 soil types identified and located on the map show the considerable extent of the tidal-marsh areas.

REF: Hydrologic Investigations Atlas HA-133, Geological Survey

543. USDI Boggess, D. H., C. F. Davis, and O. J. Coskery (1965) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE WYOMING QUADRANGLE, DELAWARE

There are 15 soil types identified and located on the map.

There is a small amount of tidal marsh area in the northeast corner of the quadrangle.

REF: Hydrologic Investigations Atlas HA-141, Geological Survey

544. USDI Boggess, D. H., and D. R. Rima (1962) ARTIFICIAL RECHARGE OF GROUND WATERS

The prospect of using excess storm water runoff to recharge the shallow water table aquifer at Newark was evaluated. There was no indication that any appreciable water reached the producing aquifer, instead a zone of saturation was created by the presence of an impermeable bed above the water table. However, the unsaturated material at shallow depths of the ditch dug is sufficient to permit the disposal of large volumes of storm runoff.

REF: Water-Supply Paper 1594-B, Geological Survey

545. USDI Cohen, B., and L. T. McCarthy (1962) SALINITY OF THE DELAWARE ESTUARY

The survey covered on the Delaware River from Philadelphia to the Appoquinimink River, Delaware includes the effect of water inflow on distribution of salinity; the frequency of chloride concentration changes; the major effect on salinity of hurricanes, dissolved solids and chloride concentration as functions of specific conductance, chloride movement in the river. The salinity at any one time is the resultant of fresh-water flow and changes in sea level at the mouth of Delaware Bay. The sea level and therefore salinity is highest from August to October, least from December to May.

REF: Water-Supply Paper 1586-B, Geological Survey

546. USDI Coskery, O. J., and R. A. Garnder (1965) GROUND-WATER LEVELS IN THE U. S. 1958-1962, NORTHEASTERN STATES

About 47 wells were observed during 1958 through 1962. Well locations (by 5' quadrangles and 1' blocks) were tabulated and water-levels are reported in tabular form for about 6-8 months of each year. The highest and lowest water levels for period observed are given.

REF: Water-Supply Paper 1782, Geological Survey

547. USDI Davis, C. F., and Boggess, D. H. (1964) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE MISPILLION RIVER QUADRANGLE, DELAWARE

The map locates and identifies 16 soil types and indicates a large expanse of tidal-marsh area.

REF: Hydrologic Investigations Atlas HA-137, Geological Survey

548. USDI Davis, C. F., D. H. Boggess, and O. J. Coskery (1965) WATER-TABLE, SURFACE-DRAINAGE, AND ENGINEERING SOILS MAP OF THE FREDERICA AREA, DELAWARE

There are 14 soil types identified and located on the map. The tidal-marsh area is extensive.

REF: Hydrologic Investigations Atlas HA-140, Geological Survey

549. USDI Durfor, C. N., and W. B. Keighton (1954) CHEMICAL CHARACTERISTICS OF DELAWARE RIVER WATER, TRENTON TO MARCUS HOOK

Report on the quality of water from August, 1949 to December, 1952.

REF: Water-Supply Paper 1262, Geological Survey

550. USDI Geological Survey (1964) HYDROLOGIC INVESTIGATIONS ATLAS

Water-table, Surface-Drainage and Engineering soils map of various areas in Delaware. The maps are on a scale of 1: 24,000; they show specific locations of various types of soil in the particular areas. Samples of soil are taken from several pits at 2 to 4 depths. Samples are analyzed for mechanical properties and plasticity index and the results tabulated. Soils are classified by HRB (Highway Research Board) systems and by unified (unified soil classification) systems in Tables 2, 3, and 4. Maps show water-table contours at 10 foot intervals and engineering characteristics of soils, perennial and intermittent streams; they also show marine tidal-marsh deposits. Figure 2 shows ground water levels over a period of 12 years in 13 observation wells in entire state of Delaware (1951-1962). There are

separate abstracts for those areas showing tidal-marsh lands along Delaware Bay.

REF: Hydrologic Investigations Atlas HA-Series of Maps, Geological Survey

551. USDI Hardison, C. H., and R. O. R. Martin (1963) WATER SUPPLY CHARACTERISTICS OF STREAMS IN THE DELAWARE RIVER BASIN AND IN SOUTHERN NEW JERSEY

Annual low flows at short-term stream gaging stations in the Delaware River Basin are compared with the annual low flows at long-term stations to determine the magnitude and frequency of annual low flows at 95 stations for the period 1913-1953.

REF: Water-Supply Paper 1669-N, Geological Survey

552. USDI Heck, L. W. *et al.* (1966) DELAWARE PLACE NAMES

Alphabetical list of known geographic names in Delaware. Gives graphic coordinate for most of the streams, bays, islands, lakes and populated places.

REF: Bulletin 1245, Geological Survey

553. USDI Hely, A. G., and F. H. Olmsted (1963) SOME RELATIONS BETWEEN STREAM FLOW CHARACTERISTICS AND THE ENVIRONMENT IN THE DELAWARE RIVER REGION: CONTRIBUTIONS TO STREAM-BASIN HYDROLOGY

Summary of hydrologic parameters is given for 107 gaging stations: physiographic units, draining area, average precipitation runoff and discharge for 1921-1950. Conclusion: very large proportion of the area variations in low-flow characteristics of streams is associated with area variations in average precipitation and geology. Has 5 tables, 10 figures, and 13 references.

REF: Professional Paper 417-B, Geological Survey

554. USDI Henry, H. R. (1964) INTERFACES BETWEEN SALT WATER AND FRESH WATER IN COASTAL AQUIFERS

In a coastal aquifer a steady flow of fresh water toward the sea limits the encroachment of the sea water. Under the assumption that the salt water and the fresh water do not diffuse into one another so that a sharp interphase exists, this action is treated for steady two-dimensional flow. Exact solutions for the position of the interface and the boundary velocities are derived for several sets of boundary conditions.

REF: Water-Supply Paper 1613-C, Geological Survey

555. USDI Keighton, W. B. (1966) FRESH-WATER DISCHARGE--SALINITY RELATIONS IN THE TIDAL DELAWARE RIVER

The chemical quality of the Delaware River was measured at three locations in Pennsylvania over a 14 year period. Sustained flows of fresh water into the Delaware River Estuary at Trenton greater than 3,500, 4,400, and 5,300 cfs assure low salinity at Marcus Hook, etc. With a discharge of less than these critical values, salinity is very sensitive to change in discharge, so that a relatively small decrease in fresh water discharge results in a relatively great increase in salinity in the Delaware River estuary at Trenton, New Jersey. Comparison of the discharge-salinity relations observed from August 1949-December, 1963, with relations proposed by other workers but based on other time periods indicate that such relations change with time and that salinity is affected not only by discharge but also by dredging; construction of breakwater, dikes and tidal barriers; tidal elevation; changing sea level; tidal range; and wind intensity and direction. Has 16 pages.

REF: Water-Supply Paper 1586-G, Geological Survey

556. USDI Keighton, W. B. (1969) WATER QUALITY IN THE DELAWARE ESTUARY FOR TWO YEARS OF DROUGHT--1965 and 1966--FROM TRENTON TO REEDY ISLAND

Salinity and dissolved oxygen for different months at the various locations are charted and described on 2 charts 34 x 43 inches.

REF: Hydrologic Investigations Atlas HA-335, Geological Survey

557. USDI Livingstone, D. A. (1963) CHEMICAL COMPOSITION OF RIVERS AND LAKES

A compilation of representative chemical data for the lakes and river of the world. The rate of chemical denudation ranges from 6 (for Australia) to 110 long tons per square mile (for Europe). The rivers of the world deliver 3.9 billion tons of dissolved material to the sea each year. Water analyses of the Delaware River at Trenton, N. J., and Belvedere, N. J., are included.

REF: Professional Paper 440-G, Geological Survey

558. USDI MacKichen, K. A., and J. C. Krammorer (1961) ESTIMATED USE OF WATER IN THE UNITED STATES

Estimates for 1960 are given for each state for irrigation, industrial use, public utility, air-conditioning, water power, and as public supplies for rural use.

REF: Circular 456, Geological Survey

559. USDI Miller, E. G. (1960) CHARACTERISTICS OF TIDE-AFFECTED FLOW OF THE LOWER DELAWARE RIVER

The depth and velocity of the tidal flow through one complete cycle was measured at the Burlington-Bristol Bridge.

REF: Water Resources Division, Geological Survey. *Abstracted in* Journal of Geophysical Research, volume 65, page 2511, 1960.

560. USDI Miller, E. G. (1962) OBSERVATIONS OF TIDAL FLOW IN THE DELAWARE RIVER: HYDROLOGY OF TIDAL STREAMS

Data was taken at the Burlington-Bristol Bridge and at the Delaware Memorial Bridge by crews working simultaneously on 5 days in August 1955-1957. On one day of measurement, the maximum downstream rate flow at Delaware Memorial Bridge was 400,000 cfs and the maximum upstream rate 600,000 cfs, as compared to a daily ocean discharge of 1,650 cfs at Trenton. Apparently reliable figures of net downstream flow cannot be obtained by subtracting the total upstream flow from total downstream flow and correcting for changes in storage.

Satisfactory correlation might be obtained between velocity at a fixed point in a cross section of the river and its mean velocity in that cross section.

Observation of specific conductance at the Burlington-Bristol Bridge showed no significant variation during the tidal cycles studied. At the Delaware Memorial Bridge the variation was pronounced: an increase on the incoming tide and a decrease on the outgoing tide.

REF: Water-Supply Paper 1586-C, Geological Survey

561. USDI Minard, J. P., H. E. Gill, J. F. Mello, J. P. Owens, and N. F. Sohl (1969) CRETACEOUS-TERTIARY BOUNDARY IN NEW JERSEY, DELAWARE AND EASTERN MARYLAND

Discussions of stratigraphy of the Cretaceous-Tertiary Boundary in New Jersey, Delaware, and Eastern Maryland. Present geologic quadrangle mapping of more than 600 square miles in Coastal Plains of New Jersey and detailed reconnaissance in parts of Delaware and Maryland offer evidence of the unconformable nature of the control for 120 miles along the strike. Figure 5 gives specific stratigraphic sections in area of Odessa, Delaware and Gregg Neck, Maryland. Figure 9 shows cross section (geologic) from Dover, Delaware to Laurelton, New Jersey, based on gamma ray logs. 33 references.

REF: Bulletin 1274-H, Geological Survey

562. USDI Moody, D. W., and E. D. Van Reenan (1967) HIGH RESOLUTION SUBBOTTOM SEISMIC PROFILES OF THE DELAWARE ESTUARY AND BAY MOUTH

Continuous longitudinal profiles were made along center of navigation channel and channel cross-sections at 1-kilometer intervals by means of a high-resolution boomer system. This was found to be an effective means of determining the thickness of sediments overlying bedrock. This might also be useful in locating areas where a wider and deeper channel might truncate shallow aquifers and possibly increase movement of salt water into local ground-water supplies. It was poosible to penetrate as much as 42 meters of sediment by this method.

REF: Professional Paper 575-D, Geological Survey

563. USDI Parker, Gerald G., *et al.* (1964) WATER RESOURCES OF THE DELAWARE RIVER BASIN

The basin, including areas tributary to Delaware Bay, contains 12,756 square miles and occupies major parts of Delaware, New Jersey, Pennsylvania, and New York plus parts of Maryland. Unusually large and increasing demands are made of these water resources because of its proximity to great urban and industrial centers. Extensive detailed maps give the geology, annual and seasonal precipitation, water loss (difference between precipitation and runoff), average annual temperature, and chemical analyses.

REF: Professional Paper 381, Geological Survey

564. USDI Paulson, R. W. (1970) A GRAPHICAL SUMMARY OF SPECIFIC CONDUCTANCE DATA FOR THE DELAWARE RIVER ESTUARY

Cumulative frequency distributions of daily statistics of specific conductance data are computed and graphed as computer printouts from five water-quality monitors located in the Delaware River estuary. They provide information about salt-water intrusion in the estuary between October 1964 and September 1969 between Trenton, New Jersey, and Liston Point. The monitor stations are distributed from 36.78 to 119.21 river miles from the ocean.

REF: Water Resources Division, Pennsylvania District, Geological Survey

565. USDI Pearre, N. C., and A. V. J. Heyl (1960) CHROMITE AND OTHER MINERAL DEPOSITS IN SERPENTINE ROCKS OF THE PIEDMONT UPLAND, MARYLAND, PENNSYLVANIA, AND DELAWARE

Map of area shows only 1 mine in Delaware; Way's Feldspar quarry near Mt. Cuba. Predominantly covers Maryland and Pennsylvania areas.

REF: Bulletin 1082-K, Geological Survey

566. USDI Pyatt, E. E. (1964) ON DETERMINING POLLUTANT DISTRIBUTION IN TIDAL ESTUARIES

The study of mixing processes in an estuary is an exceedingly complicated undertaking involving at least 28 independent variables. Investigations must make some compromise between

a vigorous mathematical approach and a workable engineering solution. The various compromises are discussed; the statistical approach is considered the most useful and is used for analysis of the St. Johns estuary in Florida. Some work with the Delaware Estuary model is reviewed.

REF: Water-Supply Paper 1586-E, Geological Survey

567. USDI Rasmussen, W. C., J. W. Odell, and N. H. Beamer (1966) DELAWARE WATER

Based on cooperative work with Delaware Geological Survey, Delaware State Highway Department, and others. Geological structure, topography, quality of water, pollution, salt-water intrusion, ground-water reservoirs. A popular review of all facets of water supply and use in Delaware. Many statistics and percentages are included.

REF: Water-Supply Paper 1767, Geological Survey

568. USDI Slaughter, T. H. (1962) BEACH-AREA WATER SUPPLIES BETWEEN OCEAN CITY, MARYLAND, AND REHOBOTH BEACH, DELAWARE

A summary of the occurrence, quantity, and quality of ground water. The potential for development of aquifers along beach is good at Rehoboth and Ocean City. Only sands and gravel in the uppermost 300 feet of sediments are used for ground water. Some wells are capable of sustained yields of 500 gpm. Discussion of chemical analyses and salt-water infiltration.

REF: Water-Supply Paper 1619-T, Geological Survey

569. USDI Stanley, D. J. (1969) ATLANTIC CONTINENTAL SHELF AND SLOPE OF THE UNITED STATES: COLOR OF MARINE SEDIMENTS

Detailed color map of the Continental Shelf. Sediment color reflects differences in composition, texture, physiography, and sedimentary processes active now and in the recent geological past.

REF: Professional Paper 529-D, Geological Survey

570. USDI Upson, J. E. (1966) RELATIONSHIPS OF FRESH AND SALTY GROUND WATER IN THE NORTHERN ATLANTIC COASTAL PLAIN OF THE UNITED STATES

Area studied from Chesapeake Bay in Virginia to Long Island, New York. In some aquifers salt water occurs many miles from the sea, and at some localities near the shore a deep well penetrates alternating bodies of fresh and salt ground water. Salt-water boundaries in the other aquifers are believed to be controlled chiefly by the circulation patterns of the fresh water in the aquifers, notably the location of discharge zones. Proximity to present shoreline is a controlling factor only in the shallowest aquifers. Has 5 figures, 1 table, 20 references.

REF: Professional Paper 550-C, Geological Survey

571. USDI (1966) DELAWARE ESTUARY COMPREHENSIVE STUDY 1966: PRELIMINARY REPORT AND FINDINGS

Chapters (1) Background and objectives. (2) The study area, geography, geology, climate, principal communities and industries, hydrology. (3) The economic environment and its waste inputs. (4) Water quality. (5) Water uses. (6) Water quality improvement. Has 118 pages, 2 appendices.

REF: Federal Water Pollution Control Administration

572. USDI (1967) PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS--1967

REF: Report 11020-12/67. *Prepared by* the American Public Works Association *for* Federal Water Pollution Control Administration

573. USDI (1969) NATIONAL ESTUARINE POLLUTION STUDY

This report presents an analysis of the importance of estuaries in the economic and social environment and the effects of pollution on the natural ecosystem, as specified in the Clean Water Restoration Act of 1966 (Public Law 89-

753). The study recommends a national program based on institutional management with multiple long-term use as a common denominator; it presents a technical analysis of the estuarine zone, identification of scientific knowledge gaps, and an inventory of the available knowledge. Has 629 pages.

REF: Federal Water Pollution Control Administration

574. USDI Wastler, T. A., and L. C. de Guerreo (1968) NATIONAL ESTUARINE INVENTORY: HANDBOOK OF DESCRIPTORS

As part of the National Estuarine Pollution Study, The Handbook of Descriptors is the skeletal format around which the information of the inventory is organized. It consists of a set of tables (no data) stating the organization of the information to be obtained. The Estuarine Register Area designations for Delaware are:

Delaware Bay	*NE 37*
Delaware Coast	*NE 38 (North East)*
Indian River Bay	*NE 38-1*
Rehoboth Bay	*NE 38-1-1*
Little Assawoman Bay	*MA-1-1-1*
Isle of Wight Bay and Assawoman Bay	*MA-1-1 (Middle Atlantic)*

REF: Office of Estuarine Studies, Division of Technical Services, Federal Water Pollution Control Administration

COUNCILS AND COMMISSIONS

575. Commission of Marine Science, Engineering and Resources (1969) INDUSTRY AND TECHNOLOGY: KEYS TO OCEANIC DEVELOPMENT: PANEL REPORTS VOLUME 2

Report of the Panel on Industry and Private Investment
Report of the Panel on Marine Engineering and Technology

REF: Government Printing Office, Washington, D. C.

576. Commission on Marine Science, Engineering and Resources (1969) MARINE RESOURCES AND LEGAL-POLITICAL ARRANGEMENTS FOR THEIR DEVELOPMENT: PANEL REPORTS VOLUME 3

Report of the Panel on Marine Resources

Report of the International Panel

REF: Government Printing Office, Washington, D. C.

577. Commission on Marine Science, Engineering and Resources (1969) OUR NATION AND THE SEA: A PLAN FOR NATIONAL ACTION (STRATTON REPORT)

The Commission has undertaken an intensive investigation of a broad array of marine problems ranging from the preservation of our coastal shores and estuaries to the more effective use of the vast resources that lie within and below the sea. As a result, it has made recommendations for a program which it expects will assure the advancement of a national capability in the oceans and will go far in meeting the needs of the future.

REF: Government Printing Office, Washington, D. C.

578. Commission on Marine Science, Engineering and Resources (1969) SCIENCE AND ENVIRONMENT: PANEL REPORTS VOLUME I

Report of the Panel on Basic Science
Report of the Panel on Environmental Monitoring
Report of the Panel on Management and Development of the Coastal Zone
Report of the Panel on Manpower, Education, and Training

REF: Government Printing Office, Washington, D. C.

579. Committee on Commerce (1969) EFFECTS OF PESTICIDES ON SPORTS AND COMMERCIAL FISHERIES

Hearing with appendices of letters, statements, and articles by ecologists and representatives of business and of U. S. Department of Agriculture

REF: Hearings Before the Subcommittee on Energy, Natural Resources, and the Environment, U. S. Senate Committee on Commerce, Library of Congress, Washington, D. C.

580. NCMRED (1969) CATALOGUE OF MARINE RESEARCH ACTIVITIES FOR 1968

MARINE SCIENCE AFFAIRS: 1967 A YEAR OF TRANSITION--First report to the President and Congress on Marine resources and engineering development describing current and proposed federal programs within the scope of the Marine Resources Engineering Development Act.

MARINE RESEARCH: FISCAL YEAR 1968--Subject index; abstracts for 12589 projects, supported by both federal and non-federal funds.

580. NCMRED (1969) CATALOGUE OF MARINE RESEARCH ACTIVITIES FOR 1968

BRADLEY, E. (1969) SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY NORTH AREA--Study of local movements of sand waves, and bottom sediment transport; this will be correlated with tidal currents and quality of water generally.

DAIBER, F. C. (1968) TIDE MARSH ECOLOGY AND WILDLIFE--Project involves analysis of phosphorous and nitrogen compounds in tidal marsh drainage with an evaluation of the effects of various types of marshland management.

HELDMEIR, J. R. (1969) THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS--purpose to conduct research focused on the long term objectives of better utilization resources of the Delaware riverine-estuarine complex including effects of thermal pollution; study and design of industrial wasteline for Delaware estuary.

ISARD, W. (1969) ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM--to guide investment and quality management policy on the Delaware estuary.

KRAFT, J. C. (1969) RECENT MARINE AND NON-MARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS

MOODY, D. W. (1969) DELAWARE ESTUARY SEDIMENTATION STUDY--Sediment transport processes are being studied to determine the rate of shoal development.

PAULSON, R. W. (1968) REMOTE SENSING OF DELAWARE ESTUARY--to determine effectiveness and feasibility of remote sensing devices in estuarine hydrologic investigations.

REF: National Council on Marine Resources and Engineering Development, Government Printing Office, Washington, D. C.

581. National Council on Marine Resources and Engineering Development (1968) Daiber, F. C. SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA

To develop methods of systems engineering for growing and marketing shellfish

REF: NCMRED, U. S. Government Printing Office, Washington, D. C. July 1969

582. Outdoor Recreation Resources Review Commission (ORRRC) (1962) OUTDOOR RECREATION FOR AMERICA

The final report of the Commission created by Public Law 85-470, 72 Stat 238, June 28, 1958, contains findings of the Commission and its recommendations for action to meet the nation's outdoor recreation needs in 1976 and 2000. The special reports submitted to the committee by its own staff, public agencies, universities, nonprofit research organizations, and individual authorities are included as supplements to the final report. There are 27 of these ORRRC Study Reports; they are listed and abstracted on pages 91-95; the 27th report is a 100-page survey of the literature.

REF: Outdoor Recreation Resources Review Commission, Councils and Commissions, Washington, D. C.

583. President's Science Advisory Committee (1965) REPORT OF THE ENVIRONMENTAL POLLUTION PANEL

Discusses the effects and sources of pollution; recommendations are included. There are several appendices: Challenging tasks to improve environment; index of chemical pollution; standards; metropolitan problems; air problems; water quality; soil contamination; atmospheric carbon dioxide; solid wastes; effects of chlorinating wastes; agricultural wastes; aquatic blooms; pest control. Has 317 pages.

REF: Government Printing Office, Washington, D. C.

KEY WORD INDEX

Numbers refer to the bibliography number for each abstract containing the specific term listed.