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Hydraulic Research in the United States

1957

United States Department of Commerce

National Bureau of Standards

Miscellaneous Publication 221

THE NATIONAL BUREAU OF STANDARDS

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UNITED STATES DEPARTMENT OF COMMERCE • Sinclair Weeks, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Hydraulic Research in the United States

1957

(Including Contributions from Canadian Laboratories)

Edited by Helen K. Middleton

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FOREWORD

The information contained in this publication was compiled from reports by the various hydraulic and hydrologic laboratories in the United States and Canada. The cooperation of these agencies is greatly appreciated.

Projects are numbered chronologically, and the number once assigned is repeated for identification purposes until a project is completed. Numbers commencing with 2500 refer to projects which are reported for the first time. All projects are in active state, unless otherwise noted under (f).

It is emphasized that the National Bureau of Standards does not have in its files reports or detailed information regarding the research projects reported by other organizations. Such information may be obtained from the correspondent listed under (c) or immediately following the title of the organization reporting the work. It is of course understood that any laboratory submitting reports on its work will be willing to supply information to properly qualified inquirers.

A similar bulletin, "Hydraulic Research", compiled and published by the International Association for Hydraulic Research, contains information on hydraulic research being conducted in foreign countries. This bulletin is edited by Prof. J. Th. Thijsse, Director of the Hydraulic Laboratory at the Technical University of Delft, Netherlands, and Secretary of the International Association for Hydraulic Research. Copies may be obtained from the Secretary at $6.00 each (postage included).

A. V. Astin, Director

CONTENTS

Key to Projects

(a) Number and title of project
(b) Project conducted for
(c) Correspondent
(d) Nature of project
(e) Description
(f) Present status
(g) Results
(h) Publications

THE BALDWIN-LIMA-HAMILTON CORPORATION, Hydraulic Turbine Laboratory.

Inquiries concerning Projects Nos. 271, 1814, 2050, 2500, and 2501, should be addressed to Mr. A. W. Madora, Hydraulic Turbine Laboratory, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pennsylvania.

(271) ADJUSTABLE AND FIXED BLADE PROPELLER-TYPE HYDRAULIC TURBINE MODELS.

(b) Laboratory project.
(d) Experimental; applied research for design.
(e) To improve performance of present designs, and to extend the range of application of this type turbine. Propeller runners of various designs in combination with modified turbine settings are methodically tested in the 11-inch cavitation flume. Efficiency output, cavitation, runaway speed, hydraulic thrust, and hydraulic blade torque are measured.
(g) Results provide data for improvement of existing design and information for designs which extend the range of application.

(1814) PUMP MODELS.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Model pumps of the centrifugal and axial flow types have been tested to determine characteristics of efficiency, horsepower, discharge, cavitation, thrust, runaway speeds, blade and wicket gate torques.

(2050) PUMP TURBINE LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Various pump turbine designs have been designed and manufactured and will be installed and tested in our newly completed pump turbine laboratory. The performance characteristics of efficiency, horsepower, cavitation, discharge, runaway speeds, thrust, gate and blade torques will be obtained on models of prototype designs.

(2500) AXIAL FLOW PUMP LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Various axial flow pumps have been designed and manufactured, and will be installed and tested in our new axial flow pump laboratory when completed. The performance characteristics of efficiency, horsepower, cavitation, discharge, runaway speeds, thrust, gate and blade torques will be obtained on models of prototype design.

(2501) UPPER BAKER POWER PLANT, CONCRETE, WASHINGTON.

(b) Power Authority of the State of Washington.
(d) Experimental; applied research for design.
(e) A completely homologous model was tested through the entire operating range expected on the prototype installation.
(f) Completed.
(g) Results of the model tests indicate that all operating requirements for the prototype were generously exceeded.

POLYTECHNIC INSTITUTE OF BROOKLYN.

Inquiries concerning Projects Nos. 1546 and 1547 should be addressed to Prof. M. W. Stewart, Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn 1, New York.

(1546) DESIGN AND CONSTRUCTION OF A FLUID POLARISCOPE.

(c) Prof. Matthew W. Stewart, Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn 1, New York.
(f) Completed.
(h) "Study of Fluid Flow by Means of Fluid Polariscope." Bacherlor's Thesis, A.M. James, available on loan.

(1547) DESIGN AND CONSTRUCTION OF A 6-INCH WATER TUNNEL.

(f) Design completed - construction suspended.
(h) "Design and Construction of 6-Inch Water Tunnel." Bacherlor's Thesis, S. Moskowitz. (Available on loan.)

CALIFORNIA INSTITUTE OF TECHNOLOGY, Civil Engineering Department.

(2258) THE RESUSPENSION OF FLOCCULENT SOLIDS IN SEDIMENTATION BASINS.

(b) The United States Public Health Service.
(c) Dr. A. C. Ingersoll, Assistant Professor of Civil Engineering, California Institute of Technology, Pasadena, California.
(d) Experimental, directed from theoretical considerations. Basic research. Fundamental study on mechanics of flocculent suspensions will be doctoral thesis material for Mr. R. T. McLaughlin.
(e) The purpose of the project is (a) to investigate the resuspension of flocculent settled material from the sludge bed in settling tanks, (b) to minimize this resuspension, thereby improving the efficiency of settling tanks, (c) to test the methods evolved from theory in laboratory models and in full-scale settling tanks, and (d) to evaluate current parameters of efficiency for settling tanks and to provide laboratory apparatus that will yield better measures of performance.
(g) A glass-walled flume 14 ft long by 16 in. wide with adjustable depth has been constructed. Removable floor sections may be replaced with sludge or other movable bed material, to study entrainment at low values of bed shear and settling velocity. Grids upstream provide reproducible levels of turbulence in the tank. First bed material to be studied is gilsonite, sp. gr. 1.04, in uniform sizes of 60 mesh and larger.
Effect of flocculation on settling is evidenced in striking difference between efficiency tests on flocculent sewage and non-flocculent sand and silt. Sewage tanks yielded removals considerably greater than those predicted for the ideal tank, as determined by settling-tube tests. Desilting basins yielded removals less than predicted for the ideal tank.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Hydrodynamics Laboratory.

Inquiries concerning projects should be addressed to the following, all at Hydrodynamics Laboratory, California Institute of Technology, Pasadena 4, California.

Nos. 6, 2259..... to Prof. Vito A. Vanoni
Nos. 15, 804, 1815, 2502..... to Dr. Robert D. Knapp
Nos. 16, 2054..... to Mr. Robert W. Kermeen
No. 279..... to Prof. A. J. Acosta
No. 1548, 1816, 2503..... to Prof. Milton S. Plessett

(6) MECHANICS OF SEDIMENT TRANSPORTATION.

(b) Laboratory project cooperative with U. S. Army, Corps of Engineers, Missouri River Division.
(d) Experimental and theoretical; basic research.
(e) To investigate the mechanics of transportation of sediment by flowing fluids, including studies of the suspended load as well as the bed-load phases of the problem.
(h) "Effects of Sediment Load on the Velocity Field and Friction Factor of Turbulent Flow in an Open Channel", by George N. Nomicos. Thesis, California Institute of Technology, 1956.

(15) STUDIES OF CAVITATION PHENOMENA.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Details of fixed void type cavitation have been studied experimentally in the water tunnel. Special emphasis has been given to characteristics of the interface, dynamics of entrainment at downstream end of cavity, and behavior of entrained voids.
(f) Project terminated May 31, 1956.
(g) This project was a part of a general research program on cavitation. During 1956 the major emphasis of this program was on the mechanics of cavitation damage; hence, there are no additional findings to be reported on this project.

(16) HYDRODYNAMIC FORCES ON SUBMERGED BODIES.

(b) Bureau of Ordnance and Office of Naval Research, Department of Navy.
(d) Experimental; basic and applied research.
(e) Hydrodynamic forces on axially symmetric bodies of different shapes are measured in water tunnels. The important steady-state and damping force coefficients are obtained. The data are used to predict full scale behavior.
(h) "Measurement of Dynamic Coefficients of Ellipsoids", by John A. Stallkamp, California Institute of Technology, Hydrodynamics Laboratory Report No. E-35.4, Sept. 1956.

(279) FLOW IN ROTATING CHANNELS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical.
(e) Studies on the internal and over-all flow behavior and hydrodynamic performance of centrifugal pump impellers, volutes, and axial flow pumps, with special emphasis on cavitation.
(h) "An Experimental Study of Centrifugal Pump Impellers", Transactions ASME, Paper 56-A-41.

(804) THE EFFECT OF PHYSICAL CHARACTERISTICS OF LIQUIDS ON THE INCEPTION OF CAVITATION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Scope of investigations has been extended to include the dynamic testing of treated samples under normal flow conditions. To date pressurized samples show significant apparent tensile strengths, but of somewhat lower magnitude than those determined by boiling-point measurements. The results of these experiments, like all others in this particular research, appear to have inherent wide scatter. Thus, considerable additional work will be required before generalizations can be made.

(f) Project terminated May 31, 1956.
(g) A summary report of the over-all findings of this project has been prepared for the Office of Naval Research. Although this is not available for general distribution, it is anticipated that the material will be published as a technical article in the future.

(1300) WATER ENTRY STUDIES.

(b) Bureau of Ordnance, Department of the Navy.
(c) Mr. Joseph Levy, California Institute of Technology, Hydrodynamics Laboratory, Pasadena 4, California.
(e) An investigation of the phenomena accompanying the entry into water of solids traveling at moderate speeds. The study covers the relative importance of Froude and cavitation number modeling of the oblique entry into water of air-launched missiles.
(f) Inactive.
(h) "On Modeling the Oblique Entry into Water of Air-Launched Missiles", by Joseph Levy, California Institute of Technology, Hydrodynamics Laboratory Report No. E-12. 19 August, 1956.

(1548) SPECIAL PROBLEMS IN HYDRODYNAMICS. (Includes Project Nos. 803 and 1817, Dynamics of Cavitation and Cavitation Damage, and Scale Effects in Cavitating Flow, reported in MP218.)

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental; basic research.
(e) Studies of cavitating and noncavitating flow; dynamic behavior of cavitation bubbles; theoretical and experimental studies of cavitation damage.
(h) "A Note on the Linear and Nonlinear Theories for Fully Cavitated Hydrofoils", by T. Yao-tsu Wu, Hydrodynamics Laboratory Report No. 21-22, August 1956.
"Hydrofoils in Cavitating and Noncavitating Flow", by M.S. Plesset and B. R. Parkin, Cavitation in Hydrodynamics, Proceedings of a Symposium held at the National Physical Laboratory, England, 1955, Paper No. 15, published 1956.
"Techniques for Pressure Pulse Measurements and High-Speed Photography in Ultrasonic Cavitation", by A. T. Ellis, Cavitation in Hydrodynamics, Proceedings of a Symposium held at the National Physical Laboratory, England, 1955, Paper No. 8, published 1956.
"On Physical Effects in Cavitation Damage", by M.S. Plesset, Deformation and Flow of Solids, Proceedings of a Colloquium of the International Union of Theoretical and Applied Mechanics, published by Springer-Verlag, Berlin, 1956.
"Two-Dimensional Sink Flow of a Viscous, Heat-Conducting, Compressible Fluid; Cylindrical Shock Waves", by T. Yao-tsu Wu, Quarterly of Applied Mathematics, Vol. XIII, No. 4, January 1956, pp. 398-418.
"On the Stability of the Spherical Shape of a Vapor Cavity in a Liquid", by M. S. Plesset and T. P. Mitchell, Quarterly of Applied Mathematics, Vol. XIII, No. 4, January 1956, pp. 419-430.
"On the Theory of Surface Waves Generated by Moving Obstacles on Water", by C. R. de Prima and T. Y. Wu, Book of Abstracts, IX International Congress of Applied Mechanics, Brussels, 1956.

(1815) THE CORRELATION OF THE MECHANICS OF CAVITATION WITH THAT OF PHYSICAL DAMAGE.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Objective is on the basis of the present knowledge of the mechanics of the cavitation process to endeavor to clarify the mechanics of cavitation damage of solid surfaces. Two approaches are being used: (1) Study of damage on standard metal specimens subjected to cavitation in the water tunnel; (2) study of damage on samples of same material in the standard magnetostriction equipment.
(f) Project terminated May 31, 1956.

(g) A new phase of this project has been explored during the current year. The preliminary experiments have been made to obtain the quantitative measure of cavitation intensity in a large scale field installation. Test plates of the standardized metal test surfaces were installed in a region of known cavitation in a large hydraulic turbine. A series of short runs (5 to 20 minutes) was made to obtain records of the location and intensity of the damage zone. These were correlated with the damage characteristics on small guiding surfaces in the water tunnel. It was found that the pitting rates of the large field installation and the water tunnel results were of the same order of magnitude, which implies that there is no large scale effect in the damage process.
(h) "Accelerated Field Tests of Cavitation Intensity". Paper No. 56-A-57. To be presented at the Annual Meeting of the American Society of Mechanical Engineers, Nov. 25 - December 1, 1956.

(1816) FORCE CHARACTERISTICS OF SUBMERGED HYDROFOILS UNDER CAVITATING CONDITIONS.

(b) Bureau of Ships, Department of the Navy.
(d) Theoretical and experimental; basic research.
(e) Studies of hydrofoils.
(h) "Water Tunnel Tests of NACA 4412 and Walchner Profile 7 Hydrofoils in Noncavitating and Cavitating Flows", by R. W. Kermeen, Hydrodynamics Laboratory Report No. 47-5, February 1956.
"Experiments on Circular Arc and Flat Plate Hydrofoils in Noncavitating and Full Cavity Flows", by Blain R. Parkin, Hydrodynamics Laboratory Report No. 47-6, February 1956.
"Water Tunnel Tests of the NACA 66_1-012 Hydrofoil in Noncavitating and Full Cavity Flows", by R. W. Kermeen, Hydrodynamics Laboratory Report No. 47-7, February 1956.
"Water Tunnel and Theoretical Investigations of a Supercavitating Hydrofoil", by R. L. Waid and Z. M. Lindberg, Hydrodynamics Laboratory Report No. 47-8, in preparation.
"A Note on the Cavity Flow Past a Hydrofoil in a Liquid with Gravity", by Blaine R. Parkin, Hydrodynamics Laboratory Report No. 47-9, in preparation.

(2051) EFFECT OF VISCOSITY ON CENTRIFUGAL PUMP PERFORMANCE.

(b) Standard Oil Company of New Jersey; Byron Jackson Company.
(d) Experimental.
(e) Investigation of the effects of Reynolds number on the internal and overall flow characteristics of a centrifugal impeller with a view to improving the performance by means of design changes.
(f) Completed.

(2054) FORCES ON UNDERWATER MISSILES RUNNING IN A CAVITY.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental; basic and applied research and development.
(e) The hydrodynamic forces on missiles and simulated missile body components are being measured in water tunnels for cavity flow. Model studies of forces on individual body components of basic geometric shapes have been correlated with studies made on composite bodies.
(g) Data have been obtained on the effects of lateral water surface curvature on the forces on cylinders planing on a free surface on the inside of cavities. The effects of cavitation on the planing forces were also studied.
(h) "Forces on Cylinders Planing on Flat and Curved Surfaces in Cavitating and Noncavitating Flow", by R. L. Waid and R. W. Kermeen, California Institute of Technology, Hydrodynamics Laboratory Report No. 75.1, in preparation.

(2259) STUDIES OF MECHANICS OF SUB-AQUEOUS DUNES.

(b) National Science Foundation grant.
(d) Experimental and theoretical; basic research.

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(e) The purpose of the project is to study the behavior of sub-aqueous sand dunes in laboratory flumes, and to determine under what conditions they will and will not form. It is hoped that this study will lead to a better understanding of the variations in roughness of alluvial streams due to dune formations.
(f) Terminates January 31, 1957.
(h) Final report will be available early in 1957.

(2502) MECHANICS OF CAVITATION DAMAGE.

(b) National Science Foundation.
(d) Experimental, laboratory and field; basic research.
(e) The specific objectives of this program are to attempt to clarify the effects on the cavitation damage potential of two variables: the physical size of the guiding surface or body, and the flow velocity. In this phase the work will be restricted to the investigation of the fixed type cavitation.

(2503) EXPERIMENTAL STUDY OF VORTEXING IN LIQUIDS DRAINING FROM A CYLINDRICAL TANK.

(b) Convair, San Diego, California.
(d) Theoretical and experimental; basic research.
(e) Study of viscous damping in rotational flows; flow discharge of rotating liquids in cylindrical tanks.

UNIVERSITY OF CALIFORNIA, Division of Agricultural Sciences, Department of Irrigation and Soils.

Inquiries concerning Projects Nos. 26, 27, 1058, 1303 and 2504 should be addressed to Prof. M. R. Huberty, Chairman, Department of Irrigation and Soils, University of California, Los Angeles 24, California.

(26) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

(b) Cooperative between the Coachella Valley County Water District, Coachella, California; U. S. Salinity Laboratory, Riverside, California; U. S. Bureau of Reclamation, Boulder City, Nevada; and this laboratory.
(d) Field investigations; applied research and design.
(e) To develop and improve techniques for observing shallow ground water movement, for reclamation of saline and alkali soils, and for installation of drainage devices and systems.
(g) This project has been inactive for a period of approximately 10 years. During that period techniques have been developed which have aided in land reclamation and in developing design criteria for drainage systems.

(27) HYDROLOGY OF WATER SUPPLIES IN CALIFORNIA.

(b) Laboratory project coordinated with the Department of Irrigation, University of California, Davis.
(d) Experimental; applied research.
(e) Factors in watershed management that influence the disposition of precipitation and yield of water reclamation of saline waters.
(h) "Water Resources of the West", Martin R. Huberty, Proc. California Academy of Sci., Feb. 1956.

(1058) SOIL PHYSICAL CONDITIONS IN RELATION TO IRRIGATION.

(b) Coordinated laboratory studies with field observations of water transfer in soils.
(d) Continuing laboratory and field studies; basic and applied research.
(e) Study of the soil properties and management practices which affect the flow of water into and through soils, the storage of water in soils and evaporation from soil, and soil compaction.

(h) "A Method for Minimizing Compaction in Putting Greens." O. R. Lunt, Southern California Turfgrass Culture 6, No. 3: 1-4, July 1956, and USGA Journal and Turf Management Vol. 9: No. 5: 25-30.
"Anomalies in Capillary Intake as Explained by Capillary Rise Experiments", Dale Swartzendruber, Soil Science Proceedings, Oct. 1956, pp. 453 - 458.

(1303) HYDRAULIC CHARACTERISTICS OF IRRIGATION DISTRIBUTION PIPE SYSTEMS.

(b) Laboratory project, cooperative with College of Engineering, University of California, Los Angeles 24, California.
(d) Basic and applied research.
(e) Continued analysis of the operational characteristics of pipe irrigation systems.
(h) "Concrete Pipe for Irrigation", A. F. Pillsbury, Irrigation Engineering and Maintenance, Vol. VI No. 2, Feb. 1956.

(2504) DYNAMICS OF WATER FLOW IN SATURATED SOILS, AND ITS APPLICATION TO THE DESIGN OF DRAINAGE SYSTEMS.

(b) Laboratory project - coordinated with similar work of Department of Irrigation, Davis.
(d) Experimental; applied research.
(e) Relation of soil hydraulic conductivity and other boundary conditions to tile drainage design.

UNIVERSITY OF CALIFORNIA, College of Engineering, Fluid Mechanics Laboratory.

Inquiries concerning Projects Nos. 38, 40, 280, 529, 1307, 1554, 1823, 1824, 1825, 1829, 1830, 2058, 2059, 2060, 2062, 2063, 2261, 2262, 2263, 2265, 2266, and 2505 to 2509, incl., should be addressed to Prof. J. W. Johnson, Department of Engineering, University of California, Berkeley 4, California.

(38) STRUCTURES EXPOSED TO WAVE ACTION.

(b) National Science Foundation.
(d) Experimental (laboratory).
(e) To obtain experimental data for the design of offshore structures. Present work involves the measurement of forces exerted on model elements subjected to wave action.
(f) Completed.
(h) "Breaking Wave Forces", by R. L. Wiegel and R. E. Skjei, University of California, Institute of Engineering Research, Series 95, Issue 2, June 1956.

(40) FLOW CHARACTERISTICS OF GAS-SOLIDS MIXTURES.

(b) Laboratory project.
(d) Experimental; basic and applied research, design.
(e) The flow characteristics of a gas-solids mixture (Al_2O_3, SiO_2 catalyst and air) are investigated in a 17 mm. I.D. glass conduit for various gas flow and solids flow rates. Pressure drops across test sections are accurately measured for a series of air flow rates in which the solids to air ratio is varied from zero to 11.0 pounds of solids per pound of air. The solids are introduced into the flow system through a mixing nozzle fed by a slide valve controlled weighing tank, and have a size distribution varying from particles less than 10 microns to particles greater than 220 microns. Investigation on the metering of solids-gas mixtures by nozzle and Venturi-tubes has been carried out. Studies on the heat transfer to flowing gas-solids mixtures have been carried out and are being continued. Metering and heat transfer studies to be continued using fixed size particles.
(g) Equipment for the study of the heat transfer characteristics of flowing mixtures has been completed.

(280) SEDIMENT TRANSPORT.

(b) Laboratory project and U. S. Corps of Engineers.
(d) Experimental and theoretical.
(e) Various fundamental problems in relation to sediment transport have been studied, and efforts have been made to apply the results of research to solve practical problems.
(g) The changes are studied experimentally and theoretically which the distributions of velocity and suspended sediment undergo if the sediment concentration near the bed becomes very high, such changes occur whenever the concentration surpasses 100 gr/lit concentration.
(h) "Effects of Heavy Sediment Concentration Near the Bed on the Velocity and Sediment Distribution", H. A. Einstein and Ning Chien, University of California, Institute of Engineering Research Report, Series 33, Issue No. 2.

(529) LITTORAL SEDIMENT FLOW ON A BEACH.

(b) Beach Erosion Board, Department of the Army, Washington, D. C.
(d) Field, laboratory, experimental and theoretical research.
(e) The object of this investigation is to determine the mechanism of sand transport on beaches and in the water immediately off shore along the coast of California. For several years previous to the year 1954-1955, attention had been focused on movement of sand along the coast near Santa Barbara, but beginning in 1954 investigations were made of the movement of sand upon Point Reyes Beach, exposed to the full force of the ocean 35 miles northwest of San Francisco. The beach is a high steep beach characterized by coarse sand. The sand varies greatly from place to place on the beach and from one season of the year to another. It is 35 percent coarser in February than it is in October. The sand at any one area on the beach varies in size from 20 to 25 percent from the mean value of the beach; that is a suite of samples at any given time of occupation of the beach shows a range in mean diameter of 20 to 25 percent coarser or finer than the mean population. Also within a radius of 15 feet of any given spot the grain size varies up to 60 percent of the variation of the beach as a whole. The beach also cuts and fills at a rapid rate, depending upon the migration and position of the cusps that form from time to time and then disappear.
(h) "Sand Variation at Point Reyes Beach, California", by Parker D. Trask, and Charles A. Johnson, Beach Erosion Board Technical Memo 65, 81 pp. Oct. 1955 (Also published as University of California Publ. Inst. Engr. Research, Series 14, Issue 18, Sept. 1955). "Cut and Fill on Point Reyes Beach, California", by Parker D. Trask and Charles A. Johnson, and Theodore Scott, University of California Publ. Inst. Engr. Research, Series 14, Issue 19, 31 pp., Sept. 1955.

(1307) DETERMINATION OF PRESSURE FLUCTUATIONS IN TURBULENCE IN LIQUID FLOW.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental.
(e) Development of instruments and methods to measure pressure fluctuations in the free stream and at the flow boundaries.
(f) Discontinued.
(g) A Rutishauser pressure gage is tested for its applicability to the problem. The frequency response is measured and calculated for various measuring arrangements. A set of wall measurements was made in a turbulent open channel flow of oil. The records are analyzed and interpreted. A flow system to measure wall pressures as well as point velocities in pipes is in operation.
(h) "Measurement of Pressure Fluctuations at the Smooth Boundary of an Incompressible Turbulent Flow", Huon Li, University of California, I.E.R., Series No. 65, Issue 1, Dec. 1954.

(1554) SEA WATER RESEARCH.

(b) State of California, U. S. Department of the Interior.

(d) The several investigations for demineralizing sea water carried on during the past year are: (1) Solar distillation; (2) low-temperature difference method; (3) use of high liquid pressures in combination with appropriate permeable membranes (osmotic pressures); (4) thermodynamic analyses of separation methods; and (5) ion exchange using heat for regeneration. Solar distillation, low-temperature difference, osmotic pressures, and ion exchange are experimental. The thermodynamic analysis is a theoretical investigation. The thermodynamic analysis should be regarded as basic research only. The other three projects should be classified as applied research.
(e) The purpose of this investigation is to discover whether there is available any method for the large scale, low-cost demineralization of sea water. Operation of the solar stills was continued, with an additional wick-type still in operation. Also, a small project was carried out on the use of paraffin wax as a heat absorber and storage material. The data on the large Low-Temperature-Difference plant is being summarized in report form. The U.C.L.A. program of work on the use of reversed osmosis was continued and a larger unit is now under construction. Work was initiated at Berkeley on a means for constructing high strength osmotic membranes. The Berkeley development consists of the use of bundles of parallel fibers with flow parallel to the fibers. By using synthetic materials which swell in water, it has been possible to get down to pore sizes of the order of 50 Angstroms. Present efforts are directed toward reducing these pore sizes.
(g) Detailed results may be obtained from the progress reports.
(h) "Interim Report on Sea Water Conversion Project", by Everett D. Howe, Aug. 1956.
"Research and Development of Molecular Oil Film for Use in the Large-Scale-Low-Cost Demineralization of Saline Waters by a Pressure Method", by Gerald L. Hassler. Progress reports issued as follows: November 1955 (Aug.-Oct.); February 1956 (Oct.-Dec.); May 1956 (Dec.-Feb.); May 1956 (Feb.-Apr.); September 1956 (Final report).
"Thermodynamic and Economic Analysis of Systems for Preparing Fresh Water from the Sea", by Myron Tribus, April 1956.
"The Purification of Water by Means of Pressure", by Myron Tribus, Aug. 1956.
"Vacuum Distillation of Water on a Laboratory Scale Thermal Difference Plant", L. Akobjanoff and E. D. Howe. RESEARCH, Vol. 9, June 1956, pp. 220-226.

(1823) THE MECHANICS OF BOTTOM SEDIMENT MOVEMENT WITH OSCILLATORY WAVES.

(b) Beach Erosion Board, Department of the Army.
(d) Experimental.
(e) To obtain experimental information on the criterion for initial and general movement of bottom sediment by wave action. Prototype conditions of the relative motion of water and bed were simulated by use of an oscillating plate in still water.
(g) A theoretical solution has been found for the turbulent boundary layer flow along an oscillating surface and was empirically checked for the smooth bottom. Work is continued for a rough bottom.

(1824) BEHAVIOR OF AIR ABOVE MECHANICAL OCEAN WAVE MODEL.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) Measurement of velocity distributions in air above a mechanical model of long-and-short-crested ocean waves as a function of wind velocity, wave height and wave length. Drag forces as a function of distance from wave plane to a rigid ceiling determination.
(g) Data being collected.

(1825) WIND WAVES IN SHALLOW WATER.

(b) Beach Erosion Board, Department of the Army.
(d) Experimental.
(e) To obtain experimental information on the factors of wind velocity, wind duration, water depth, bottom slope, and bottom roughness as related to wave generation and wind tide produced in shallow water of limited extent. Runup and overtopping of wind waves on various levee sections also have been studied. A glass-wall channel 70 feet long, 15 inches deep, and 12 inches wide has been constructed for this study.

(h) "A Model Study of the Run-Up of Wind Generated Waves on Levees with Slopes of 1:3 and 1:6", by O. J. Sibul and E. G. Tickner, Univ. of Calif. Inst. of Engr. Research, Series 71, Issue 7, Sept. 1955.
"Model Study of Overtopping of Wind-Generated Waves on Levees with Slopes of 1:3 and 1:6", by O. J. Sibul and E. G. Tickner, Univ. of Calif. Inst. of Engr. Research, Series 71, Issue 8, Feb. 1956.

(1829) STUDY OF INCLINED GAS-LIQUID FLOW IN TUBES.

(b) Laboratory research project.
(d) Experimental and theoretical; basic research.
(e) Collection and correlation of data on several diameters of tubing at inclinations from horizontal to vertical.
(g) One inch diameter smooth and rough tubes tested. Two papers in preparation.

(1830) MEASUREMENT OF THE DISTRIBUTION OF A GAS AND TWO LIQUIDS IN A POROUS MEDIUM BY X-RAY TECHNIQUES.

(b) Laboratory project.
(d) Experimental; applied research.
(d) Development of a calibration and measurement method for the distribution of three or more materials in a laboratory sample of sandstone.
(g) Tests completed. Paper in preparation.

(2058) STUDY OF EXCHANGE CHARACTERISTICS IN A TURBULENCE COLUMN.

(b) Laboratory project.
(d) Experimental.
(e) Exchange of various properties are studied and compared for various properties in a column with reproducible turbulence pattern.
(g) The column is constructed. Sediment distributions are observed for various degrees of turbulence.

(2059) STUDY OF BED-LOAD MOTION IN A FLOW SUBJECTED TO COMPOSITE FRICTION.

(b) Laboratory project.
(d) Experimental.
(e) A granular bed is developed between a system of obstructions such as piles. It is attempted to determine the part of the flow resistence which determines the rate of sediment motion.
(f) Inactive.

(2060) ESTIMATING STREAMFLOW INTO A TIDAL ESTUARY FROM SALINITY MEASUREMENTS.

(b) Analytical study.
(d) Applied research.
(e) Estimates of streamflow from the Sacramento-San Joaquin River system into San Francisco Bay are to be prepared from available salinity, tidal, current, and hydrographic data.
(f) Completed.
(g) Computed streamflows have agreed favorably with actual channel streamflow measurements; however, limitations of the method preclude greater accuracy for this tidal estuary.
(h) "On Estimating Streamflow Into a Tidal Estuary" by David K. Todd and Leung-Ku Lan, Trans. American Geophysical Union, Vol. 37, No. 4, pp. 468-473, 1956.

(2062) STRESS-STRAIN RELATIONSHIPS FOR SHEAR IN A SAND-WATER MIXTURE.

(b) Laboratory project.
(d) Experimental.
(e) The relationship is determined in an especially constructed rotating shear device for various normal pressures. The results will be used to predict the behavior of a granular stream bed subjected to high shear by a flow.

(g) Preliminary results have been obtained. Work is now concentrating on improvement of the instrumentation.

(2063) METHODS OF DETECTING AND TRACING THE MOVEMENT OF GROUND WATER.

(b) U. S. Bureau of Reclamation.
(d) Experimental; applied research.
(e) This study has as its objectives study of velocity variations observed in tracing the flow of liquids through porous media, development of methods and tracers for field determination of water movement underground, and application of these methods to location and measurement of seepage from canals.
(g) From measurements of chloride passing through sand columns, longitudinal dispersion rates have been related to velocity and length of flow. A theoretical analysis based on probability concepts gives dispersion curves in good agreement with experimental data.
(h) "Dispersion Phenomena in Laminar Flow Through Porous Media", by M. N. E. Rifai, W. J. Kaufman, and D. K. Todd, Canal Seepage Research Rep. No. 2, Inst. of Engineering Research, University of California, Berkeley, 157 pp., 1956 (available on request).

(2261) WAVE REFRACTION RESEARCH.

(b) Beach Erosion Board, Dept. of Army, Washington, D. C.
(d) Laboratory.
(e) In shallow water the velocity of a water gravity wave depends upon the depth of water as well as upon the length of the wave. When it travels in shoaling water it bends. This refraction changes the wave height and direction. Powerful graphical and analytical tools are available for use by the engineers; however, there is an almost complete lack of evidence as to their accuracy. The purpose of this contract has been to perform laboratory experiments to check the validity of the techniques used in practice. The first series of tests were performed in a ripple tank; these showed that the techniques were fairly reliable from a practical standpoint.

(2262) ANCHORING FORCES RESEARCH.

(b) California Research Corporation.
(d) Laboratory.
(e) Model studies are being made of the forces in mooring lines of a vessel anchored at sea. Tests are being made with both uniform and non-uniform wave conditions.
(f) Completed.
(h) "Model Studies of the Motions and Mooring Forces of a Marine Coring Vessel", L. W. Thrasher and R. L. Wiegel.

(2263) MOORING FORCES RESEARCH.

(b) Bureau of Yards and Docks, U. S. Navy, Port Hueneme, California.
(d) Laboratory.
(e) A model study of the forces induced in mooring cables and fender systems by water gravity waves acting on moored vessels.
(f) Completed.
(h) "Model Study of Ship Mooring Forces: AFDL-1", by R. L. Wiegel, R. W. Clough, R. A. Ditley, S. F. Whisenand, J. B. Williams, and A. L. Arnold, Univ. of Calif. Inst. of Engr. Research, Series 92, Issue 4, 35 pp. March 1956.
"Model Study of Ship Mooring Forces: ARD-12", by R. A. Dilley, R. L. Wiegel and J. B. Williams, Univ. of Calif. Inst. of Engr. Research, Series 92, Issue 5, 32 pp., July 1956.
"Model Study of Ship Mooring Forces: CVE-78", by R. A. Dilley, J. B. Williams and R. L. Wiegel, Univ. of Calif. Inst. of Engr. Research, Series 92, Issue 6, 30 pp., August 1956.
"Model Study of Ship Mooring Forces: ARG-11", by R. A. Dilley, J. B. Williams and R. L. Wiegel, Univ. of Calif. Inst. of Engr. Research, Series 92, Issue 7, 22 pp., August 1956.
"Model Study of Ship Mooring Forces: Final Report", by R. L. Wiegel, R. A. Dilley, R. W. Clough and J. B. Williams, Univ. of Calif. Inst. of Engr. Research, Series 92, Issue 8, 66 pp., August 1956.

(2265) FORCES ON ACCELERATED CYLINDERS.

(b) Engineering Foundation and laboratory project.
(d) Experimental; basic research.
(e) Measurement of drag coefficients and flow configurations about cylinders during accelerated motion in fluids as related to wave forces as cylinders.
(g) Constant acceleration drag forces measured for three cylinders. Paper in preparation.

(2266) HYDROLOGIC INVESTIGATIONS OF SMALL DRAINAGE BASINS IN CALIFORNIA.

(b) U. S. Bureau of Public Roads.
(d) Analytic study; applied research and development.
(e) The purpose of this investigation is to summarize streamflow records in California, to classify records on the basis of homogeneous areas for analysis, to test the adequacy of methods for estimating flood flows in California from those developed in other parts of the country, and, if required, explore new methods of estimating flood flows.
(g) Intensive study has been made of means of estimating the 10-year flood for the Western slope of the Sierra Nevada Range. It was found from a multiple regression analysis of basin parameters that area, annual precipitation, and difference in elevation gave the best estimate.
(h) A final report is nearly completed.

(2505) EFFECT OF SEDIMENT DISTRIBUTION IN STREAM CHANNELS.

(b) University project.
(d) Experimental; basic research.
(e) Alluvial flows in channels with artificially secured banks are studied systematically for their tendency to meander as expressed by the development of alternate bars. It is the aim of this study to develop criteria for stability.

(2506) SEDIMENT MOTION IN SILT CARRYING STREAMS.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) An alluvial stream with a bed material in the sand sizes or coarser follows relationships generally called bed-load formulas. This study tries to find what the corresponding laws are if the bed sediment consists mainly of particles in the silt sizes as fines.

(2507) SAND DEPOSITS IN CANALS.

(b) U. S. Bureau of Reclamation.
(d) Experimental; basic research.
(e) The relationships are sought governing the deposit of various sediment sizes and types in lined canals under various flow conditions. Of particular interest is any resulting change of the effective channel roughness and of its flow capacity.

(2508) SHIP WAVES IN WATERWAYS.

(b) Laboratory project.
(d) Experimental.
(e) To obtain experimental information on the characteristics of waves generated by ships in shallow water. Such information is of value in the problem of wave wash and bank erosion in waterways. Ship models are towed at various speeds in water of various depths and the wave characteristic measured at various distances from the sailing line.

(2509) NON-STEADY FLOW ANALOGY.

(b) Department of Water Resources, State of California.
(d) Experimental; applied research.
(e) By means of an electric analog model of the San Francisco Bay and the Sacramento-San Joaquin Delta Region, the feasibility of barriers and channel works is being investigated, with the purpose of providing a greater flow of fresh water southward in the Central Valley.

UNIVERSITY OF SOUTHERN CALIFORNIA, Research Foundation for Cross-Connection Control.

(49) RESEARCH FOUNDATION FOR CROSS-CONNECTION CONTROL.

(b) Laboratory project.
(c) Dr. Kenneth C. Reynolds, Supervisor, Research Foundation for Cross-Connection, University of Southern California, Los Angeles 7, California.
(d) Experimental research and field investigations; basic research.
(e) To determine by proper research the relative value and protection afforded by various backflow prevention devices.
(g) Establishment of standardized laboratory and field test procedures and minimum specification requirements for backflow prevention equipment and continuous evaluation and improvement of such procedures and specifications.

(2270) BACKFLOW PREVENTION.

(b) Department of Water and Power, City of Los Angeles, California.
(c) Dr. K. C. Reynolds, Supervisor, Research Foundation for Cross-Connection Control, University of Southern California, Los Angeles 7, California.
(d) The Department, in order to be advised on backflow prevention problems, has entered into a contract with the University from December 1954 to December 1957.
(e) This contract involves the following: (a) Consulting services regarding backflow prevention installations and other hydraulic problems; (b) preparation of specifications covering the design, material, and operational requirements for backflow prevention units; and (c) maintenance of a laboratory for testing backflow prevention devices and other hydraulic equipment for the Department.
(h) Quarterly progress reports to the Department. Preliminary draft of proposed specifications being revised.

UNIVERSITY OF SOUTHERN CALIFORNIA, School of Engineering.

Inquiries concerning Projects Nos. 2271 and 2273, should be addressed to Dr. K. C. Reynolds, School of Engineering, Los Angeles 7, California.

(2271) FLOW OVER A SIDE CHANNEL SPILLWAY.

(b) Graduate research.
(d) An experimental study of flow over a side channel spillway and down the collecting channel.
(e) Two models of the Pleasant Valley Dam had been built under a contract with the Department of Water and Power, City of Los Angeles. This research utilized a 1 to 25 model of the final design. Model data were collected for all possible flows which might occur in nature so that a correlation could be made between model and prototype values, whenever the latter are observed.
(g) "Model Investigation of a Side Channel Spillway by the Use of a Photographic Cross Section Tracer" by J. C. Dodd and J. S. Grossman, M. S. Thesis, June 1956.

(2273) FREE OVERFALL OF A CIRCULAR CONDUIT.

(b) Graduate research.
(d) An experimental study of the free overfall of a partially filled circular conduit, 0.5039 feet in diameter laid on a mild slope.
(e) For various rates of flow the profile of the water surface was determined; the calculated critical depth was found; correlation between the measured depth at the drop off; and the rate of flow was investigated.
(g) Data being collected for circular conduits 0.655 and 0.333 feet in diameter with Master's thesis in progress by C. E. Robinson.
(h) "Discharge of a Circular Conduit at a Free Overfall", by R. L. White and C. A. Magnusen, M. S. Thesis, June 1956.

CARNEGIE INSTITUTE OF TECHNOLOGY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1834, 2064, 2275, and 2276 should be addressed to Prof. F. T. Mavis, Carnegie Institute of Technology, Pittsburgh 13, Pennsylvania.

(1834) AIR-WATER FLOW.

(b) Laboratory project.
(d) Theoretical and experimental.
(e) An investigation to determine the amount of air that can be carried by flowing water. Experiments are conducted with free water jets and with air-water mixtures flowing in pipes at different slopes.

(2064) VIRTUAL MASS.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Measurement of virtual mass in bodies of fluid with free and fixed boundaries.

(2275) FLOW OF LIQUID-SOLID MIXTURES.

(b) Laboratory project.
(d) Basic experimental and analytical research for master's thesis.
(e) Determination of energy losses, solid and liquid velocities, concentration of solids, and characteristics of flow.
(h) "Hydraulic Transportation of Solids in a Horizontal Pipe", H. G. Workneh, Ph.D. Thesis, Carnegie Institute of Technology, 1956.

(2276) UNSTEADY FLOW THROUGH CONDUITS, WEIRS AND ORIFICES.

(b) Laboratory project.
(d) Experimental and analytical for undergraduate thesis.
(e) Analysis of steady-flow characteristics from measurements with unsteady flow.

COLORADO A AND M COLLEGE, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1074, 1313, 1565, 1839, 2070, 2071, and 2510 to 2517, incl., should be addressed to Dr. Maurice L. Albertson, Department of Civil Engineering, Colorado A and M College, Fort Collins, Colorado.

(55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.

(b) Soil and Water Conservation Research Branch, Colorado Experiment Station, Bureau of Reclamation, State Engineer of New Mexico, and State Engineer of Wyoming.
(c) Mr. H. J. Stockwell, Soil and Water Conservation Research Branch, Colorado A and M College, Fort Collins, Colorado.
(d) Field investigations; applied research.
(e) Systematic measurements of depth and water content of snow at high elevations in Colorado mountain areas for the purpose of forecasting the runoff of the principal rivers of the state in the interest of irrigation, power, domestic supplies, and other uses. The use of electrical resistance soil moisture units is being tested to determine a factor of soil moisture deficiency for water supply forecast purposes.
(g) Snow measurement data are correlated with runoff. Once the relationship is established, the snow measurement data are used to predict the runoff for the coming season.
(h) Colorado Agricultural Experiment Station General Series Papers--Monthly Snow Survey reports for the Rio Grande, Colorado and Platte-Arkansas Drainage Basin.

(287) PERFORMANCE OF WELL SCREENS.

See U. S. Department of Agriculture, Agricultural Research Service, page 116.

(820) THE STUDY OF SEEPAGE LOSSES FROM IRRIGATION CHANNELS.

See U. S. Department of Agriculture, Agricultural Research Service, page 116.

(821) GROUND-WATER FLUCTUATIONS AND THEIR RELATION TO PUMPING.

(b) Colorado A and M Experiment Station.
(c) Mr. W. E. Code, Colorado A and M College, Fort Collins, Colorado.
(d) Field investigation; applied research.
(e) Steel tape measurements are made to the water table twice annually in about 255 wells in the South Platte and Arkansas Valleys. These wells are located in the areas where pumping for irrigation is of importance. In addition, four wells equipped with automatic recorders are maintained.
(g) Records on many wells begin in 1929. New wells are added to the system as conditions warrant. These records have been of great value in recent years in revealing trends associated with water supply and use of ground water.
(h) Measurements published annually since 1945 in Geological Survey Water Supply papers.

(822) DIFFUSION OF HEAT, VAPOR, AND MOMENTUM.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(c) Mr. Jack E. Cermak, Civil Engineering Department, Colorado A and M College.
(d) Experimental; fundamental.
(e) A controlled study in a wind tunnel of the fundamental principles describing the process of diffusion of vapor, heat, and momentum from various surfaces. Eventually it is intended to use the fundamental information to aid in determining evaporation from free surfaces and land areas with various soil and crop covers.
(f) Completed.
(g) A non-dimensional parameter containing the rate of evaporation is found to be a function of the Reynolds number in terms of shear velocity at the end of the evaporation surface. The results so presented are practically independent of the length of dry approach and the regime of boundary layer flow. Sutton and Koehler-Yih solutions are found to yield identical vapor profiles. A theoretical curve for the rate of evaporation is calculated on the basis of Sutton's theory of turbulent exchange as modified by Pasquill. This curve follows the data closely. An equation obtained by Cermak in an earlier study through use of the Reynolds analogy was found to represent the data with good accuracy.
(h) "Vapor Transfer by Forced Convection from a Smooth, Plane Boundary" by J. E. Cermak and P. N. Lin. Final Report, Contract N9onr-82401, Jan. 1955.

(1074) HYDRAULICS OF STILLING BASINS.

(b) Laboratory and field project, Agricultural Research Service and U. S. Bureau of Public Roads.
(d) Experimental; applied and fundamental.
(e) To obtain generalized design information for stilling basins utilizing a scour hole created by a jet of water, as well as stilling basins utilizing the hydraulic jump together with chute blocks, floor blocks, and sills.
(g) Studies have been completed using circular jets and two-dimensional jets. The variables considered were the depth of the pool, the fall velocity of the erodible material, the size of the jet, and the velocity of the jet. Results show that the depth and rate of scour depend upon the depth of water in the stilling basin, the size and velocity of the jet, and the size and gradation of the bed material. Studies have been completed determining the influence of size gradation and the sorting of the finer materials which leaves the coarser materials as armor plating to protect the hole from further scour. Relatively small amounts of gravel riprap protection were found to reduce the scour to as little as 10 per cent of that without protection. Pit-run, graded riprap proved to be much more effective than any size of riprap of a narrow size range. Large-size material was least effective. Prototype installations were made in the field in 1955 and the various design factors studied. Qualitatively these confirm the experimental results.

(h) "Recent Developments in the Design of a Simple Overfall Structure", by D. E. Hallmark and M. L. Albertson, Jan. 1956.
"Methods of Hydraulic Energy Dissipation " by C. S. Donabedian, Master's Thesis, Sept. 1956.
"Stabilization of Thompson Lake Outlet Channel", by T. T. Williams, Master's Thesis, Nov. 1956.

(1313) HYDRAULICS OF ALLUVIAL CHANNELS.

(b) Laboratory project cooperative with Missouri River Division, Corps of Engineers, Department of the Army.
(d) Experimental and theoretical; basic research and design; for master's and doctor's theses.
(e) The laboratory study on the roughness of alluvial channels has been completed. Thirty runs were made in a variable slope flume 70 feet long and 4 feet wide. The following measurements were made for each run: (1) water discharge, (2) total sediment discharge, (3) slope of water surface, (4) suspended sediment load, (5) velocity distribution, (6) average length and height of dunes, (7) depth of flow, (8) miscellaneous such as temperature, etc.
(f) Completed.
(g) The variation of Chezy's resistance coefficient with Reynolds number shows that for a given size of bed material relative to depth of flow the bed is plane and smooth at a low Reynolds number but ripples and random dunes develop to create a maximum resistance as Reynolds number increases. As Reynolds number increases still farther, the dunes increase in height and spacing (and become more uniform in shape and spacing) but the resistance decreases until the bed becomes plane and rough prior to development of antidunes at highest Reynolds numbers.
(h) "A Study of the Sediment Transport in Alluvial Channels", by J. R. Barton and P. N. Lin, prepared for the Corps of Engineers, March 1955.
"A Preliminary Study of Sediment Sampling Efficiency", by Donald J. Sadar, Master's Thesis, Nov. 1954.

(1565) SEDIMENT CARRYING CAPACITY OF CLOSED CONDUITS.

(b) Armco Drainage and Metal Products, Inc., Middletown, Ohio; Research Corporation, Santa Monica, Calif., and a Fellowship from Tau Beta Pi Association.
(d) Experimental; applied.
(e) During the period 1955-56 experiments were conducted on smooth, standard-corrugated and helical-corrugated pipes 12 in. in diameter, using 0.60 mm diameter sediment with water as continuous medium. For this, a complete recirculation system was designed and experiments were conducted in the range where part of the sediment was carried along the bottom. Quantities measured were: discharge energy gradient, temperature, total sediment concentration, and nature of bed-load movement. Data were also collected from other sources, for smooth pipe, to study effect of sediment size and pipe diameter.
(f) Completed.
(g) For transporting a given quantity of sediment of given size, helical corrugated boundary is most economical as far as energy aspect is concerned.
Darcy-Weisbach resistance coefficient f is adequate to study sediment transport phenomena through pipes. The resistance coefficient f is affected by sediment concentration, characteristics of sediment, and nature of boundary form.
For smooth boundary the relation

$$Re\ \sqrt{f} = \left\{ \frac{I}{d/D} \right\}^{s_1} C_T^{1/3}$$

adequately represents variation in f with Reynolds number Re, size of sediment d, diameter of pipe D, and concentration C_T; I and s_1 are functions of d alone.

(h) "Effect of Boundary Form on Fine Sand Transport in Twelve-Inch Pipes", by A. R. Chamberlain, Doctor's Thesis, (covers work done during 1952-55).
"Sediment Transport Through Pipes", by R. J. Garde, Master's Thesis, (covers work done during 1955-56).

(1566) DIFFUSION INTO AN AIR STREAM HAVING VARIOUS DEGREES OF STABILITY.

(b) Air Force Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Massachusetts.
(c) Mr. Jack E. Cermak, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental and theoretical; fundamental.
(e) By means of a horizontal, heated, metal plate placed in the floor of a wind tunnel, the effect of various artificially created lapse rates upon mean velocity profiles, turbulence structure, and flat plate heat transfer coefficients were investigated.
(f) Completed.
(g) An increase of eddy diffusivity up to 500% was found under some of the thermal and flow conditions examined. For the case of flow with a positive vertical density gradient, the increase in eddy diffusivity was found to be a function of a Froude number, a Reynolds number and the relative distance above the heated boundary.
(h) "Turbulent Diffusion of Momentum and Heat from a Smooth, Plane Boundary with Zero Pressure Gradient", by A. C. Spengos, Scientific Report No. 1, Feb. 1956.
"Heat Transfer by Forced Convection from a Horizontal Flat Plate into a Turbulent Boundary Layer", by A. C. Spengos and J. E. Cermak, June 1956.
"Turbulent Diffusion of Momentum and Heat from a Smooth, Plane Boundary with Zero Pressure Gradient", by A. C. Spengos and J. E. Cermak, Final Report -- Part I, August 1956.
"Turbulent Diffusion of Momentum and Heat from a Smooth, Plane Boundary with Zero Pressure Gradient", by A. C. Spengos and J. E. Cermak, Final Report -- Part II, August 1956.

(1567) BEHAVIOR OF SEAPLANE HULLS IN SIMPLE SEAS.

(b) Bureau of Aeronautics, Department of the Navy.
(c) Mr. E. F. Schulz, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental.
(e) The behavior of model seaplane hulls when towed at different angles to a wave train has been studied experimentally. The model motions have been obtained from motion picture films made of the tests.
(f) Completed.
(h) Final report in progress.

(1570) FLOW PATTERNS ON LANDING IMPACT OF SEAPLANES.

(b) Bureau of Aeronautics, Department of the Navy.
(c) Dr. A. R. Chamberlain, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental.
(e) To record the force-time history of the impact of V-wedges with angles of dead rise from 3° to 50°, and two "constant force" hulls. To record the flow field development by photographic means as the wedges are dropped into a tank of bentonites, or zero-buoyancy bubbles, and water.
(g) The force-times histories have been recorded, and indicate the earlier work along similar lines by MIT and Colorado A and M employed too small a tank. Bentonite proved unsatisfactory as a material for use in obtaining photographs of the flow field. Computations of the apparent mass as a function of immersion depth for various V-wedges are being completed. Zero buoyancy bubbles located in the water of the drop-tank permitted photographs of the path lines of the bubbles to be made for each impact of a V-wedge.

(1837) SEALING OF IRRIGATION CANALS BY BENTONITE SEDIMENTING.

(b) U. S. Bureau of Reclamation, various irrigation companies and districts, bentonite companies, chemical companies and equipment companies.
(c) Mr. R. D. Dirmeyer, Jr., Department of Civil Engineering, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied.

(e) The research and development work has included trial installations at 19 field sites in operating canals and laboratory model studies. The sedimenting method involves the use of a stably dispersed bentonite in water. The sealing is accomplished by the bentonite in the water seeping into the cracks and voids of the in-place pervious canal bed materials.
(g) The bentonite sedimenting trials in actual canals has resulted in seepage losses being cut to one-eighth to seven-eighths of the before-sedimenting losses. Thus, additional development work is needed, but significantly, in most of the trials, the experimental costs have been less than the value of the water salvaged in the first season.
(h) "Bentonite Linings Stop Seep Losses", by R. D. Dirmeyer, Jr., Jan.-Feb. 1956.
"Methods of Sealing Irrigation Canals in the United States", by R. D. Dirmeyer, Jr., July 1957.
"Use of Colloidal Clay Sediments in Sealing Irrigation Canals", by R. D. Dirmeyer, Jr.
"The Penetration and Sealing Effects of Dispersed and Flocculated Bentonite Suspensions in a Dune Sand", by E. C. Newman, Master's Thesis, August 1956.
"Progress Reports of Sediment Lining Investigations for Fiscal Years 1954, 1955 and 1956", by R. D. Dirmeyer, Jr.
"Report on Sediment Lining Installations in Colorado - 1954 to 1956", by D. L. Bender.

(1838) BEHAVIOR OF MODEL SHIP HULLS IN AN OBLIQUE SEA SYSTEM.

(b) David Taylor Model Basin through the Office of Naval Research, Department of the Navy.
(c) Mr. E. F. Schulz, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental.
(e) A model tanker hull was towed at five different headings relative to the travel of a simple wave train. The motions of heave, pitch and roll were measured from motion picture films taken during the tests.
(f) Completed.
(g) The above data were used to compute the amplitude response operators for the motions of heave, pitch and roll.
(h) Final report in progress.

(1839) INVESTIGATIONS OF REGIME THEORY OF SELF FORMED CHANNELS.

(b) Cooperative project sponsored by Colorado A and M College, U. S. Bureau of Reclamation, U. S. Engineers, U. S. Geological Survey.
(d) Experimental; applied and fundamental.
(e) An investigation of regime channels and of conditions related to channel stability. The field data collected from selected straight reaches of canals having a reasonably steady discharge include the following: (1) Slope of energy gradient, (2) velocity profiles, (3) discharge, (4) shape of channel, (5) suspended sediment load, (6) total sediment load when possible, (7) samples of side material, (9) dune and ripple formations on the bed, (10) temperature of water, and (11) photographs of the reaches investigated for both empty and full supply conditions. The primary purpose of the study is to obtain information that will assist in establishing a more precise theory applicable to the design of stable channels in alluvium. The data collected should also be useful in the investigation of other related open channel problems. Field data have been collected and are currently being analyzed.
(h) Report in preparation.

(2066) STUDY OF OPEN CHANNEL CONSTRICTIONS IN A SLOPING FLUME.

(b) U. S. Bureau of Public Roads.
(c) Dr. H. K. Liu, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied.

(e) Tests are conducted in a flume which is 8 ft. wide and 75 ft. long. Normal depth is established corresponding to a given slope and discharge. Different kinds of bridge abutments are put into the flume and the resulting back water measured. Also studied is how the maximum backwater is influenced by different widths of constriction, varying numbers of piers of five different shapes, skewed crossing, eccentricity of crossing. Furthermore, two bridges of the same type and of the same constriction width are put into the flume and it is determined how a variation of the distance between the models affects the maximum backwater and the upstream flow conditions. As yet, only clear water tests have been conducted. An extension to channels with erodible bed is initiated.
(h) Results will be published in a report that is in preparation. Some data and conclusions are published in the Highway Manual of the U. S. Bureau of Public Roads.

(2067) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

See U. S. Department of Agriculture, Agricultural Research Service, page 116.

(2070) ROUGHNESS IN OPEN CHANNELS.

(b) Laboratory project and National Science Foundation.
(d) Experimental; basic research for Master's and Doctor's theses.
(e) Project intended to determine the fundamental aspects of roughness in open channels. Different types of roughness are being studied to determine their influence on the resulting velocity distribution resistance coefficient, and depth and pattern of flow.
(g) Certain results have been reported in previous issues of this publication. Various spacings of baffle-type roughness studied in variable slope flume 8 ft. wide and 75 ft. long. Results show that spacing must be very dense before effective bottom is above actual bottom of flume. A special roughness parameter has been developed. At present also cooperating on project reported under Rocky Mountain Hydraulics Laboratory.
(h) "Artificial Roughness Patterns in Open Channels" by W. W. Sayre, Master's Thesis, October 1956.

(2071) MANIFOLD DIFFUSER STILLING BASIN.

(b) Laboratory project.
(d) Experimental; applied.
(e) A horizontal chamber is used with a sloping bottom and bars across the top to force jets of water to issue vertically upward. Energy of the jets is dissipated in the overhead water. A model study was originally made followed by construction of two diffusers. A systematic study is now under way to determine generalized design criteria.
(g) Operation of prototype excellent. Dissipates energy with virtually no waves at the banks. Design and construction simple. Cost much less than the conventional design using horizontal dissipation in a concrete stilling basin.

(2277) EVAPORATION FROM SOILS.

(b) W-32 (Colorado contributing project) - administered by the Colorado Experiment Station.
(c) Dr. A. T. Corey, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; fundamental.
(e) This project is a comprehensive study of moisture transfer from soil by evaporation from the soil surface. The immediate objectives are to evaluate the variables known to affect evaporation from soil in order to determine those that are most important in the field, and secondly to search for relationships among the pertinent variables which will aid in making quantitative estimates of evaporation from a given soil under prevailing ambient conditions. The work is being carried on in the Colorado A and M wind tunnel and in an air conditioned chamber designed for this purpose.
(g) The studies to date have been confined to a sandy soil and to a study of the inter-relationship between depth of water table and evaporation rates. It has been found that in the soil under investigation, there is a critical depth (about 26 inches) such that very little water will be lost by surface evaporation from a water table below this depth.

(h) "Study of Evaporation from Soil Surfaces in Terms of Soil and Micrometeorological Factors", Colorado Contributing Project of the Western Regional Research Project W-32, Progress Report No. 1, Nov. 1955 and Progress Report No. 2, Nov. 1956.

(2278) METHODS OF CREATING A COMPLEX SEAWAY FOR MODEL STUDY.

(b) David Taylor Model Basin, Department of the Navy.
(c) Dr. A. R. Chamberlain, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Theoretical; fundamental.
(e) The study is for the purpose of developing a theory that will permit estimates to be made of the wave spectrum for various combinations of operation of the pneumatic wave generators of one of the proposed David Taylor Model wave basins. This theory is to be extended to multiple generators along the circumference of a circular basin. The theory will be checked against experiments in a 1/10 scale model basin existing at David Taylor Model Basin.
(g) The theory has been essentially completed for the case of the David Taylor Model Basin. Plans are in progress for checking the theory against experimental data.

(2279) LABORATORY AND FIELD STUDY OF THE VORTEX TUBE SAND TRAP.

See U. S. Department of Agriculture, Agricultural Research Service, page 119.

(2510) STUDY OF LOW LEVEL TURBULENCE.

(b) Air Force Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Mass.
(c) Mr. J. E. Cermak, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental and theoretical; fundamental.
(e) A wind tunnel having a test section 6- x 6-ft. square and 80 ft. long with various arrangements of heating and cooling surfaces is being designed and constructed. An experimental study using the equipment of project (1566) is being conducted to determine the effect of roughness upon the characteristics of a turbulent boundary layer formed over a rough, plane, heated boundary.
(g) Several elements of the new wind tunnel have been constructed.

(2511) IRRIGATION WATER APPLICATION AND DRAINAGE OF LANDS IN THE UPPER COLORADO RIVER BASIN.

(b) Colorado Agricultural Experiment Station as contributing project to Regional W-28 project.
(c) Mr. Norman A. Evans, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied.
(e) Methods of diagnosis of drainage problems in western irrigated valleys are being studied. Corrective measures are also being studied, both by field experiment and theoretical analysis. Techniques of evaluating present and potential drainage problems have been developed. Reclamation techniques and crop and soil management practices are under study.
(g) Pumping for drainage is possible in western valleys having an artesian aquifer contributing to the problem. This drainage depends upon the existance of openings into the aquifer through which the shallow ground water may enter the aquifer.
Important investigative techniques developed include equipment and procedures for making economical highly intensive stratum surveys. This is of great importance in investigating drainage problems in many western valleys.
(h) "Reclamation of Saline-Alkali Soils in the Upper Colorado River Basin", Colorado A and M College, Agricultural Exp. Sta. Gen. Ser. Paper 619, 1955.
"Soil, Water and Crop Management Research in the Upper Colorado River Basin", Colo. Agr. Exp. Sta. Gen. Ser. Paper 586, 1954.

(2512) MODEL STUDIES FOR BOCONÓ DAM.

(b) Tipton and Kalmbach, Inc., Denver, Colorado.
(d) Experimental.
(e) This is a study of the various aspects of the flow of water through and over the scale model of Boconó Dam in Venezuela. Boconó Dam will be built as a multi-purpose structure, for irrigation, power and flood control.

(2513) FLOW MEASURING DEVICES FOR EPHEMERAL STREAMS.

(b) Rocky Mountain Forest and Range Experiment Station.
(c) Dr. A. R. Chamberlain, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied.
(e) The purpose of the initial phases is to test a 1/6 scale model of a modified WSC flume, to determine its suitability and calibration curve for applications at flow measuring stations along steep (5%) channels of ephemeral streams.
(g) Experiments completed on above described phase. Device is showing some promise of being acceptable for use. Calibration curve varies with roughness of approach channel. Tests have led to ideas for devices that (1) will not require stilling wells, and (2) will decrease structure failures due to scour hole downstream of the structure.

(2514) FUNDAMENTAL INVESTIGATION OF ALLUVIAL CHANNEL ROUGHNESS.

(b) U. S. Geological Survey.
(c) Mr. E. V. Richardson, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; fundamental.
(e) Determination of bed roughness in an alluvial channel. In a 150- by 8-ft. tilting flume water will be recirculated over a sand bed until equilibrium conditions and the following measurements have been made: (a) Water discharge, temperature, depth, and surface slope, (b) dune configuration and movement, (c) total sediment load, (d) sediment size distribution in the bed, on the bed, and of the total load, and (e) velocity profiles in the vertical and cross-section.

(2515) EXPERIMENTAL STUDIES ON THE BEGINNING OF SAND RIPPLE FORMATION.

(b) Laboratory project.
(c) Dr. H. K. Liu, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Fundamental study.
(e) The beginning of ripples is studied in a 10-ft. laboratory flume of 8 in. width. Principal objectives: (a) To define the flow conditions under which ripples start forming, (b) to obtain data of fundamental nature for the purpose of checking existing theories on the beginning of sand ripples or to base future theoretical investigations on them, and (c) to compare the behavior of rigid and movable beds formed from equal grains. To keep the variables involved to a minimum, uniform sand sizes were studied. (0.3 mm and 0.63 mm, standard deviation in both cases about 10%.) Ottawa sand for eliminating shape influences. Sediment not recirculated. Conditions studied under normal depth only, slope varied.
(g) For one sand size the tractive force which exists when ripples form is constant.
As long as there is no rippled bed, a movable bed and a rigid bed of same grain size produce the same normal depth for the same discharge and slope. If the bed is rippled, the normal depth which is established before ripples form is mostly smaller than that for the comparative case of rigid bed.
Ripples are reproducible.
The flow is turbulent when ripples form; artificial disturbance seems not to influence the critical conditions for the beginning of ripple formation.
The critical conditions for the beginning of sediment motion and the beginning of ripple formation are not identical.

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(2510) ANALYTICAL STUDY OF ALLUVIAL CHANNEL ROUGHNESS.

(b) National Science Foundation.
(c) Dr. H. K. Liu, Civil Engineering Department, Colorado A and M College, Fort Collins, Colorado.
(d) Fundamental.
(e) A considerable amount of field and experimental data has been gathered from many different sources. An empirical relationship between dimensionless parameters pertinent to the flow and to the sediment has been established. An attempt will be made to confirm the empirical correlation through theory and contribute towards an understanding of the mechanics of ripple formation, of the interaction between flow and sediment in alluvial channels, and to develop design formulas for alluvial channel flow which are valid for a wide range of field conditions, and which show how sediment properties influence the roughness coefficients of the conventional discharge formulas.

(2517) EFFECT OF WASH LOAD ON CONCENTRATION OF BED MATERIAL IN SUSPENSION.

(b) Laboratory project.
(d) Experimental; fundamental.
(e) Using a tank with lattice-type agitator to create uniform turbulence, the fine sand in the bed of the tank was carried into suspension and measurements made of concentration. A kaolin-type clay was introduced in varying concentrations and the concentration distribution of the suspended bed sand again measured. The temperature was also varied.
(g) Concentrations of 0.5, 1.0 and 2.0 per cent of clay were found to increase the average concentration of bed material in suspension by 5.0, 18.0, and 36.0 per cent respectively. Although this marked increase in concentration could be attributed in part to the increased viscosity due to the clay, it did not account for all the increase.
(h) Report in preparation.

COLORADO SCHOOL OF MINES, Civil Engineering Department.

Inquiries concerning Projects Nos. 2280 to 2282, incl., should be addressed to Prof. Henry A. Babcock, Civil Engineering Department, Colorado School of Mines, Golden, Colo.

(2280) DEEP NOTCH WEIRS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The purpose of the work is to determine the relationship between the discharge coefficient, and the ratio of crest length to head for sharp crested weirs with end contractions.

(2281) THE EFFECT OF GRAIN SIZE DISTRIBUTION AND VOID RATIO ON PERMEABILITY.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Samples of definite size distribution will be fluidized, and variation of pressure gradient and sorting action will be observed.

(2282) PULP DENSIMETER.

(b) Laboratory project.
(d) Design and development.
(e) The device will measure continuously the density of liquid-solid mixtures in a pipe without being influenced by fluctuations in the velocity of flow.

UNIVERSITY OF COLORADO, Hydraulics Laboratory. Department of Civil Engineering.

Inquiries concerning Projects Nos. 2283 and 2518 should be addressed to Prof. Warren DeLapp, University of Colorado, Boulder, Colorado.

(2283) GRAPHICAL SOLUTIONS FOR HYDRAULIC TRANSIENTS.

(b) Laboratory project.
(d) Theoretical; for design and master's thesis.
(e) Graphical solutions are presented for various types of problems involving unsteady flow in closed conduits.
(f) Completed.
(h) "Graphical Solution of Hydraulic Shock Problems", M. Mozayeny, M.S. Thesis, 1956, (available on inter-library loan).

(2518) SHIP-WALL IMPACT.

(b) Laboratory project.
(d) Theoretical; for design and master's thesis.
(e) The forces produced by a ship striking a wall are determined analytically by making certain assumptions.
(f) Completed.
(h) "Ship-wall Impact", Donald M. McManus, M. S. Thesis, 1956, (available on inter-library loan).

COLUMBIA UNIVERSITY, Department of Civil Engineering and Engineering Mechanics.

(1324) LOSSES IN TWO-DIMENSIONAL JUNCTIONS.

(b) Laboratory project.
(c) Prof. R. Skalak, Dept. Civil Engineering, Columbia University, New York 27, New York.
(d) Theoretical and experimental; doctoral thesis.
(e) A study of flow patterns at junctions in rectangular conduits which can be considered two-dimensional with particular attention to the influence of initial velocity distribution on the characteristics of the side jet.
(f) Completed.
(g) When the initial velocity distribution is essentially uniform, the characteristics of the side jet measured in the laboratory agree very closely with theoretical results based on ideal fluid theory. When the initial velocity distribution is not uniform, the experiments show a systematic, although not very large, divergence from the uniform velocity case.
(h) "Divided Flow Through a Divergent Inlet Conduit", S. Tsakonas, Doctoral Thesis, Columbia University, 1956.

(2519) DISPERSION OF DISSOLVED MATERIALS BY FLOW THROUGH GRANULAR MEDIA.

(b) U. S. Geological Survey.
(c) Mr. E. Simpson, Dept. of Geology, Columbia University, New York 27, New York.
(d) Experimental and theoretical; doctoral thesis.
(e) Experiments are being conducted to determine the extent of dispersion of dissolved tracer material perpendicular to the direction of flow in a granular media.

(2520) TRANSITIONS FOR SUPERCRITICAL FLOW IN TRAPEZOIDAL CHANNELS.

(b) Laboratory project.
(c) Prof. R. Skalak, Dept. of Civil Engr., Columbia University, New York 27, New York.
(d) Experimental and theoretical; master's thesis.
(e) Small scale experiments are used to explore the merit of various transition designs where the initial flow is supercritical in an open trapezoidal channel.

UNIVERSITY OF CONNECTICUT, Soil Mechanics Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1574, 1575, and 1577, should be addressed to Prof. Edward V. Gant, Box U-37, University of Connecticut, Storrs, Conn.

(1574) VARIATION IN AMOUNT OF FROST HEAVE WITH DEPTH OF GROUND WATER TABLE.

(b) Laboratory project; State Highway Department.
(d) Experimental; applied research.
(e) Investigation is under way on a series of 12 test cells, 6 containing silt and 6 glacial till at depths from 2-1/2 to 6 ft. Observations taken on heave, depth-temperature variation, and water consumed from water table.

(1575) EFFECT OF WASHED CONCRETE SAND IN INCREASING CAPILLARY RISE AND FROST HEAVING IN ADJACENT SOIL.

(b) Laboratory project; State Highway Department.
(d) Theoretical and experimental; applied research.
(e) Investigations are being made of the effect of washed concrete sand in raising the ground water table in adjacent silt or glacial till.

(1577) FILTER TESTS OF VARIOUS MATERIALS.

(b) Laboratory project; State Highway Department.
(d) Experimental; applied research.
(e) Factors affecting the stability of filters are being studied.

CORNELL UNIVERSITY, Agricultural Engineering Department.

(2284) METHODS TO IMPROVE DESIGN AND UTILIZATION OF SPRINKLER IRRIGATION SYSTEMS.

(b) Laboratory project; Cornell Agricultural Experiment Station and Agricultural Research Service, USDA.
(c) Dr. H. E. Gray and Dr. Gilbert Levine, Department of Agricultural Engineering, Cornell University, Ithaca, New York.
(d) Experimental and design.
(e) Determination of most effective amount and time for irrigation of New York State crops and determination of hydraulics of irrigation systems including losses in pipe, couplers and other fittings.

(2521) AN INVESTIGATION OF LAND DRAINAGE PROBLEMS UNDER NEW YORK STATE CONDITIONS, WITH SPECIAL EMPHASIS ON DESIGN PRINCIPLES AND PRACTICES.

(b) Cornell Agricultural Experiment Station and Agricultural Research Service, USDA.
(c) Dr. Gilbert Levine, Department of Agricultural Engineering, Cornell University, Ithaca, New York.
(d) Experimental field and laboratory investigation; applied research.
(e) To determine specific drainage design criteria as applicable to New York State agricultural land. Investigations include maximum permissible velocities in bare and protected open channels; management effects on operation of tile drainage system; and techniques to preserve effectiveness of mole drains.

CORNELL UNIVERSITY, School of Civil Engineering.

Inquiries concerning Projects Nos. 2074, 2285, 2286, 2292, 2522, and 2524, should be addressed to Dr. Andre Jorissen, and No. 2523 to Prof. Marvin Bogema, School of Civil Engineering, Department of Hydraulics and Hydraulic Engineering, Cornell University, Ithaca, New York.

(2074) EFFECT OF INSTALLATION ON PERFORMANCE OF INFERENTIAL FLOW METERS.

(b) Builders-Providence Inc., laboratory project.
(d) Experimental.
(e) Study of effect of two short-radius elbows in orthogonal planes on coefficient of discharge of Venturi tubes and Dall flow tubes. Effect of straightening vanes.
(f) Completed.
(h) "A New Development in Flow Measurement: the Dall Flow Tube", Andre L. Jorissen, Proc. A.S.C.E., Journal of the Hydraulics Division, No. HY4, Aug. 1956.

(2285) QUADRANT EDGE ORIFICE STUDIES.

(b) A.S.M.E. Research Committee on Fluid Meters; laboratory project.
(d) Experimental.
(e) Study of the quadrant edge orifice for discharge measurements at low Reynolds numbers. Tests of reproducibility. Effect of size. Effect of diameter ratio. Influence of pipe roughness.
(h) "Discharge Measurements at Low Reynolds Numbers--Special Devices", Andre L. Jorissen, Trans. A.S.M.E., February 1956.
"Studies on the quadrant-edge orifice", Peter L. Monkmeyer, Master of Science Thesis, Cornell University, September 1956.

(2286) EFFECTS OF ROUGHNESS ON VENTURI TUBE COEFFICIENTS.

(b) Builders-Providence Inc., laboratory project.
(d) Experimental.
(e) Study of the effects of roughness in the approach pipe and in the converging cone on the coefficient of discharge of Venturi tubes of various characteristics.

(2292) TESTS OF CHECK VALVES.

(b) Ross Valve Manufacturing Company.
(d) Experimental.
(e) Pressure loss tests of 4-inch and 6-inch check valves, with and without throttling.
(f) Completed.

(2522) MODEL STUDIES OF CONDENSER WATER INTAKE.

(b) American Gas and Electric Service Corporation, New York, N. Y.
(d) Experimental.
(e) Model study of debris movement in vicinity of condenser water intake of the Kanawha River Plant near Charleston, West Virginia, and of the Muskingum River Plant near Beverly, Ohio.
(f) One study completed and one in progress.

(2523) 18 INCH FLOW NOZZLES CALIBRATION.

(b) Builders-Providence Inc.
(d) Experimental.
(e) Volumetric calibration of four 18-inch flow nozzles.
(f) Completed.

(2524) CALIBRATION OF 2- AND 30-INCH FLOW NOZZLES.

(b) Public Service Electric and Gas Company.
(d) Experimental.
(e) Volumetric calibration of two 2-inch and four 30-inch flow nozzles.
(f) Completed.

UNIVERSITY OF FLORIDA, The Engineering and Industrial Experiment Station, Coastal Engineering Laboratory.

Inquiries concerning Projects Nos. 2296, 2297, 2298, 2300, 2525 to 2528, incl., should be addressed to Dr. Per Brunn, Coastal Engineering Laboratory, University of Florida, Gainesville, Florida.

(2296) INVESTIGATION OF EXISTING DATA OF TIDAL ENTRANCES.

(b) Beach Erosion Board, Washington, D. C.
(d) Field investigation; basic research.
(e) To analyze existing data on tidal inlets, including estuaries, in order to relate tidal characteristics, tidal prism, inlet area, littoral drift, and pertinent factors to the controlling depth and shoaling tendencies of tidal inlets.

(2297) FIELD STUDY OF BEACHES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Beach profiles and configurations of shore line on protected and unprotected coasts in Florida are being investigated. The purpose is to obtain data from the Florida shore line. From these data basic information will be derived and they will be used as a basis for practical coastal protection design.

(2298) MODEL STUDY OF DESTRUCTION OF WAVE ENERGY BY VERTICAL WALLS.

(b) National Science Foundation.
(d) Experimental and theoretical; basic research.
(e) The destruction of wave energy by vertical walls will be studied in a wave tank. Different kinds of vertical walls will be investigated.

(2299) MODEL STUDY ON THE BEHAVIOR OF LAKE WORTH.

(b) Port of Palm Beach (Gee and Jensen, Consulting Engineers, West Palm Beach, Florida).
(c) Mr. F. Gerritsen, Coastal Engineering Laboratory, University of Florida, Gainesville, Florida.
(d) Experimental; applied research.
(e) Engineering information will be obtained on the behavior of Lake Worth, if Lake Worth Inlet will be deepened to accommodate seagoing vessels of greater draft. A hydraulic model of the Lake Worth area has been built to investigate this problem. The model has a solid bottom, and scales of 800 and 40 for the horizontal and vertical dimensions respectively. In the model the behavior of the water table in Lake Worth is investigated when the inlet is deepened to different extents. The tide level in the ocean is used as a boundary condition. The investigation was carried out at normal tide and at storm and hurricane conditions.
(g) Model is in operation and measuring equipment developed.

(2300) BEACH EROSION AT FERNANDINA BEACH.

(b) City of Fernandina Beach. Cooperative study with Beach Erosion Board, Washington, D. C.
(d) Field investigation; applied research.
(f) Suspended.

(2525) SEAWALL MODEL STUDY.

(b) Laboratory project.
(d) Experimental and theoretical; basic and applied research.
(e) The absorption of wave energy at different kinds of sea walls will be investigated. Special reference to coastal protection and harbor problems.

(2526) COASTAL ENGINEERING INVESTIGATION AT LONGBOAT PASS.

(b) Florida State Road Department.
(c) Florida State Road Department, Tallahassee, Florida.
(d) Field investigation; applied research and design.
(e) The purpose of the investigation is to secure data on the development of Longboat Pass and the adjacent shore lines from which recommendations can be made for proper coastal protection for the bridge connection between Anna Maria and Longboat Key. The research plan involved investigations of changes in the shore line and of beach profiles.
(f) Completed.

(2527) BEACH EROSION INVESTIGATION AT JUPITER ISLAND.

(b) Town of Jupiter Island.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Jupiter Island and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
(f) The field study has been completed and preliminary report has been made.
(g) Continuous artificial nourishment of the beach has been recommended.

(2528) COASTAL ENGINEERING STUDY AT THE FREEPORT CAUSEWAY.

(b) Florida State Road Department.
(c) Florida State Road Department, Tallahassee, Florida.
(d) Field investigation; design.
(e) The purpose of the study is to improve the present design of sea walls used for protection of the causeway; approximately 3 miles of bulkheads of different construction.

GEORGIA INSTITUTE OF TECHNOLOGY, School of Civil Engineering.

Inquiries concerning Projects Nos. 291, 1584, 1852, 1854, 1855, 2302, and 2529, should be addressed to Prof. C. E. Kindsvater, School of Engineering, Georgia Institute of Technology, Atlanta, Georgia.

(291) FLOW OF WATER OVER HIGHWAY EMBANKMENTS.

(b) Laboratory project.
(d) Experimental; research for master's thesis (J. Davidian).
(e) Experimental data are being obtained on the discharge characteristics of an embankment-shaped weir. Emphasis has been placed on free discharge over smooth-surfaced embankments. Limited data have been obtained on the influence of embankment height and roughness and tailwater submergence. Detailed velocity surveys have been made to define the boundary layer between the upstream edge of the upstream shoulder and the crown. Preliminary tests were made on 1:12- and 1:6-scale, two dimensional models of a typical two-lane highway embankment. Present tests are being made on a 1:9-scale model in a 3-foot wide flume.

(g) It has been established that the discharge characteristics of an embankment can be related to the theoretical equation of discharge for a broad-crested weir by means of the discharge-displacement boundary-layer thickness. Data and procedures for computing the thickness of the boundary-layer at the control section are being sought as a means of generalizing the discharge equation for various shapes, sizes and roughnesses of embankments. Experimental work for second thesis completed.
(h) "Discharge Characteristics of an Embankment-Shaped Weir", by Gunnar Sigurdsson (1956); Master's Thesis, available on loan from Price Gilbert Library, Georgia Institute of Technology.

(1331) THE DIFFUSION MECHANISM OF FOREIGN PARTICLE IN A FLUID.

(b) Laboratory project; sponsored by the National Science Foundation.
(c) Mr. M. R. Carstens, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Georgia.
(d) Experimental; basic research for doctoral dissertation.
(e) The diffusion of macroscopic foreign particles is to be studied in a vertical diffusion chamber. The turbulence pattern is to be repetitive in the vertical direction and is to be controlled both in amplitude and frequency. The purpose of the study is to determine the difference in diffusion characteristics of the foreign particles and the fluid.
(f) Experimental equipment is being designed. Literature survey is being conducted.

(1584) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Library search, re-analysis and correlation of published data, plus original research as required.
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Initial phase includes the preparation of bibliography and the collection of experimental data from all known sources. Objectives include the publication, in generalized form, of available experimental data.

(1852) DISCHARGE CHARACTERISTICS OF RECTANGULAR PLATE WEIRS IN RECTANGULAR CHANNELS.

(b) Laboratory project; partly sponsored by the U. S. Geological Survey.
(d) Experimental and analytical; research for two masters theses.
(e) An investigation of the comprehensive discharge characteristics of the basic sharp-edged, rectangular-notch weir. An attempt to evaluate by experimental means the influence of the several variables excluded by restrictions on the standard weir formulas. Tests cover a full range of notch widths, weir heights, and heads. Investigation limited to free flows of water at normal temperatures.
(f) Completed. Technical paper in preparation for publication. Master's Thesis by R. W. Carter, 1956.

(1854) INFLUENCE OF BOUNDARY ROUGHNESS ON ABRUPT ENLARGEMENTS IN ENCLOSED CONDUITS.

(b) Laboratory project.
(d) Experimental; research for two masters theses.
(e) An experimental investigation of the influence of boundary roughness on the total energy loss due to abrupt area-enlargements in circular conduits. Variables include discharge, expansion ratio and roughness.
(h) Experimental work on second thesis (B. J. Kittle) completed.

(1855) TRANQUIL FLOW THROUGH SEVERAL OPENINGS IN AN OPEN-CHANNEL WIDTH CONSTRICTION.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Experimental; basic research.
(e) Objective is to establish principles of flow division at a multi-opening width constriction. A 14-foot wide by 80-foot long flume is being used in the experimental investigation. Channel shape, degree and pattern of boundary roughness and constriction geometries will be varied. Boundary conditions considered will be governed by highway bridge practice.

(2077) UNSTEADY FLOW IN SMOOTH PIPES.

(b) Laboratory project; sponsored by the National Science Foundation.
(c) Mr. M. R. Carstens, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Georgia.
(d) Experimental; basic research for four masters theses.
(e) The mean flow characteristics in a pipe line during the time flow is being established has been studied experimentally. The flow was from a quiescent reservoir, through a rounded inlet, and thence through a straight smooth pipe. Flow was established by instantenously opening a downstream valve. Data were taken in order to determine mean velocity as a function of time and to determine pressure as a function of time at various stations along the pipe. The purpose of the work was to investigate boundary shear in unsteady flow and to investigate the transition from laminar to turbulent flow.
(f) Completed.
(g) Turbulence begins as turbulent spots within the pipe. The downstream face of these spots were transported downstream at the centerline velocity of the laminar flow. The movement of the upstream face of the turbulent spots was slight. The tubulent flow replaced the laminar flow by the movement of the downstream face of a turbulent spot. The position of turbulent spot formation was found to be established by very small roughness projections at the pipe junctions. The flow parameters at the time of turbulent spot formation are in agreement with the Tollmein-Schlichting theory of small disturbances.
Analysis of the turbulent-flow results is indicative that the boundary shear is slightly greater than the steady-state value during deceleration and is slightly less during acceleration.
(h) The following masters theses are available on loan from the Price Gilbert Library, Georgia Institute of Technology.
Unsteady Flow in a Smooth Pipe After Instantaneous Opening of a Downstream Valve:
Part I. "Mean Flow Characteristics - Velocity", Ben Gray Christopher.
Part II. "Transition from Laminar to Turbulent Flow", James Blaire Trimble.
Part III. "Mean Flow Characteristics - Pressure and Boundary Shear", John Edwin Roller.
Part IV. "Mathematical Analysis", Ryland Wrenn Olive, Jr.
Publication is pending of the results pertaining to transition (a limited number of copies are available from the correspondent). A publication is being prepared concerning shear in unsteady flow.

(2302) FLOW ANALYSIS OF WATER DISTRIBUTION SYSTEMS CONTAINING RESERVOIRS.

(b) Laboratory project.
(d) Analytical; for masters thesis.
(e) The methods and principles of introducing reservoirs into a water distribution system were surveyed. Numerical analyses of several simple systems are presented.
(f) Completed.
(h) "Flow Analysis of Distribution Systems Containing Elevated Reservoirs", A. T. Adams, Proceedings of the 27th Annual Convention, Southeastern Section, American Water Works Association, Journal No. 1, Volume 20, 1956, pp. 40 - 53.

(2529) UNIFORM FLOW IN OPEN CHANNELS.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Re-analysis and correlation of existing data; original experimental research and analysis.
(e) A fundamental investigation of the mechanics of uniform flow in open channels, with emphasis on the influence of channel shape and non-uniform roughness patterns. Experimental work will be conducted in a 90-ft. long flume 18 inches deep and 3.5 feet wide.
(g) Flume under construction. Literature search under way.

HARVARD UNIVERSITY, Department of Mathematics.

(1335) MATHEMATICAL THEORY OF SHIP WAVE RESISTANCE.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. Garrett Birkhoff, Department of Mathematics, Harvard University, 2 Divinity Avenue, Cambridge 38, Massachusetts.
(d) Basic theoretical investigation.
(e) The purpose of present work is to perfect our methods of calculating Michell's Integral numerically. The methods are based on previous theoretical work (see 1954 edition Hydraulic Research Bulletin).
(g) "Methods for Evaluating Michell's Function", by R. Parikh. Deals with the problem of tabulating Michell's function.

(2530) THEORY OF EDGE WAVES.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. G. F. Carrier, Harvard University, Pierce 307, Cambridge 38, Massachusetts.
(d) Theoretical.
(e) Prediction of velocity of edge waves generated by moving pressure spots.
(g) Available data on coastal surges caused by hurricanes have been successfully correlated with theory.

UNIVERSITY OF IDAHO, Engineering Experiment Station.

Inquiries concerning Projects Nos. 1859, 2080, and 2305 should be addressed to Prof. C.C. Warnick, College of Engineering, and Projects Nos. 1860, 1861, 1862, 2081, and 2304, to Prof. J. W. Martin, Agricultural Engineering Dept., University of Idaho, Moscow, Idaho.

(1859) A STUDY OF EFFECTIVENESS OF CANAL LININGS AND SOIL SEDIMENTS IN CONTROLLING SEEPAGE LOSSES.

(b) Laboratory project; cooperative with U. S. Bureau of Reclamation.
(d) Field investigation; basic and operational research.
(e) Different types of canal linings are being studied and various ways of evaluating performance are being considered especially ideas for measuring canal seepage from both lined and unlined canals.
(g) Four years of field testing have been completed and much data collected on seepage loss characteristics and conditions of experimental linings. A new cooperative agreement was undertaken for period 1956-59.
(h) "Experimental Studies with Canal Linings and Soil Sediments for Controlling Seepage Losses", C. C. Warnick, Progress Report No. 3, Engineering Experiment Station, University of Idaho, Moscow, Idaho, May 1956.
"Experimental Studies with Canal Linings for Controlling Seepage Losses", C. C. Warnick, Proceedings, First Western Conference on Asphalt in Hydraulics. Bulletin of the University of Utah, Vol. 47, No. 14, June 1956.

(1860) APPLICATION OF ELECTRICAL RESISTANCE METHODS OF MEASURING SOIL MOISTURE IN IDAHO SOILS.

(b) Laboratory project; under investigation in the Agricultural Experiment Station.
(d) Experimental.
(e) Laboratory and field investigation of commercial types of soil moisture resistance blocks.
(g) Three seasons of field testing of replicated installations are complete. Methods of improving installations and accuracy of results are being devised.
(h) Annual progress report (unpublished).

(1861) THE IMPROVEMENT AND DEVELOPMENT OF STREAMFLOW MEASURING DEVICES.

(b) Laboratory project; cooperative with Agricultural Research Service, being carried on under the Agricultural Experiment Station.
(d) Experimental; applied.
(e) Study is being made, in laboratory and in field streams with full-size models, of the hydraulic characteristics of crest gages under controlled conditions. A direct reading current meter of new design is being developed for convenient field use.
(g) Several crest gages have been evaluated and an improved design developed. This has been studied in a fluid polariscope to establish flow characteristics. The new current meter has been calibrated and used experimentally.

(1862) DETERMINATION OF ANNUAL RUNOFF FROM WATERSHED CHARACTERISTICS.

(b) Laboratory project; being carried on under Agricultural Experiment Station.
(d) Experimental; applied research.
(e) A statistical study has been started on a correlation between various watershed characteristics and annual runoff on gaged watersheds for eventual application to ungaged areas.
(g) Work just in progress.

(2080) A STUDY OF RIME ICE AND SNOW CAPPING ON HIGH ALTITUDE PRECIPITATION GAGES.

(b) Laboratory project; in cooperation with U. S. Weather Bureau, Bureau of Reclamation, Corps of Engineers, Soil Conservation Service and City of Moscow.
(d) Field investigation; basic and applied operational research.
(e) Several experimental gages have been installed to obtain basic data on snow capping. An electrical means of heating the orifice of the gage is being studied.
(g) Field gages have been in operation for two years and new special heated-orifice gages have been placed in operation. Several pieces of weather measuring equipment have been incorporated into the project the past year.
(h) "A Study of Rime Ice and Snow Capping on High-Altitude Precipitation Gages", C. C. Warnick, Progress Report on Special Research Project 17 A, Engineering Experiment Station, University of Idaho, Moscow, Idaho, July 1956. (Limited publication).

(2081) THE DESIGN AND EVALUATION OF SPRINKLER IRRIGATION SYSTEMS.

(b) Cooperative with Soil and Water Conservation Research Branch, under the Agricultural Experiment Station.
(d) Field investigation; applied research.
(e) To evaluate the engineering design of existing sprinklers, obtain field data related to design and operation of systems and to establish sprinkler design criteria for Idaho conditions.
(g) Several evaluations have been completed and data are being assembled on IBM cards for statistical analysis.
(h) Annual progress report (unpublished).

(2304) MECHANICS OF WATER CONTROL ON STEEP IRRIGATED LAND.

(b) Laboratory project; under investigation in Agricultural Experiment Station.
(d) Field investigation; applied research for master's thesis.
(e) To test the characteristics and effectiveness of water control structures and devices used on farms. To evaluate the resistance to erosion of irrigated soils. To develop improved devices and techniques for control of erosion and to increase efficiency in application of water.
(g) Several water control devices were tested both in the laboratory and in the field. Several techniques for measuring erosion were developed.
(h) "Characteristics and Effectiveness of a Number of Water Control Devices for Irrigation", Rhys Tovey, M. S. Thesis, May 1956.

(2305) SEEPAGE LOSS STUDY OF SOUTHERN IDAHO CANAL SYSTEMS.

(b) Laboratory and field project; in cooperation with Soil Conservation Service and canal companies.
(d) Field investigation; basic and operational research.
(e) An investigation of seepage loss from several types of canals to provide check measurements for studies being made by the field offices of Soil Conservation Service. Particular attention is being given seepage problems where canals operate through basalt, through lime hardpan and where ground-water levels may influence seepage rates. Correlation with permeability data were made.
(f) Completed.
(g) Seepage rates were found in test section and later extended for use on economic studies. Several new devices for evaluating seepage were utilized. Air permeability measurements were encouraging in the places where an air permeameter could be used.
(h) "Investigation of Seepage Losses from Salmon Falls Canal System", C. C. Warnick and A. A. Johnson, Preliminary Report on Special Research Project No. 47, November 1955.

ILLINOIS INSTITUTE OF TECHNOLOGY, Armour Research Foundation.

(2531) FREE SURFACE, VARIABLE DEPTH HYDRODYNAMIC TANK.

(b) Laboratory project.
(c) Dr. V. J. Cushing, Manager, Propulsion and Fluid Mechanics Research Department, Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Illinois.
(d) Design.
(e) Tank 19 feet long and 5-1/2 feet wide can be used with stationary or circulating water for basic or applied research problems. Models may be stationary, floating (at surface or submerged), or towed. Water depth may be varied from 1/2 inch to approximately 15 inches. Preliminary studies of two and three dimensional flow (internal, external flow, and design problems) can be approached by flow visualization techniques; stability and force investigations can be made; and the method of hydraulic analogy may be applied. Control of eddy flow in liquids and gases may be achieved.
(g) Construction is complete to the extent that the basic apparatus may be tailored further to meet the requirements of individual projects. Power supply and circuit system is also complete.
(h) "ARF-Hydrodynamic Tank", by K. Frey, Internal Final Report, July 1956.

(2532) FLOWMETER EVALUATION.

(b) Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio.
(c) Mr. Fred W. Rohr, Associate Engineer, Armour Research Foundation, Illinois Institute of Technology, Chicago 16, Illinois.
(d) Experimental investigation; applied research.
(e) A flow stand to investigate the performance of turbine-type flowmeters was developed to determine the rate of flow by weight to within 1/10 of 1 per cent of full scale. Tests were run with water to determine effects of piping configuration and flowmeter life. Temperature effect was determined between -5 and 450°F and viscosity effect was evaluated between 0.85 and 115 centistokes.
(f) Completed.

ILLINOIS STATE WATER SURVEY DIVISION, Champaign.

(551) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project, cooperative with U. S. Geological Survey.
(c) Mr. W. J. Roberts, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research, design.
(e) Measurements of watershed rainfall and streamflow, of stage-discharge over the spillway, and municipal pumpage reduced in scope to two central Illinois water supply reservoirs. Collection of similar data at three southern Illinois reservoirs is complete and that part of project is terminated.
(g) Data to 1946 published as State Water Survey Bull. 38. Annual summaries 1946 to 1955 for all five reservoirs and summaries for the two central Illinois reservoirs for the 1955-56 water year available for distribution.

(552) SEDIMENTATION OF ILLINOIS RESERVOIRS.

(b) Laboratory project, cooperative with Agricultural Research Service, Soil Conservation Service, Illinois Agricultural Experiment Station.
(c) Mr. J. B. Stall, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) For design of water supply reservoirs, measurements of sediment accumulation have been made on 18 lakes in Illinois. Sediment samples are being analyzed and complete surveys of watershed soil type, slopes, land use and conservation practices are being made.
(g) Results of Lake Decatur, Decatur, Illinois showed correlation between rate of sedimentation and land use on watershed.
(h) Reports of Investigation Nos. 4, 7, 8, 9, 10, 12, 15, 16, and 18; sedimentation surveys of Spring Lake, Ridge Lake, Lake Chautauqua, Carbondale Reservoir, Lake Bracken, West Frankfort Reservoir, Lake Calhoun, Lake Springfield, and Lake Carthage, respectively.

(553) RADAR-RAINFALL PROJECT.

(b) Laboratory project, cooperative with Signal Corps, Department of the Army.
(c) Mr. G. E. Stout, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; basic research.
(e) Radar is being used to track rain clouds, showing extent, movement, and intensity of each rain area. Two concentrated recording rain gage networks, consisting of 10 and 50 rain gages each, yield rainfall data which are correlated with photographic records of radar PPI scopes.
(g) Results indicate that radar is capable of matching an equivalent rain gage spacing of at least one gage each 150 square miles.
(h) Reports of Investigation 13, 19, 21, 27, 29; Circular 49, Illinois State Water Survey, Progress reports to Signal Corps.

(555) EVAPORATION IN ILLINOIS.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Measurements are being made of evaporation at three stations in northern, central, and southern Illinois. Vapor pressure gradients are obtained at Urbana. Evaporimeters constructed and installed adjacent to pans for year-round records.
(h) Measurements published in Climatological Data, Illinois Section.

(561) GROUND WATER INVESTIGATION IN THE EAST ST. LOUIS AREA.

(b) Laboratory project.
(c) Mr. R. E. Aten, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.

(e) To evaluate the ground water resources of the American Bottom (E. St. Louis region). Ground water levels are measured continuously. Pumpage, river stage, and rainfall data are collected. Chemical quality of ground water is measured. Areas of infiltration are to be determined, and all data are correlated with consideration of local conditions. Statistical studies have been made of the service lives of municipal wells.

(843) GROUND WATER RESOURCES IN JO DAVIESS, STEPHENSON, AND CARROLL COUNTIES.

(b) Laboratory project.
(c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) To determine ground water resources of the area, water level contours of the sandstone aquifers, transmissibility and storage coefficients of the aquifers, and quantity of water available were obtained.
(g) Data indicate that piezometric surface conforms generally with topography, with a 500-foot drop in about 30 miles with no apparent withdrawal. The sandstone aquifers are overlain with 100 to 300 feet and more of impervious limestone.

(1092) HYDROLOGIC CYCLE EVALUATION.

(b) Laboratory project; cooperative with the U. S. Geological Survey.
(c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Data from rain gage networks (gathered under Project 553) together with information from 5 stream gaging stations and 5 ground water level recorders are being maintained. Data will be used in analyzing storm rainfall-runoff relationships on small watersheds and effect of runoff on water table. Analysis in progress.

(1341) CORROSION STUDY.

(b) Laboratory project.
(c) Dr. T. E. Larson, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Experimental.
(e) A basic study of corrosion occurring at the steel electrodes under flow through a twenty-foot plastic tower.

(1342) STUDY OF CORROSION AND DEPOSITION RATES WITH DIFFERENT FLOW RATES.

(b) Laboratory project.
(c) Dr. T. E. Larson, Illinois State Water Survey, Box 232, Urbana, Illinois.
(e) One-half inch pipes made of different material are in service. Changes in the flow due to corrosion and at constant head are being measured.
(f) Abandoned; lack of personnel.

(1865) HYDRAULIC DESIGN OF DROP INLET SPILLWAY STRUCTURES FOR SMALL RESERVOIRS.

(b) Laboratory project.
(c) Prof. J. M. Robertson, 125 Talbot Lab., University of Illinois, Urbana, Illinois.
(d) Experimental; applied research.
(e) A complete study of the hydraulics of such structures, to provide necessary information on flow relations and discharge coefficients so that these structures may be economically designed. Initial phases of study concerned with hydraulics of square risers with free discharge. Effect of lip or crest shape and anti-vortex devices being studied. Second phase of study is to involve interrelationship between discharge barrel and riser.
(g) The hydraulics of the various types of flow possible in square risers are well defined as well as some of the effects of non-square crest shape.
(h) "Flow Regimes of a Drop-Inlet Spillway," G. H. Nelson, Agricultural Engineering, 37(3):177, 1956.

(2310) GROUND WATER MOVEMENT DURING INFILTRATION.

(b) Laboratory project.
(c) Mr. R. E. Aten, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Analysis of data obtained from piezometer wells concerning movement of ground water during infiltration with possible extension to watershed areal study.

(2311) A METHOD OF DETERMINING PERMEABILITY AND WELL YIELD FROM THE EFFECTIVE GRAIN SIZE.

(b) Laboratory project.
(c) Mr. H. G. Rose, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field data; applied research.
(e) Study to determine relationship between the effective grain size and the permeability and between the coefficient of transmissibility and the specific capacity.
(f) Completed (not published to date).
(g) Curves established to illustrate relationships.

(2312) STUDY OF GROUND WATER LEVELS IN TAYLORVILLE, ILLINOIS AREA.

(b) Laboratory project.
(c) Mr. H. G. Rose, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Correlated field data.
(e) Study of pumpage, rainfall in Taylorville area to determine cause or causes for water-level recession. Analysis in progress.

(2313) GROUND WATER INVESTIGATION AT CRYSTAL LAKE, ILLINOIS.

(b) Laboratory project.
(c) Mr. R. T. Sasman, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) To study the correlation of lake levels and ground water levels in the vicinity of Crystal Lake. Ground water levels are measured continuously. Lake stage and precipitation data are collected.

(2532) EVAPORATION RETARDATION.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research, design.
(e) Experiments with monomolecular chemical films to retard evaporation from a 100,000 gallon capacity concrete basin. Laboratory studies continuing on smaller containers.
(g) Analysis in progress.

(2533) MOISTURE INFLOW PROJECT.

(b) Laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Theoretical; applied research.
(e) Computation of moisture inflow over the State of Illinois and subsequent correlation with precipitation. Moisture and wind data are obtained from RAOB data.

(2534) DENSE RAINGAGE NETWORK PROJECTS.

(b) Field and laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.

(e) Data from four raingage networks, consisting of 50 gages in 400 square miles, 10 gages in 100 square miles, 40 gages in 400 square miles, and 10 gages in 8 square miles, are used in the following studies: (1) Rainfall variability; (2) frequency of point and areal mean rainfall rates; (3) area-depth relations; (4) variation of point rainfall with distance; (5) areal representativeness of point rainfall; and (6) reliability of areal mean rainfall estimates.
(h) "Precipitation Relations on Small Areas in Illinois", F. A. Huff and J. C. Neill (State Water Survey Bulletin in preparation).

ILLINOIS STATE WATER SURVEY DIVISION, Peoria.

Inquiries concerning Projects Nos. 556 to 560, incl., 845, 1335, 1866, 2314, 2315, and 2535 should be addressed to Dr. Max Suter, Engineering Research Subdivision, Illinois State Water Survey Division, Box 717, Peoria, Illinois.

(556) PERMEABILITY OF GRADED SAND MIXTURES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The permeabilities of known mixtures of graded sand are measured to determine functional changes.
(f) Reactivated.
(g) Sand mixtures containing 60 to 70 percent of fine material in 40 to 30 percent of coarser from 2 adjoining sieves of the $\sqrt{2}$ series have less permeability than the material of the fine screen alone. Evidence accumulates that the permeability is not much influenced by the amount of voids but greatly by the size of the smallest opening between sand grains.

(557) TURBULENT FLOW THROUGH GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Critical flow is determined to define conditions under which turbulent flow occurs outside of well screens.
(f) Reactivated.
(g) In flow through granular media, the Reynolds number cannot be calculated from ordinary formulas. By assuming a critical Reynolds number as existing at the determined critical flow conditions, the corresponding pore size can be calculated. This has been done in preliminary tests, but further work is needed to get a correlation with screen analysis.

(558) STUDY OF CAUSES AND PREVENTION OF SAND BOILS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) Sand boils occurring during floods in levied districts are mapped classified, and sampled. Also sampled are river and nearby well waters.
(g) From chemical analyses and temperature measurements, it was found that the water flowing in typical sand boils (those free from pipe connections towards the river) is different from the river water and similar to well water in neighboring wells. Such sand boils can be stopped from flowing by damming them up to a level that is below that of the river stage. They are not caused by leaks through the levee.

(559) ARTIFICIAL RECHARGE OF GROUND WATER.

(b) Laboratory project.
(d) Experimental laboratory and field investigation; basic research.
(e) Experimental pilot plant consists of river intake, control tower with chlorination and measuring devices, gravel pit with bottom 10 feet below river pool stage, sides and bottom covered with pea gravel. A model of 1/8 of pit (centerline to diagonal) is available to study different types of pits and variations in ground water gradients.

(g) Pit in operation for sixth winter. Seven months of uninterrupted operation gave silting in only the top 2 inches of the 6-inch layer of pea gravel. The pea gravel gave satisfactory filtration and nearly tripled the inflow compared with using sand to give a rate of inflow of from 20 to 25 million gallons per day per acre.
(h) Mimeographed reports for each of the first five seasons have been issued.

(560) GROUND WATER INVESTIGATION IN THE PEORIA, ILLINOIS DISTRICT.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To determine the ground water resources of the district, inventory of wells was made, including construction and logs of wells. Ground water levels are measured continuously, pumpage data collected, river stages and rainfall recorded, chemical analyses for changes in composition of ground water are made, areas of infiltration are determined, and all data are correlated with consideration of local ground conditions.
(g) So far conservation measures have shown more effect than artificial recharge.

(845) EXTENSION OF THEIS' NON-EQUILIBRIUM THEORY FOR VARIABLE FLOW.

(b) Office project.
(d) Theoretical; basic research.
(e) Development of formulas that could be used for conditions of variable flow.
(g) Formulas developed for most important types of variable flow, but the series obtained have not been calculated for wide ranges.

(1335) GROUND WATER INVESTIGATION IN THE CHICAGO AREA.

(b) Laboratory project.
(d) Field study on variations of natural resources. Investigation of artesian well field with wells 1200 to 2200 feet deep, locally heavily pumped. Study of ground water level recession, interferences, transmissibilities, effect of additional demands.
(g) Results determine recession and give good data for future prediction. Collection of data continued.

(1866) GROUND WATER FORMULAS.

(b) Office project.
(d) Theoretical.
(e) Compilation of all published ground water theories and formulas and a comparative evaluation of their range of usefulness.
(h) Report in preparation.

(2314) ELECTRICAL ANALOGUE OF CHICAGO GROUND WATER CONDITIONS.

(b) Laboratory project.
(d) Experimental; applied research.
(e) On a paraffin base is held tap water about 2" deep. The boundary of the depression cone is given by a metal band. Wells or well groups are marked geographically by metal rods. These are charged by electrical voltage in proportion to existing or planned pumpage. A separate probe measures the location of equal potential lines which correspond to equal heights of ground water levels. Variations in permeability are represented by variations in water depth and determined by comparison with the actual ground water levels as found in observation wells.
(f) Apparatus is being adjusted.

(2315) INTERFERENCE BETWEEN RECHARGE PITS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) A recharge pit is being built about 200 feet from the pit mentioned in project (559) and the mutual influence of the two pits is studied by a series of observation wells between the pits.
(g) Pit in operation.

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(2535) FILTERING THROUGH COARSE MATERIAL.

(b) Laboratory project.
(d) Various sizes of rounded gravel and of broken limestone have been put in tile rings into bottom of recharge pit to determine how coarse material can be used as a filter.
(g) Three-eighths inch gravel can be used. On larger material no results have been obtained thus far.

ILLINOIS STATE WATERWAYS DIVISION, Springfield.

(1863) EROSION CONTROL, ILLINOIS SHORE OF LAKE MICHIGAN.

(b) State of Illinois.
(c) Mr. Thomas B. Casey, Chief Engineer, Division of Waterways, 201 W. Monroe Street, Springfield, Illinois.
(d) Field investigation; applied research.
(e) To obtain and correlate basic data on the several forces and factors involved in erosion processes along the Illinois Shore of Lake Michigan to the end that future efforts toward the prevention of erosion might be founded upon a more definite and factual basis with a consequent greater degree of assurance that the works will serve the intended purposes.

UNIVERSITY OF ILLINOIS, Soil and Water Conservation Engineering Laboratory, Department of Agricultural Engineering.

Inquiries concerning Projects Nos. 2316 and 2317 should be addressed to Professor R. C. Hay, 100 Agricultural Engineering, University of Illinois, Urbana, Illinois.

(2316) RUNOFF FROM SMALL AGRICULTURAL AREAS IN ILLINOIS.

(b) Laboratory project co-operative with ARS USDA.
(d) Experimental and field investigation; basic research.
(e) To determine frequencies of peak rates and total amounts of runoff from agricultural watersheds of 25 to 1,000 acres; to determine maximum rates of runoff from agricultural watersheds in different soil association areas in Illinois; to compare runoff from agricultural watersheds under accepted soil conservation practices with watersheds cultivated without soil conservation practices.
Watersheds of 45.5, 63, 82, and 390 acres near Monticello, Illinois are covered with a rain gage network, and runoff is measured at weirs and spillway structures by water level recorders. Maximum stage recorders are installed at field structures on 25 watersheds in Champaign, Piatt, Vermillion, and Ford Counties on watersheds ranging in size from 45 to 1,400 acres. Model studies and field calibrations are made on the field structures.
(g) Data being analyzed.

(2317) A STUDY OF DRAINAGE OF SOME ILLINOIS SOILS.

(b) Laboratory project co-operative with ARS USDA.
(d) Field investigation; applied research.
(e) To determine on different soil types the effect of tile spacing and depth on (1) water table as measured by drawdown wells (2) on crop yields; to verify present tile depth and spacing formulas for soil types investigated; and to compare physical laboratory measurements with field measurements.
The rate of water table drawdown is measured in wells perpendicular to tile lines. Field permeability and laboratory permeability measurements are made as well as physical analysis of the soil type. Crop yields are determined laterally from the tile lines.

UNIVERSITY OF ILLINOIS, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1097, 1589, 2085, 2086, 2087, 2088, and 2318 should be addressed to Prof. J. C. Guillou, Civil Engineering Dept., University of Illinois, Urbana, Illinois.

(564) HYDROLOGY OF URBAN AREAS.

(b) Laboratory project, cooperative with Illinois State Water Survey Division and U. S. Geological Survey.
(c) Prof. J. J. Doland, University of Illinois, Urbana, Illinois.
(d) Experimental, theoretical, and field investigation; applied research and design.
(e) Rainfall-runoff study of an urban watershed, having an effective drainage area of 4.45 square miles and a population density of 14 persons per acre. Runoff is measured by a U. S. G. S. stream gage and precipitation by a network of fourteen raingages strategically located in and out of the watershed. New type of evaporimeter has been developed and check studies are being made.
(h) Civil Engineering Studies No. 2 has been published.

(1097) CORRECTION OF SCOUR BELOW TWO PIER HIGHWAY BRIDGE.

(b) Laboratory project, in cooperation with Illinois Division of Highways.
(d) Experimental; applied research.
(e) A 1:50 scale model of an overflow bridge on flood plain of the Wabash River has been constructed as an aid in determining the cause of excessive scour just downstream from the bridge. Remedial dikes and topography changes have been tested in the model to determine their suitability.
(f) Completed.
(h) Final report has been submitted to sponsor.

(1589) OPEN CHANNEL METER.

(b) Laboratory project in cooperation with Theoretical and Applied Mechanics Department.
(d) Experimental and analytical.
(e) Data has been collected on a critical depth meter which may be built in a sewer leading from a manhole, after the sewer has been in service. Models have been tested in 6 inch pipe and in a 6 inch by 6 inch open channel. Adjustable slope apparatus, utilizing 12 inch pipe and a lucite test section, is under construction.

(1591) DETERMINATION OF WATERWAY AREAS.

(b) Laboratory project, cooperative with Illinois Division of Highways.
(c) Prof. J. J. Doland, University of Illinois, Urbana, Illinois.
(d) Analytical and field investigation; applied research and design.
(e) To determine the amount of water which will reach openings of highway drainage structures, such as bridges and culverts and provide a simple but scientific procedure for use of engineers in establishing the economical and adequate size of opening.
(g) Four preliminary reports and two field reports have been prepared. Analysis of rainfall and runoff data is under way.
(h) Publications not yet available to the public.

(2085) CALIBRATION AND USE OF CERTAIN INLET GRATES.

(b) Illinois Division of Highways.
(d) Laboratory investigation, applied research.
(e) Full scale model tests of four standard Division of Highways inlets. Original and revised inlet grate designs have been tested.
(h) Project report has been submitted to sponsor.

(2086) A STUDY OF FISHWAYS.

(b) Departmental graduate study.
(d) Laboratory investigation; basic research.
(e) Scale model tests of a pool-type fishway to determine efficient orifice design and ladder-pool length.
(h) Preparation of final laboratory report is in progress.

(2087) EFFECTIVENESS OF SUBWAY GRATINGS FOR HIGHWAY DRAINAGE.

(b) Departmental special study.
(d) Laboratory investigation; applied research.
(e) Full scale model tests of two subway grating designs are being tested in standard Illinois Division of Highways, Type II inlet frame.
(f) Suspended temporarily.

(2088) DISCHARGE CHARACTERISTICS OF RECTANGULAR TYPE INLET BOXES.

(b) Departmental study.
(d) Laboratory investigation; basic research.
(e) Scale model investigation of rectangular inlet box with long lucite discharge pipe to verify or disprove the weir-orifice discharge theory.
(f) Suspended temporarily.

(2318) FAUBER BRIDGE MODEL STUDY.

(b) Departmental graduate study.
(d) Laboratory investigation; applied research.
(e) A design has been developed whereby a three tube culvert and an energy dissipator may replace an inadequate highway bridge. Model studies are being conducted to verify the proposed design.

(2319) FREQUENCY STUDY OF HYDROLOGIC DATA.

(b) Independent study.
(c) Dr. V. T. Chow, Civil Engineering Department, University of Illinois, Urbana, Illinois.
(d) Basic research.
(e) A survey of existing literature and applications of the log-probability law and a theoretical interpretation of the logarithmic normal distribution of hydrologic data.
(f) Completed.
(g) Results include derivation of characteristic values of the log-probability law, revision of Hazen's table, verification of the extreme-value law as a special case of log-probability law, and suggestion of a new method for fitting data.
(h) "The Log-Probability Law and its Engineering Applications", by Ven Te Chow has been accepted for publication in Transactions, American Society of Civil Engineers.

UNIVERSITY OF ILLINOIS, Fluid Mechanics and Hydraulics Laboratory, Department of Theoretical and Applied Mechanics.

Inquiries concerning Projects Nos. 1343 and 2083 should be addressed to Mr. W. M. Lansford, 219 Talbot Laboratory, and Projects Nos. 2320, 2321 2536, and 2537, should be addressed to Prof. J. M. Robertson, 125 Talbot Laboratory, University of Illinois, Urbana, Ill.

(1343) VELOCITY DISTRIBUTION STUDY IN A FLOOD-PLAIN CHANNEL.

(b) Laboratory project.
(d) Basic research.
(e) Data has been collected on quantities of flow varying from 1.59 cfs to 11.5 cfs in a flood plain channel. The channel is of wood 160+ feet long; the cross-section of the channel having a sloped flood plain on each side.
(f) Inactive.

(2083) VELOCITY DISTRIBUTION IN AN OPEN CHANNEL HAVING A TRIANGULAR CROSS-SECTION.

(b) Laboratory project.
(d) Basic research.
(e) Data were obtained from a channel artificially roughened.
(g) Data further analyzed and additional tests being planned.
(f) Thesis on file in the University Library.

(2320) TURBULENT BOUNDARY LAYER IN A DIFFUSER.

(b) Laboratory project.
(d) Experimental and analytical; basic research.
(e) Effect of adverse pressure gradient on the development of a turbulent boundary layer is being studied in a 10-degree conical diffuser. Air is the fluid medium being used.
(g) Thesis completed; additional tests anticipated.

(2321) EFFECT OF ROUGHNESS ON VELOCITY PROFILE.

(b) Laboratory project.
(d) Analytical.
(e) This is initially an attempt to verify the indications of the "Universal" velocity profile relations that a unique relation exists between friction factor and pipe factor. A second phase of the study is a reanalysis of rough pipe velocity profiles in terms of the more recent concepts of boundary layer flow. Thus the inner wall region and outer region will be analyzed separately.
(g) Some anomalies in Nikuradse's rough pipe data have been found - thus the pipe factor when the pipe is acting smooth does not agree with that for a smooth pipe. All rough pipe data found to date indicate poor correlation between pipe and friction factors.

(2536) STUDY OF HOMOLOGOUS TURBULENCE.

(b) National Science Foundation.
(d) Basic research.
(e) The nature of turbulence, its production and dissipation, are to be studied in the simplest possible shear flow. This is to be produced in plane conette flow in which the shear is constant and the turbulence homogeneous but not isotropic.
(f) Test apparatus designed, construction being initiated.

(2537) WATER EXIT HYDROBALLISTICS.

(b) Office of Naval Research.
(d) Basic research; experimental.
(e) Information on water exit behavior of ellipsoidal bodies of fineness ratios 4 to 12 is being obtained photographically.
(g) Initial tests underway with buoyancy propelled bodies.

IOWA INSTITUTE OF HYDRAULIC RESEARCH, State University of Iowa.

Inquiries concerning projects should be addressed to the following, all at State University of Iowa, Iowa City, Iowa:
Nos. 66, 1870, 2326, 2327, 2538, and 2539 ..... to Prof. J. W. Howe
Nos. 67 and 68 ..... to Mr. V. R. Bennion
Nos. 73 and 2541 ..... to Dr. Philip G. Hubbard
Nos. 79, 1102, 1875, 2092, 2324, and 2328 ..... to Dr. Hunter Rouse
Nos. 81, 854, 1871, 2091 ..... to Dr. Louis Landweber
Nos. 568, 1101, 1107, 1597, and 2540 ..... to Mr. Emmet M. Laursen

(66) HYDROLOGIC STUDIES, RALSTON CREEK WATERSHED.

(b) Cooperative with Department of Agriculture, Geological Survey, and Iowa Highway Research Board.
(d) Field investigation; applied research, and masters theses.
(e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 3-square-mile area measured by U. S. Geological Survey; rainfall records at five automatic recording stations collected by Soil Conservation Service. Continuous records since 1924 of precipitation, runoff, groundwater levels, and vegetal cover.
(g) Yearly records available for examination at Iowa Institute of Hydraulic Research.
(h) Reports prepared annually since 1924 available in files at the Iowa Institute of Hydraulic Research.

(67) COOPERATIVE SURFACE-WATER INVESTIGATIONS IN IOWA.

(b) Cooperative with Geological Survey.
(d) Field investigation; collection of basic stream-flow data.
(e) Stream-flow and sediment measuring stations maintained throughout the State of Iowa cooperatively on a continuous basis. Records collected by standard methods of U. S. Geological Survey.
(g) Records of stream flow and sediment discharge computed yearly.
(h) Records contained in Water-Supply Papers available through offices of the Geological Survey.

(68) HYDROLOGIC STUDIES, RAPID CREEK WATERSHED.

(b) Cooperative with Department of Agriculture and Geological Survey.
(d) Field investigation; applied research and masters theses.
(e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 25-square-mile area measured and flood runoff on main sub-basins determined by U. S. Geological Survey; rainfall records at four automatic recording stations collected by U. S. Weather Bureau. Continuous records since 1941 of precipitation, runoff, and ground-water levels.
(g) Rainfall records published in Weather Bureau Climatological Bulletins and surface runoff and ground-water levels published in Geological Survey Water-Supply Papers.

(73) MEASUREMENT OF TURBULENCE IN FLOWING WATER.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical.
(e) Instruments, primarily electrical in operation, are being developed to measure the characteristics of turbulent flow under a wide range of laboratory and field conditions. Both sensing and computing elements are involved.
(g) Complete analysis of the sensing element operation and the circuit performance and descriptions of finished instruments are presented in the publications below.
(h) "The Hot-Film Anemometer: A New Device for Fluid Mechanics Research", S. C. Ling and P. G. Hubbard, Journal of the Aeronautical Sciences, Vol. 23, No. 9, pp. 890-891, Sept. 1956.
"Recent Developments in Electronic Instrumentation", P. G. Hubbard, Proceedings of the Sixth Hydraulics Conference, State University of Iowa, Studies in Engineering Bulletin 36, 1956.

(79) CAVITATION.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research and graduate theses.

(e) Basic information is sought on cavitation for systematically varied boundary conditions. Tests are conducted in two variable-pressure water tunnels and a special cavitation tank. Studies of high-velocity submerged jets are being continued. Instrumentation is being developed for measurement of the correlation between the velocity and pressure fluctuations to make possible prediction of the incipient cavitation index for given mean-flow conditions. Previous measurements of the pressure distribution around rounded, ellipsoidal, and conical head forms are being extended in one tunnel to various angles of yaw. Dynamometer studies in other water tunnel are covered in Project (1871).
(h) "An Experimental Study of Cavitation of Submerged Jets", D. W. Appel, Report to the Office of Naval Research, October 1956.

(81) MATHEMATICAL ANALYSIS OF PRESSURE DISTRIBUTION.

(b) Cooperative with Office of Naval Research and David Taylor Model Basin, Department of the Navy.
(d) Theoretical; basic research.
(e) (1) A theory of stream functions for general three-dimensional flow has been developed and accepted by "La Houille Blanche" for publication. (2) The development of a method for the determination of flow about bodies of revolution and symmetrical two-dimensional forms in arbitrary states of motion, based on solutions of integral equations of the first kind, has been completed and a description of the method will be submitted for publication. (3) An analog computer for potential flow, consisting of an array of electrical resistances, has been constructed. A manual describing its application is being prepared.
(h) "Determination of the Motion of a Body from Measurements of Flow Ahead of the Body", L. Landweber, TMB Report 987, April 1956.
"Potential-Flow Analogs and Computers", S. C. Ling, Proceedings of the Sixth Hydraulics Conference, State University of Iowa Studies in Engineering Bulletin 36, 1956.

(568) SCOUR AT BRIDGE PIERS AND ABUTMENTS.

(b) Cooperative with Iowa Highway Research Board and U. S. Bureau of Public Roads.
(d) Experimental; applied research.
(e) To investigate the effects of pier and abutment geometry, sediment properties, and stream-flow characteristics on the rate and pattern of scour, to the end of providing safe design criteria.
(f) Completed.
(g) Final report includes means for predicting the probable local depth of scour at a bridge pier.
(h) "Scour Around Bridge Piers and Abutments", by E. M. Laursen and A. Toch, Iowa Highway Research Board Bulletin No. 4, May 1956.

(854) BOUNDARY-LAYER DEVELOPMENT ON SMOOTH AND ROUGH SURFACES.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research.
(e) Purpose of work is to determine the relations between boundary-layer characteristics for smooth and rough boundaries of arbitrary shape. A critical study of the boundary layer on a smooth flat plate in zero pressure gradient has been completed and a report written, but not yet published. The boundary-layer on a smooth circular cylinder with axis parallel to the stream, in a zero pressure gradient, is now being investigated.

(1101) MOVEMENT OF SEDIMENT IN HIGHWAY DRAINAGE SYSTEMS.

(b) Cooperative with Iowa State Highway Commission and U. S. Bureau of Public Roads.
(d) Experimental; for basic research and graduate theses.
(e) A study of the movement of sediment in pipes, including the pattern of sand transport and the accompanying hydraulic energy losses for quasi-uniform flow in a circular conduit. Both full-pipe and free-surface flows have been studied.
(f) Completed.

(g) Final report includes design recommendations for determining the maximum allowable sediment load in pipes and the efficiency of short sand traps.
(h) "The Hydraulics of a Storm-Drain System for Sediment-Transporting Flow", by E. M. Laursen, Iowa Highway Research Board Bulletin No. 5, June 1956.

(1102) HISTORY OF HYDRAULICS.

(b) Institute project.
(e) To trace the historical development of the important theories of hydraulics, covering the fundamental ideas of the science, the critical periods of its development, and the personalities whose contributions were of major importance.
(h) Has appeared during past two years as French and English supplements to La Houille Blanche. English version is now being reproduced by photo-offset for publication in book form by the Iowa Institute.

(1107) TRANSPORTATION OF SEDIMENT AS SUSPENDED AND TOTAL LOAD.

(b) Laboratory project; formerly cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) To determine the suspended and total load as a function of hydraulic and sediment parameters.
(f) Completed.
(g) An empirical relationship has been found for both suspended and total load as a function of the velocity and depth of flow, the shear velocity, the sediment size, and the fall velocity. A final report has been submitted to the original sponsor, and a paper summarizing the work has been prepared for consideration by the ASCE Hydraulics Division.

(1597) A STUDY OF THE EFFICIENCY OF SAND TRAPS.

(b) U. S. Bureau of Public Roads and Iowa State Highway Commission.
(d) Experimental; for master's thesis.
(e) A study of the effects on the efficiency of sand traps of the geometry of the trap and the ratio of velocity of flow to settling velocity of particles. Trap proportions, sand sizes, and rates of both sediment and water transport have been varied.
(f) Completed.
(g) Efficiency of trap shown to be a function of relative trap dimensions and ratio of conduit velocity to fall velocity of sediment. Final report combined and published with that of Project (1101).

(1870) EFFECT OF SHAPE OF VERTICAL DRAFT TUBES ON THEIR EFFICIENCY.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) Comparative study of conical, Prasil, White, and Moody draft-tube efficiency under identical conditions.
(g) Results of tests on conical and Prasil tubes have been completed.

(1871) CAVITATING FLOW AROUND HYDROFOILS.

(b) David Taylor Model Basin, Department of the Navy.
(d) Experimental and theoretical.
(e) Purpose is to obtain forces and moments on cavitating hydrofoils at various angles of attack. Hydrofoils are tested in a variable-pressure water tunnel on a balance which records electrically the instantaneous forces on the models. One hydrofoil of the NACA 66-series has been tested and the results compared with a linearized theory of cavitating hydrofoils.

(1875) CHARACTERISTICS OF STABLE EDDIES.

(b) Laboratory project, partially supported by Office of Naval Research, Department of the Navy.
(d) Experimental; basic research for master's thesis.
(e) Distributions of velocity, pressure, and turbulence are being measured in an air tunnel throughout the vicinity of separation zones produced by abrupt changes in flow section, to the end of establishing the primary eddy characteristics as functions of the boundary geometry.
(f) Mean eddy patterns behind normal plates have been investigated. Preliminary study has also been made of the flow pattern produced by a normal wind curtain.
(h) "Experiments on Two-Dimensional Flow over a Normal Wall", Mikio Arie and Hunter Rouse, Journal of Fluid Mechanics, Vol. 1, Part 2, 1956.
"Diffusion in the Lee of a Two-Dimensional Jet", Hunter Rouse, Ninth International Congress of Applied Mechanics, Brussels, 1956.

(2091) RESEARCH ON SHIP THEORY.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research.
(e) To determine the laws governing the forces, moments, and motions of ships in smooth and disturbed seas, in order to furnish design data to the naval architect. A towing tank 10 feet wide, 10 feet deep, and 300 feet long is being constructed. Theoretical work on the added-mass coefficients and the forces and moments on bodies is under way. Equipment is being prepared for investigating the rolling of ships.
(h) "A Comparison of the Added Masses of Streamlined Bodies and Prolate Spheroids", L. Landweber and A. Winzer, Forschungshefte für Schiffstechnik Bd. 3, April 1956.
"On a Generalization of Taylor's Virtual Mass Relation for Rankine Bodies", L. Landweber, Quarterly of Applied Mathematics, Apr. 1956.
"Forces, Moments, and Added Masses for Rankine Bodies", L. Landweber and C. S. Yih, Journal of Fluid Mechanics, Sept. 1956.

(2092) STABILITY OF STRATIFIED FLOW.

(b) Cooperative with Office of Ordnance Research, Department of the Army.
(d) Theoretical and experimental; basic research.
(e) The interplay of inertial and gravity effects and the stability and mixing characteristics of stratified flows have been investigated in a series of studies.
(f) Completed.
(h) "An Investigation of Recirculation in Stratified Flows", G. L. Bata, M. S. Thesis, State University of Iowa, 1956.
"Recirculation of Cooling Water Discharged From Thermo-Electric Plants", G. L. Bata, Report to the Office of Ordnance Research, 1956.
"Stability of Laminar Flow in a Curved Channel", C. S. Yih and W. M. Sangster, (publication in Philosophical Magazine pending).
"On Stratified Flows in a Gravitational Field", C. S. Yih, Tellus, Vol. 9, No. 2, 1957.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF HIGHWAY CULVERTS.

(b) Iowa Highway Research Board and Bureau of Public Roads.
(c) Professor D. E. Metzler, Iowa Institute of Hydraulic Research.
(d) Experimental; applied research.
(e) The purpose is to determine the flow characteristics of box culverts.

(2322) EFFECT OF RESERVOIR STORAGE UPON SUPERFLOODS.

(b) Graduate project.
(c) Professor C. J. Posey, Department of Mechanics and Hydraulics, State University of Iowa.
(d) Theoretical; master's thesis.

(e) To find what effect reservoirs of various characteristics will have in decreasing the peak of increasingly greater superfloods.
(g) A quick approximate method has been devised which takes the principal variables into account.

(2323) FORMULATION OF STANDARDS FOR RESERVOIR SAFETY.

(b) Graduate project.
(c) Professor C. J. Posey, Department of Mechanics and Hydraulics, State University of Iowa.
(d) Theoretical, master's thesis.
(e) There are standard unit stresses and loadings for building used by the public, but none for the design of reservoirs that may menace populous communities. The possibility of formulating such standards will be explored.

(2324) ANALYSIS OF FLOW PATTERNS FOR SHARP-CRESTED WEIRS.

(b) Laboratory project.
(d) Analytical and experimental; basic research for doctor's and master's degrees.
(e) Determination of streamline configuration by means of relaxation process and electrical analog computer for various relative heights of weirs, supplemented by experimental study for relatively low weirs and sills.
(f) Experimental study of low weirs and sills completed.

(2326) SYNTHETIC UNIT GRAPHS BASED ON TRIANGULAR CHANNEL INFLOW.

(b) Laboratory project.
(d) Analytical, basic research for master's thesis.
(e) Synthesis of unit graphs based on watershed characteristics; comparison with actual hydrographs.
(f) Completed.
(g) Based upon the characteristics of a "standard catchment", the time base of a triangular hydrograph and the delay time can be computed for a particular area. The triangular hydrograph, routed through linear storage produces a synthetic hydrograph which agrees well with actual hydrographs for the cases investigated.
(h) "Synthetic Unit Graphs Based on Triangular Inflow", James Dooge, M. S. Thesis, State University of Iowa, 1956. (Available on loan.)

(2327) FREQUENCY OF INFILTRATION INTENSITIES ON RAPID CREEK WATERSHED.

(b) Laboratory project.
(d) Field investigation, basic analysis of available storms, for master's thesis.
(e) Rainfall and runoff data on 27-square mile area analyzed to determine infiltration rates. Frequency of various rates determined.
(f) Completed.
(g) The area over which precipitation is assumed to be uniform and the length of time in which it is assumed to be uniform affect the apparent infiltration rate, the first having about twice the influence of the second. The frequency of various infiltration rates are presented in graphical form.
(h) "Frequency of Infiltration Intensities on Rapid Creek Watershed," C. S. Song, M. S. thesis, 1956, State University of Iowa. (Available on loan.)

(2328) INVESTIGATION OF SURFACE ROUGHNESS.

(b) Cooperative with Office of Naval Research, Department of the Navy, and U. S. Geological Survey, Department of the Interior.
(d) Experimental research.
(e) Initial purpose is to determine effect of areal distribution of roughness elements on resistance friction. Tests are being conducted on cubical elements cemented to floor of 30-foot tilting flume in varying concentration.

(2538) EFFECT OF ANTECEDENT MOISTURE AND INTENSITY OF RAINFALL ON INFILTRATION RATES ON RAPID CREEK.

(b) Laboratory project.
(d) Analysis of hydrologic records, applied research for M. S. thesis.
(e) The purpose is to determine the correlation of antecedent moisture index and rainfall intensity with an infiltration index derived by Song (M. S. thesis 1956).

(2539) EFFECT OF ANTECEDENT MOISTURE AND INTENSITY OF RAINFALL ON INFILTRATION RATES ON RALSTON CREEK.

(b) Laboratory project.
(d) Analysis of hydrologic records, applied research for M. S. thesis.
(e) The purpose is to determine the correlation of antecedent-moisture index and rainfall intensity with an infiltration index derived by Johnson.
(h) "Infiltration Frequency on Ralston Creek Watershed", H. P. Johnson and J. W. Howe, A. G. U., Vol. 37, No. 5, p. 593.

(2540) SCOUR AT BRIDGE CROSSINGS.

(b) Cooperative with Iowa Highway Research Board and U. S. Bureau of Public Roads.
(d) Experimental; applied research.
(e) To investigate the pattern of general scour caused by contracting the flow section at a bridge crossing. Continuation of (568).
(g) Preliminary results indicate that depth and shape of the scour hole are a function of the geometry of the bridge site and the ratio of the flow in the normal stream and on the floodplain.
(h) "River Bed Scour at Bridge Foundations", by E. M. Laursen, Proceedings of the Seventh Annual Symposium on Geology as Applied to Highway Engineering, pp. 36-44, Feb. 24, 1956.

(2541) DEVELOPMENT OF INSTRUMENTS FOR USE IN ANALYZING APERIODIC SIGNALS.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(d) Experimental; applied research.
(e) The purpose is to improve the analysis of turbulent velocity and pressure fluctuations.

IOWA STATE COLLEGE, Department of Agricultural Engineering.

Inquiries concerning Projects 2330 to 2334, inclusive, should be addressed to Mr. H. P. Johnson, Dept. of Agricultural Engineering, Iowa State College, Ames, Iowa.

(2330) DEPTH, SPACING AND HYDRAULICS OF TILE DRAINS.

(b) Laboratory project.
(d) Theoretical and field investigation; basic and applied research; several M.S. and Ph. D theses.
(e) Analytical and physical approach is being studied to determine depth and spacing of tile drains by measuring soil characteristics, such as permeability. Electric and glass bead-glycerin models in addition to extensive field measurements of the rate of water table drop between tile drains are being studied. Pressures in tile flowing full are to be studied to determine need for breathers and pressure relief risers.
(g) Several field methods for measuring permeability have been developed, and many theoretical solutions have been found for the flow of water to tile drains.
(h) "Physical and Mathematical Theories of Tile and Ditch Drainage and Their Usefulness in Design", Jan van Schilfgaarde, Don Kirkham and R. K. Frevert. Agricultural Experiment Station Research Bulletin 436, Iowa State College, 1956.

(2331) ESTIMATION OF SURFACE RUNOFF FROM AGRICULTURAL WATERSHEDS.

(b) Laboratory project.
(d) Theoretical; applied research and doctoral thesis.
(e) The surface runoff volume for an individual storm was estimated by superimposing an infiltration capacity curve, which had been derived for a particular soil-crop complex and antecendent rainfall condition, on the rainfall histogram. Data from point rainfall records is being analyzed. Hydrographs from watersheds of up to 25 square miles being collected and analyzed.
(g) No significant new results.
(h) "The Estimation of surface Runoff Volumes from Agricultural Watersheds by Infiltration Theory", by Don Brakensiek, Ph. D. Thesis, Iowa State College, 1955. (Available on loan.)

(2333) IMPROVEMENT OF SURFACE DRAINAGE WITH TILE BLIND INLETS.

(b) Laboratory report.
(d) Field investigation; design; M. S. Thesis.
(e) Field study is being made to determine the effect of different backfill materials on the flow of surface water to tile drains.
(g) Studies indicate that filters about tile are of little value in increasing rate of removal of surface waters if a one-foot layer of silt loam soil is placed on the filter above the tile.
(h) "Relative Performance of Some Blind Inlets Above Tile Drains", D. Palmer, M. S. Thesis, Iowa State College, 1956. (Available on loan.)

(2334) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project, cooperative with Agriculture Research Service, United States Department of Agriculture.
(d) Field investigation; applied research, design.
(e) Measurements are being made of watershed rainfall and surface runoff on 10 Agricultural Watersheds. Sediment measurements are being made in 6 small reservoirs in the gaged watersheds.
(g) Seven years of measurements completed.

THE JOHNS HOPKINS UNIVERSITY, Applied Physics Laboratory.

Inquiries concerning Projects Nos. 1876, 1877, and 2335, should be addressed to The Director, Applied Physics Laboratory, The Johns Hopkins University, 8621 Georgia Avenue, Silver Spring, Maryland.

(1876) ANALYSIS OF DYNAMIC OPERATION OF HYDRAULIC (FORCE) AMPLIFIER TRANSFER VALVES.

(b) Bureau of Ordnance, Department of the Navy.
(d) Theoretical and experimental; applied research and development.
(e) Designed to develop a set of linearized differential equations to describe the operation of single and double nozzle type, hydraulic force amplifier, transfer valves.
(f) Suspended.
(g) The linearization of differential equations complete. Have been completed and compare favorably with experimental results.
(h) Second report on complete equations and their linearization in process.

(1877) ANALYSIS OF STATIC AND DYNAMIC OPERATING CHARACTERISTICS OF HYDRAULIC SERVO-MECHANISMS.

(b) Bureau of Ordnance, Department of the Navy.

(d) Theoretical and experimental; applied research and design.
(e) Phase (1) covers derivation of equations required in item 1876 above. Phase (2) covers the application of simple linearized equations to study the effects of complex mechanical loads and oil compressibility. Phase (3) covers the use of more sophisticated describing function techniques to analyze the nonlinear characteristics of transfer valve while operating in a closed loop and driving complex mechanical loads and including the effects of oil compressibility. Phase (3) includes single stage and two stage hydraulic transfer valves. The work under Phase (3) is being carried out by McDonnell Aircraft Corporation, St. Louis, Missouri, under technical cognizance of APL/JHU.
(f) Phase (2) completed. Phase (3) single stage valve completed, two stage valve nearly completed.
(g) Phase (2) - linearized differential equations produce reasonable correlations between experiment and theory for small changes in variables. Phase (3) describing function techniques have been successfully applied to transfer valve hysteresis, spool reaction forces, and square root characteristics, etc.
(h) Phase (2); no unclassified report. Phase (3) Contract No. NOrd 12826. Single Stage Valve - MAC Report Nos. 4580, 4581. Two Stage Valve - report in process.

(2335) APPLICATION OF SWITCHING TECHNIQUES TO HYDRAULIC CONTROL SYSTEMS.

(b) Bureau of Ordnance, Department of the Navy.
(c) Director, Applied Physics Laboratory, The Johns Hopkins University, 8621 Georgia Avenue, Silver Spring, Maryland.
(d) Theoretical and experimental; applied development and design.
(e) Study of the dynamic properties of an acceleration switching hydraulic servo while operating in a closed loop under the presence of various external loads on the transfer valve and output actuator.
(g) The use of dual mode type of operation, possible with switch techniques, has been found to provide increased servo system performance and reliability while amplifying transfer valve requirements.
(h) A report on the initial phase is available as Bumblebee Report CM-843. Current work will be reported in CF-2607.

THE JOHNS HOPKINS UNIVERSITY, School of Engineering.

Inquiries concerning Projects Nos. 855, 856, and 1111 should be addressed to Dr. John C. Geyer, Department of Sanitary Engineering and Water Resources, The Johns Hopkins University, Baltimore 18, Maryland.

(855) HYDRAULIC BEHAVIOR OF STORM WATER INLETS.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Experimental; basic research, and design.
(e) Model studies of curb, gutter, deflector and combination inlets for various gutter geometries. Attempt has been made to design a "best" inlet for given street conditions.
(f) Completed.
(g) Hydraulic behavior of curb, gutter, combination, and deflector inlets has been investigated. Equations, rating curves, and a graphic method are available for determination of inlet capacities.
(h) "The Design of Storm-Water Inlets," The Department of Sanitary Engineering and Water Resources, The Johns Hopkins University. (A price of $5.00 per copy is charged to cover printing costs only.)
"Hydraulic Behavior of Storm Water Inlets. Part V. A Simplified Method of Determining Capacities of Single and Multiple Inlets," by Paul Bock, Wen-Hsiung Li, John C. Geyer, Sewage and Industrial Wastes, Vol. 28, No. 6, pp. 774-784, June 1956. Reprints available.

(856) HYDROLOGY OF STORM DRAINAGE SYSTEMS IN URBAN AREAS.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Field investigation; basic research, and design.
(e) Study of rainfall and runoff relationships as affected by various drainage area parameters. At present, runoff from 7 urban areas ranging in size from 10 to 400 acres are gaged, 4 by a newly developed flow meter, and 3 by stage measurements only. Two recording systems which simultaneously record rainfall on and runoff from 14 inlet areas provide good opportunity for detailed study. About 5 years of rainfall records now exist for a network of 10 recording gages covering an area of about 50 square miles.
(g) A study of the Baltimore rainfall data for the period 1894-1955 shows: 1. The critical storm in the Baltimore area is the summer type cloud burst. About 2/3 of the storms - greater than 2 year frequency occur in the months of July and August. Winter storms are not important for design purposes. 2. The maximum average rainfall rate (for durations up to 60 minutes) generally occurs at the beginning of the storm. 3. Rainfall intensities (during 15, 30, and 60 minute durations) for frequencies greater than 2 years are not uniform. Difference between maximum intensity and average intensity over the duration range from 30% (for the 15 minute duration) to 75% (for the 60 minute duration). Intensities greater than those indicated by rainfall frequency curves occur during more than half the period of the 15, 30, and 60 minute durations studied. Consequently the design storm assumed in the Rational Method is unrealistic. 4. The time distributions of storms causing the highest flows at Uplands (30 acres) and Red House Run (394 acres) were not uniform. Their average time distributions resembled the average 30 minute time distribution of excessive precipitation rates (above 2 year frequency). 5. Gagings made by this project and by the Corps of Engineers indicate that where a check on the Rational Method is possible, the Rational Method produces inconsistent results. Further analyses are continuing.
(h) "Progress Report on the Storm Drainage Research Project, July 1, 1955, to June 30, 1956", Paul Bock, Department of Sanitary Engineering and Water Resources, The Johns Hopkins University, Baltimore 18, Maryland. A limited number of copies are available on request.

(1111) DEVELOPMENT OF FLOW GAGE FOR STORM SEWER DISCHARGES.

(b) Baltimore City, Baltimore County, and the Maryland State Roads Commission.
(d) Experimental; applied research.
(e) The development of gages for measuring both depth and velocity of the debris-laden shooting flow commonly found in storm sewers. The search is for a method generally adaptable to existing storm sewers that does not require extensive alterations of the sewer channel.
(f) Major activity suspended.
(g) Three years operational data are available for "Pigmy" type cup (Price) current meters in a special mount to give shielding against debris, installed in 3 storm sewers. The successful operation of the flow meters depends on the type and amount of debris present. Continuous maintenance is necessary.

THE JAMES LEFFEL AND COMPANY.

(2336) DRAFT TUBE DEVELOPMENT.

(b) Laboratory project.
(c) Mr. J. Robert Groff, The James Leffel and Co., 426 East Street, Springfield, Ohio.
(d) Experimental and applied research.
(e) A program of testing of propeller type and medium speed wheels for horsepower, efficiency, thrust, torque, runaway speed and leakage on conventional as well as newer types of draft tubes. Study of vortices or swirls in the draft tube and reliable means of preventing or breaking them up.

LEHIGH UNIVERSITY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1602, 1603, 1604, 2339, 2542, and 2543 should be addressed to Prof. M. B. McPherson, Dept. of Civil Engineering, Fritz Laboratory, Lehigh University, Bethlehem, Penna.

(1602) PRESSURE DISTRIBUTION IN CONDUIT BENDS.

(b) Laboratory project.
(d) Experimental; applied research, undergraduate and graduate special problems.
(e) Electrical-analogy study of three bends has been completed.
(f) Inactive.
(h) "Minimum Pressures in Rectangular Bends", by M. B. McPherson and H. S. Strausser, discussion in ASCE Proceeding, Sep. No. 881, Feb. 1956, closure to discussion in ASCE Proceeding, Sep. 1092, Oct. 1956.
"Potential Flow in 90° Bends by Electrical Analogy" by D. S. N. Murthy, special graduate problem, Lehigh University Library, May 1956.

(1603) BUTTERFLY VALVE STUDY.

(b) C. D. C. Controls Services, Inc., Hatboro, Pennsylvania.
(d) Experimental; applied research.
(g) Report on head loss and minimum pressure characteristics has been submitted for publication.

(2339) BUCKET-TYPE ENERGY DISSIPATOR CHARACTERISTICS.

(b) Gannett, Fleming, Corddry and Carpenter, Inc., 600 North Second Street, Harrisburg, Pa.
(d) Experimental; for general design; M. S. Thesis.
(f) All phases except study of the length of the surge have been completed.
(h) "A Study of Bucket-Type Energy Dissipator Characteristics" by M. B. McPherson and M. H. Karr, a paper presented to ASCE Convention on October 18, 1956. Copies of convention preprints may be obtained from the sponsor, Attention Mr. J. A. Romano.

(2542) MODEL TESTS - NEW DIVERSION DAM FOR SEWARD STATION.

(b) Gilbert Associates, Inc., Reading, Pennsylvania.
(d) Experimental; applied research.
(e) A 1:12 scale movable-bed two-dimensional model.
(f) Completed.
(h) Gilbert Associates Report No. 1475, by Mr. A. W. Reid, May 31, 1956.

(2543) STUDY OF CONDUIT EXIT PORTALS.

(b) Laboratory project.
(d) Experimental; M. S. thesis.
(e) Exit pressure distribution for a square conduit with and without a supported nappe now under study. Circular conduit exit transitions will be studied in an attempt to evolve an improved basic design.
(f) Initiated October 1956.

LOUISIANA STATE UNIVERSITY AND A AND M COLLEGE, School of Hydraulic Engineering.

(2544) MODEL STUDY OF PUMP INTAKE.

(b) Laboratory project (Walter S. Lemann Memorial Pumping Station).
(c) Prof. T. M. Lowe, Louisiana A and M College, Baton Rouge 3, La.
(d) Experimental; model study.
(e) Discharge of large 100 cfs capacity pumps are equipped with high head siphons on discharge lines. Object of study to improve flow conditions in pump pit and better pump operation.
(g) Model complete - study under way.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Civil and Sanitary Engineering, Hydrodynamics Laboratory.

Inquiries concerning Projects Nos. 307, 577, 578, 1355, 1609, 1881, 2101, 2103, 2341, 2342 and 2545 to 2549, incl., and requests for reprints and Technical Reports should be addressed to Dr. Arthur T. Ippen, Professor of Hydraulics, Hydrodynamics Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.

(307) STABILITY OF FLOW STRATIFIED DUE TO DENSITY DIFFERENCES.

(b) Laboratory project.
(d) Theoretical and experimental; graduate research.
(e) (1) Theoretical and experimental investigations have been made on steady-state uniform density current flows including determination of velocity distributions, resistance laws and interfacial stability. (2) Investigation of control structures for stratified flow.
(g) Initial studies on phase (2) were concerned with the design of curtain walls for condenser water intakes in which the source of water consists of a warm layer overlying a cold layer. Experiments to determine the maximum rate of flow which can be discharged under the curtain wall without drawing in water from the upper layer have been completed. Experimental investigations of other types of control structures are planned.
(h) "Submerged Sluice Gate Control of Density Currents", by D. R. F. Harleman, R. S. Gooch and A. T. Ippen, A. S. C. E. Knoxville 1956 (to be published).

(577) CHARACTERISTICS OF SOLITARY WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) (1) Experimental investigation of solitary wave characteristics in a horizontal channel. Measurements of attenuation for various bottom roughnesses. (2) Investigation of amplitude change, profile deformation and breaking characteristics of the solitary wave on a sloping beach. (3) Measurement of unsteady velocities in the boundary layer region. (4) Experimental investigation of wave characteristics in the transition between oscillatory and solitary waves. (5) Investigation of the unsteady boundary shear due to the passage of a solitary wave. (6) Measurement of velocity profiles in the boundary layer of a solitary wave for the condition of non-laminar flow.
(g) Phases (1), (2), (3), and (4) have now been completed and work on phase (5) is in progress. Measurements are being made of boundary resistance by means of a shear plate at the bottom of the wave tank. Forces are recorded during the passage of a solitary wave. Resistance coefficients obtained in this manner will be compared with those obtained in phase (1).
(h) "Application of the Solitary Wave Theory to Shoaling Oscillatory Waves", J. G. Housley and D. C. Taylor, American Geophysical Union (to be published).
"Damping of the Solitary Wave", A. T. Ippen and G. Kulin, Special Issue of La Houille Blanche commemorating the Fifth Conference on Coastal Engineering.
"Solitary Wave Attenuation on Rough Surfaces", J. G. Housley, S. M. Thesis, 1957.

(578) TURBULENCE MEASUREMENTS IN FREE SURFACE FLOW.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; development of instrumentation.
(e) Studies of turbulence characteristics in open channel flow.
(f) Inactive.
(g) Turbulence measurements in water with a Pilot tube-pressure cell combination have been obtained with a frequency response of the order of 150 cps. Oscilloscope records have been analyzed by means of a digital computer and auto-correlation curves, mean intensity spectra and macro-turbulence scale have been obtained. The results compare favorably with the work of other investigators in air.
Additional experiments on the turbulence characteristics in the wake of a cylinder in supercritical open channel flow have been made. The decay of wake turbulence with distance downstream has been obtained by studying variations in the scale of macro-turbulence.
(h) "Some Turbulence Measurements in Water with an Impact Tube-Pressure Cell Combination", A. T. Ippen, R. S. Tankin and F. Raichlen, A.S.C.E. Pittsburgh 1956, (to be published).

(1355) CAVITATION INCEPTION FOR STEADY MOTION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Cavitation inception for steady motion is being studied for systematic variations in boundary layer development and in the turbulence level for the zone of minimum pressure.
(g) A closed-jet water tunnel with a rectangular test section has been developed. The working section is arranged so that the boundary layer growth is controlled by a systematic change of its shape. Provision is also made for control of turbulence level, pressure intensity and air content.
Experiments involving the effect of velocity variation on incipient cavitation and on the influence of dissolved air content have been completed. Information on the turbulence of the flow in the cavitation region has been obtained by high-speed photographs of the cavitation bubbles.
Explorations in the boundary layer are being made to determine the local mean pressure intensities and their relation to the local velocity and turbulence. It is planned to extend this investigation to include cases of boundary roughness.
(h) "Turbulence and Boundary-Layer Effects on Cavitation Inception from Gas Nuclei", by J. W. Daily and V. E. Johnson, Jr., Trans. ASME Nov. 1956.

(1609) EXPERIMENTAL STUDY OF THE SORTING OF BEACH SEDIMENTS BY WAVE ACTION.

(b) Beach Erosion Board, U. S. Army Corps of Engineers.
(d) Experimental; basic research.
(e) Quantitative study of the sorting action and selective transport of beach material by shallow water waves moving on a plane, granular beach.
(g) Equipment consists of a wave channel 30 inches wide, 36 inches deep and 100 feet in length together with a piston-type wave generating mechanism. The wave generator is controlled by a hydraulic servomechanism which permits continuous variation of both wave amplitude and frequency during operation. Beaches consist of graded materials of selected sizes and variable physical properties. The results of the sediment transport and sorting studies are related systematically to the various wave characteristics such as shape, celerity, frequency and internal velocities.
A systematic series of observations of sediment particle velocities for a horizontal bottom and one beach slope has been completed for various surface roughnesses including a smooth beach. Size and specific gravity of the spherical particles which compose the movable sediment have been varied. An additional series of tests on another beach slope is now in progress.
(h) "A Study of Beach Sediment Motion in the Breaker Region", F. G. Rockwell, Jr. and J. E. Schweizer, M. Sc. Thesis, 1956.
"Mass Transport in Shoaling Waves ", R. M. Wilson, M. Sc. Thesis, 1956.
"The Movement of Discrete Particles on a Plane Beach Due to Shoaling Waves", P. S. Eagleson, Sc. D. Thesis, 1956.
"Properties of Shoaling Waves by Theory and Experiment", P. S. Eagleson, Trans. A. G. U., Vol. 37, No. 5, 1956.

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(1881) WAVE FORCES ON OFFSHORE STRUCTURES.

(b) Humble Oil and Refining Company, Houston, Texas.
(d) Experimental; basic research.
(e) Objective is the determination, by means of model tests, of the design forces to be expected on offshore structures subjected to shallow water wave action.
(g) Experimental equipment includes a 100-foot wave tank, an oscillatory wave generator of variable amplitude and frequency and dynamic lift and drag balances for the measurement of forces due to wave motion. Tests have been completed on a series of vertical cylinders in waves of various characteristics. Lift and drag measurements have also been made on horizontal and vertical cylinders with variable submergence and on basic shapes such as spheres and cylinders.
Various configurations of bouyancy members for a movable platform have been tested to obtain dynamic forces when the platform is rigidly fixed. Tests are being extended to include a study of mooring cable forces on a floating platform subjected to wave forces.

(2101) SPILLWAY INVESTIGATIONS.

(b) Laboratory project.
(d) Experimental; undergraduate thesis.
(e) General studies of fluid mechanics associated with spillways.
(g) Investigations have been made on the effect of crest pier location and shape on the magnitude of crest pier contraction coefficients. Particular emphasis has been placed on the action of crest piers in the supercritical flow region of the spillway.
(h) "Effect of Crest Piers on Spillway Efficiency", M. A. Isava and J. P. Solorzano, B. Sc. Thesis, 1956.

(2103) ENERGY DISSIPATION IN STILLING BASINS.

(b) Laboratory project.
(d) Experimental; graduate thesis.
(e) General study of the basic fluid mechanics associated with energy dissipation in stilling basins.
(g) Hydrodynamic forces on a single baffle pier have measured as a function of the initial Froude number and the distance between the toe of the hydraulic jump and the pier. Additional studies have also been made on the arrangement and position of baffle piers in stilling basins.
(h) "Hydrodynamic Forces on the Cavitation Free Baffle Pier", by R. A. DiMassimo, B. Sc. Thesis, 1956.
"Effect of Baffle Pier Location on Stilling Basin Performance", by A. C. Fegan, B. Sc. Thesis, 1956.

(2341) FLUID MECHANICS OF TURBOMACHINERY COMPONENTS.

(b) Office of Ordnance Research, Department of the Army.
(d) Experimental; basic research.
(e) Investigation of problems connected with the several secondary effects in a turbomachine such as seal ring friction and leakage, rotor-to-wall clearance effects, and vane tip clearance.
(g) The initial phase of the investigation is concerned with the effect of roughness, chamber dimensions and disk shape on disk friction.
Torque tests have been conducted over a wide range of disk Reynolds numbers for smooth, plane disks of 19-3/4 inches diameter rotating within a symmetrical casing at various disk-to-wall clearances. A smooth tapered disk has been constructed for similar tests. Instrumentation is being installed for pressure and velocity distribution measurements within the chamber.
(h) "The Effect of Axial Clearance on Disk Friction Torque for Smooth Plates", by W. C. Knoles, Jr., M. Sc. Thesis, 1956.

(2342) DIFFUSION OF SUBMERGED JETS WITH DENSITY DIFFERENCES.

(b) Laboratory project.
(d) Experimental and analytical; basic research.
(e) General study of the diffusion of submerged jets whose density is either greater or less than that of the surrounding fluid.
(g) A series of experiments have been made on the diffusion characteristics of submerged jets discharging horizontally and vertically into a reservoir using various salt and fresh water combinations. A small conductivity probe has been designed to measure and record salinity diffusion in the jet. Comparisons of mass and momentum diffusion for both water and gaseous jets have been made.
(h) "Development of a Continuously Recording Meter for the Measurement of Density Differences", by K. R. Read, B. Sc. Thesis, 1956.
"An Investigation of the Characteristics of Submerged Jets with Initial Density Differences", by T. C. Loper and J. L. Moffat, M. Sc. Thesis, 1956.

(2545) MODEL STUDY OF WAVE PROTECTION FOR NARRAGANSETT BAY NAVAL FACILITIES.

(b) District Public Works Office, First Naval District, Boston.
(d) Experimental; design.
(e) Model to determine size and location of breakwater to provide optimum protection from wave action for berthing facilities.
(g) A distorted scale (1:400 horizontal, 1:120 vertical) model encompassing approximately 3.5 sq. prototype miles is under construction.
A 20 foot long, movable, plunger type wave generator with continuously variable speed and stroke is also under construction.

(2546) CHARACTERISTICS OF FLOW WITH DILUTE FIBER SUSPENSIONS.

(b) Technical Association of Pulp and Paper Industries.
(d) Experimental and analytical; basic research.
(e) Basic investigation of the hydrodynamic features of paper fiber suspensions.
(g) First phase is a survey of existing knowledge of the fluid mechanics of the flow of fiber suspensions as related to the flow in paper making machines. This is being followed with an experimental program investigating the hydrodynamic characteristics of fiber suspensions in fully developed shear flows and in non-shear fields for both the laminar and turbulent ranges.
(h) "Pertinent Factors in Flow Research on Dilute Fiber Suspensions", by A. T. Ippen, J. W. Daily and G. Bugliarello. Tech. Assoc. Pulp and Paper Industries Magazine (to be published).

(2547) CHARACTERISTICS OF THE CIRCULAR HYDRAULIC JUMP.

(b) Philip Johnson Associates, New York City.
(d) Theoretical and experimental.
(e) A study of the characteristics of the circular hydraulic jump which is formed by axially symmetrical supercritical flow from a source or to a sink.
(g) A lucite water table has been constructed to obtain supercritical flows issuing radially outward from a source or directed inward toward a sink. By proper control of tailwater hydraulic jumps circular in plan view are created. Measurements of depths and velocities are being made for comparison with the momentum equations for the two types of jumps described above. The characteristics of intersecting jumps of other geometric patterns are also being studied.

(2548) MECHANICS OF WASTE WATER DIFFUSION.

(b) U. S. Public Health Service.
(d) Theoretical and experimental; basic research.
(e) An investigation of various turbulent diffusion processes for application to waste disposal in streams, lakes and oceans.

(g) On the basis of preliminary studies and some field experience, the application of jet dynamics appears to be a promising way of achieving rapid and economic dilution of waste liquids in outfall areas. Experimental equipment is being designed to investigate the jet properties, the density variations of the liquids involved and the internal flow conditions in the receiving reservoir.

(2549) SURGE TANK MODEL STUDIES.

(b) Laboratory project.
(d) Experimental; graduate and undergraduate theses.
(e) General investigations on the validity of the hydraulic analog model for the solution of the differential equations for surge tanks.
(g) A hydraulic analog model surge tank system has been used to reproduce a wide range of prototype operating conditions. Investigations have been made on both simple and restricted orifice surge tank systems. Comparison of model results with graphical and analytical solutions shows good agreement.
(h) "Model Study of a Restricted Orifice Surge Tank", by P. Kinzbruner and R. Pardo, B. Sc. Thesis, 1956.
"Investigation of a Throttled Air Flow Surge Chamber", by L. Peralta, M. Sc. Thesis, 1956.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Mechanical Engineering.

(880) RECOVERY FACTORS AND HEAT-TRANSFER COEFFICIENTS FOR SUPERSONIC FLOW OF AIR IN A TUBE.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. Joseph Kaye, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical basic research for M. S. and Sc. D. degrees.
(e) The project objectives are to measure reliable heat-transfer coefficients for supersonic flow of air in a tube to study characteristics of such flow by investigation of the fundamental differential equations, and to measure boundary layer characteristics such as velocity and temperature profiles for such flows.
(h) "Theoretical Solutions for a Steady Laminar Flow of a Compressible Fluid in the Entrance Region of a Tube", by Tau-Yi Toong and Joseph Kaye, March 15, 1956.

(1883) STUDY OF THE REGENERATIVE PUMP PERFORMANCE.

(b) Worthington Corporation.
(c) Mr. William A. Wilson, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Analytical and experimental; master's thesis.
(e) To rationalize the design of the Regenerative Pump through a better understanding of its internal flow mechanism. To investigate possible ways of improving its performance.
(g) A theory of operation has been developed which correlates satisfactorily with experimental operating data and reflects many of the peculiarities of the unit.
(h) "A Theory of the Fluid-Dynamic Mechanism of Regenerative Pumps", W. A. Wilson, M. A. Santalo, J. A. Oelrich, A.S.M.E. Trans. Nov. 1955, pp. 1303-1316.
"A Comparison of Regenerative Pump Theories Supported by New Performance Data", Y. Senoo, A.S.M.E. Trans. July 1956, pp. 1091-1102.

(1884) EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF CYCLONE DUST SEPARATOR.

(b) Mechanical Engineering Department.
(c) Joseph H. Keenan, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Study of flow patterns in the vortex of a cyclone dust separator.
(e) Several different regimes of flow have been observed qualitatively. These will be observed quantitatively and studied analytically.
(g) Analytical and experimental studies of pressure drop and separating efficiency.
(h) Master's Theses by Rodney Shuart and Richard T. Salter, Doctor's Thesis by Helmut Weber. Copies obtainable through librarian of M.I.T.

(1901) INVESTIGATION OF THE SKEWED TURBULENT BOUNDARY LAYER IN A VANELESS DIFFUSER.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. E. S. Taylor, Gas Turbine Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Primarily experimental investigation for master's and doctor's theses.
(e) Investigation is being conducted because of the importance of skewed turbulent boundary layers in fluid machinery. The vaneless diffuser was chosen because the flow is symmetrical about the axis of the diffuser and hence is one of the simplest examples of skewed boundary layer flow.
(g) It was found that the velocity near the wall in the main-stream direction correlates in the same manner as the velocity in the wall-region of a two-dimensional turbulent boundary layer.
(h) "The Three-dimensional Boundary Layer in a Vaneless Diffuser", Morris P. Isom, S.M. Thesis, Department of Electrical Engineering, M. I. T., May 1956.

(1903) STALL PROPAGATION IN AXIAL COMPRESSORS.

(b) National Advisory Committee for Aeronautics.
(c) Prof. A. H. Stenning, Asst. Prof. of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; applied research.
(e) An investigation of the phenomenon of rotating stall in axial compressors, and unsteady flow effect which has been responsible for many structural failures in gas turbine engines. Experimental study is being made with a circular cascade and a single stage compressor.
(g) In the unsteady flow, the airfoils stall by shedding circulation in the form of discrete vortex, which induces stall on the adjacent airfoil as it moves downstream. An analysis of the phenomenon based on this model has been made and compared with experiment.
(h) "Stall Propagation in Axial-Flow Compressors", Stenning, A. H., Kriebel, A. R., Montgomery, S. R., NACA TN 3580, June 1956.
"Stall Propagation in a Cascade of Airfoils", Kriebel, A. R., Gas Turbine Laboratory Report No. 36, M.I.T., September 1956.

(2112) STUDY OF TWO-STROKE ENGINE SCAVENGING.

(b) Student theses.
(d) Study of the fluid mechanics of the scavenging process.
(e) Mass flow through engine, and mass of air retained in the cylinder are studied theoretically, and measured experimentally on engines in actual operation. Analysis is on basis of flow characteristics of ports and valves, flow within cylinder, mixing of old and new gases, etc.
(h) "Scavenging the Two-Stroke Engine", Rogowski, A. R., and Taylor, C. F., Trans. SAE Vol. 62, 1954, p. 486.

(2113) TWO-PHASE INSTRUMENTATION.

(b) Pratt and Whitney Aircraft.
(c) Prof. K. R. Wadleigh, Mass. Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; applied research and development.
(e) Development of means to measure properties and composition of high-velocity, two-component, two-phase flows.
(g) Probes measure stagnation pressure, gas phase composition and mixture composition reasonably well-developed. Work on temperature probes continues.
(h) "Instrumentation to Measure Composition and Temperature of High-Velocity, Two-Phase, Two-Component Flows", K. R. Wadleigh and R. A. Oman, A.R.S. MTG, New York, Nov. 1956.

(2343) AEROTHERMOPRESSOR PROJECT.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. K. R. Wadleigh, Mass. Institute of Technology, Cambridge 39, Mass.

(d) Experimental and theoretical; applied research.
(e) The Aerothermopressor is a device in which the stagnation pressure of high temperature, high-velocity gas streams is increased by evaporation cooling of injected water. A theory of operation based upon fundamental laws has been developed. Experimental work on large and small-scale devices is under way.
(f) Completed.
(g) The aerothermopressor principle has been demonstrated experimentally. However, the measured stagnation pressure rise of 6% in a 25 lb/sec unit is not considered sufficient for application to a simple gas turbine power plant as originally envisaged. A good understanding of complex two-phase, two-component flows has been achieved through theory and experiment.
(h) "The Aerothermopressor -- A Device for Improving the Performance of a Gas Turbine Power Plant", A. H. Shapiro, K. R. Wadleigh, B. D. Gavril, and A. A. Fowle, Trans. ASME April 1956.

(2344) ATOMIZATION PROJECT.

(b) General Electric Company.
(c) Prof. K. R. Wadleigh, Mass. Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; applied research.
(e) A study of the interaction between gas and liquid streams in atomization processes to determine the dependence of drop size, drop size spectrum, spatial distribution, etc. on the properties of the fluid flows.
(f) Suspended.
(g) Study of break-up of large drops to small drops predicts critical Weber number values in terms of stability number. Experimental work with different liquids shows good agreement.
(h) "Theoretical and Experimental Study of the Deformation and Atomization of a Liquid Drop in a High-Velocity Gas Stream", N. I. Masugi, A.R.S., NITG, New York, NOJ, 1956.

(2550) BOUNDARY LAYERS IN CORNERS.

(b) Laboratory project.
(c) Prof. A. H. Shapiro, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; basic research for doctoral thesis.
(e) The boundary layer is to be studied in a 90° corner formed by two intersecting planes, with the main flow proceeding in the direction of the line of intersection. Laminar and turbulent layers, with zero pressure gradient and adverse pressure gradient, will be investigated. The objective is to compare the boundary layer in a corner with that on a plate in regard to thickness, velocity profile, skin friction, separation, and transition to turbulence.

(2551) HYDRAULIC LINE DYNAMICS.

(b) Laboratory project.
(c) Prof. F. D. Ezekiel, Dynamic Analysis and Control Laboratory, Rm. 3-244, Massachusetts Institute of Technology, Cambridge 39, Mass.
(e) Simulation of a hydraulic conduit with distributing capacitance and inertance for analogue computer use.
(h) "Computer Representation of Engineering Systems Involving Fluid Transients", ASME.

(2552) STUDY OF THE FLOW OF TWO PHASES IN PIPES AND WATER CIRCULATION IN STEAM GENERATORS.

(b) Babcock and Wilcox Company.
(c) Mr. William A. Wilson, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Analytical and experimental; doctor's, master's and bachelor's theses.
(e) The project is aimed at finding a rational method for the prediction of flow circulation and stability in steam generators. The preliminary phases involve getting a knowledge of the pressure drop of a fluid boiling in a vertical pipe as well as studying the fundamental physical phenomena of two-phase flow.

(2553) HEAT TRANSFER AND FLUID FLOW IN NON-CIRCULAR DUCTS.

(b) John B. Pierce Foundation of Connecticut, Inc., New Haven, Connecticut.
(c) Prof. W. M. Rohsenow, Dept. of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Combined analytical and experimental investigations to extend the present knowledge of heat transfer in non-circular duct flows.
(e) Any existing gaps in the laminar flow field may be investigated, but the main emphasis will be placed on turbulent flow. Assymptotic slug flow solutions for infinite Reynolds numbers will be investigated analytically. A turbulent flow analysis using a modified, experimentally determined universal velocity distribution will be attempted, using the techniques of the analogy between momentum and heat transfer.

(2554) STUDY OF FLOW PROPERTIES OF DENSE PHASE FLUIDIZED SOLIDS IN A VERTICAL PIPE.

(b) M. W. Kellogg Company.
(c) Mr. W. A. Wilson, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; doctor's, master's, B. S. theses.
(e) The nature of the inlet and discharge phenomena to and from a tube are being studied. The properties necessary to define the flow, e.g. velocity, density, "viscosity", and the ranges of stable fluidized flow are to be defined.
(g) Found significant wall forces in down flow which changes a dense phase fluidized flow to a non-fluidized part way down tube. The present program is to rationalize this phenomenon.
(h) M. S. and B. S. Theses by C. Kojabashian, M.I.T., 1954, M.S. Thesis by A. Herren, M.I.T., 1955.

(2555) THREE-DIMENSIONAL SKEWED BOUNDARY LAYER.

(b) Laboratory project.
(c) Mr. James P. Johnston, Research Assistant, Gas Turbine Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; basic research for doctor's thesis.
(e) The three-dimensional skewed boundary layer (incompressible and turbulent) is being investigated on the plane surface bounding a two-dimensional free jet that impinges on a wall perpendicular to its axis. The purpose of this project is to study the effect of boundary layer cross-flow on the development of turbulent boundary layer under adverse pressure gradient.
(g) The occurrence of a plane of symmetry in the flow (along the jet axis) leads to some simplification of the experimental and analytical problems involved in this study. At this date, most results are too inconclusive to be reported. We can report that along the plane of symmetry separation occurs at a point that corresponds roughly to that predicted by several methods of analysis used for two-dimensional turbulent boundary layers. However, the development of momentum thickness (the common θ of two-dimensional boundary layer work) diverges appreciably from the measured values in the region of developing cross flows.

(2556) END-WALL BOUNDARY LAYER ON A TURBINE NOZZLE.

(b) Laboratory project.
(c) Mr. Yasutoshi Senoo, Research Associate of Mechanical Engineering, Gas Turbine Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical; applied research.
(e) Behavior of boundary layer on the end wall of a turbine nozzle was studied, particularly, (1) influence of upstream boundary layer, (2) comparison with the theory and (3) accumulation of the swept boundary layer fluid.
(f) Completed.
(g) The end-wall boundary layer is laminar due to the high acceleration, independent of the nature of the upstream boundary layer. Secondary flow due to upstream boundary layer is not negligible, but the behavior near the end-wall is almost independent of the upstream boundary layer. The boundary layer growth can be predicted with good accuracy by three-dimensional laminar boundary layer theory.

(h) "The Boundary Layer on the End Wall of a Turbine Nozzle Cascade", Y. Senoo, Gas Turbine Laboratory Report No. 35, M.I.T., October 1956.
"Three-Dimensional Laminar Boundary Layer on Curved Channels with Acceleration or Deceleration", Y. Senoo, Gas Turbine Laboratory Report No. 37, M.I.T. (Report is not yet printed.)

(2557) STUDY OF SMALL HIGH-SPEED HIGH-HEAD LOW-FLOW CENTRIFUGAL PUMPS.

(b) Bendix Products - Missile Section, Mishawaka, Indiana.
(c) Prof. R. W. Mann, Mechanical Engineering Dept., Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; applied research directed toward design, in part for bachelor and master theses.
(e) Study of losses and pressure flow relationships in small high-speed centrifugal pumps as a function of geometry using viscous fluid. Study of a novel configuration in which the fluid is rotated relative to a stationary pitot tube outlet.
(g) Disk friction losses correlate well with theory.
(h) "Disk Friction Losses in Small Centrifugal Pumps", Gideon I. Gartner, B.S., Dept. of M.E., M.I.T., Cambridge 39, Mass.

(2558) INVESTIGATION OF BENDING MOMENTS ON A VESSEL IN A REGULAR WAVE SYSTEM.

(b) S-3 Panel, Society of Naval Architects and Marine Engineers.
(c) Prof. James A. Fay, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Theoretical; applied research.
(e) Theoretical study of hydrodynamic force distribution on a vessel moving into a regular wave system; determination of pitching and heaving motions and internal reactions.
(f) Completed.
(g) Comparison of results with model experiments of Lewis (ETT) shows fair agreement for motions, poorer agreement for bending moment.
(h) Report in progress.

(2559) ANALYSIS OF THE JET PIPE VALVE.

(b) Laboratory project.
(c) Mr. John F. Dunn, Dynamic Analysis and Control Laboratory, Bldg. 20D-208, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical applied research for doctoral thesis.
(e) Study of the jet pipe valve with object of relating performance of valve to physical parameters so as to make possible rational design.

(2560) INVESTIGATIONS OF UNSTEADY-STATE CONVECTIVE HEAT TRANSFER PHENOMENA.

(b) Wright Air Development Center, USAF, Wright-Patterson Air Force Base, Ohio.
(c) Prof. Richard J. Nickerson, Dept. of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; basic research for doctor's thesis.
(e) At present, the effect of free stream oscillations on the laminar velocity and temperature boundary layers on an isothermal flat plate is being studied.
(g) Theory shows the presence of free stream oscillations to have a small effect on the steady rate of heat transfer when the boundary layer is sufficiently thin. This effect decreases with increasing boundary layer thickness. Experimental work is not yet completed.

UNIVERSITY OF MASSACHUSETTS, Department of Civil Engineering.

(2121) EFFECT OF AIR POCKET FORMATION AT THE SUMMIT OF A PRESSURE PIPE SYSTEM ON FLOW THROUGH THE SYSTEM.

(b) Laboratory project.
(c) Dean George A. Marston, Director, Engineering Research Institute, University of Massachusetts, Amherst, Massachusetts.
(d) Experimental; applied research.
(e) The purpose of the investigation is to correlate the amount of air pocket formation and the resultant head loss, with the angle of a vertical bend and the velocity of flow through a system.
(f) Suspended.

(2561) HYDROLOGIC STUDIES IN WESTERN MASSACHUSETTS.

(b) Cooperative with U. S. Soil Conservation Service, U. S. Weather Bureau, and U. S. Geological Survey.
(c) Dean George A. Marston, Director, Engineering Research Institute, University of Massachusetts, Amherst, Massachusetts.
(d) Experimental; field and laboratory; for design of watershed protection and flood peak reduction projects and general information.
(e) Rainfall and runoff studies will be made for small drainage areas which when combined with other hydrologic factors such as temperature, vegetal cover, ground water, etc., will provide a better basis for design of small reservoirs whose chief purpose is reduction in flood peaks.
(f) Project in planning stage.

UNIVERSITY OF MICHIGAN, Department of Civil Engineering.

(2129) DEVELOPMENT OF OPEN CHANNEL FLOW CONTROL.

(b) Rackham Research Grant.
(c) Prof. V. L. Streeter, 322 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Experimental and analytical.
(e) Determination of effectiveness of the principle of single orifice flow control with a nonlinear spring resistance as applied to open channels.
(g) Several nonlinear resistances have been developed and utilized in the flow controller. Accuracies within the range of the controller are ± 3%. Similar accuracies are obtained as a flow meter.
(h) "A Flow Controller for Open or Closed Channels", V. L. Streeter, Journal of Hydraulics Division, ASCE Proceeding Separate 1037, 1956.

(2347) WAVE FORCE ON SUBMERGED STRUCTURES.

(b) Cooperative project sponsored by University of Michigan School of Graduate Studies, Bethlehem Steel Co., and Shell Oil Co.
(c) Prof. E. F. Brater, 320 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Experimental and analytical.
(e) To determine and analyze wave forces on submerged barge-like structures of various shapes for various wave conditions.
(f) Experimental work and analysis completed.
(g) Coefficients of drag and inertial resistance were determined for various wave characteristics and for various body shapes.

(2562) MODEL TEST OF BOOSTER PUMPING STATION FOR WATER WORKS PARK, DETROIT, MICHIGAN.

(b) Detroit Board of Water Commissioners.
(c) Prof. V. L. Streeter, 322 W. Engineering Bldg., Ann Arbor, Michigan.

(d) Experimental.
(e) A 1:21 scale model of plexiglass pumping station includes complete hydraulic system within caisson except pump impellers, for four 66" diameter adjustable-blade, vertical shaft axial-flow pumps.
(g) Not evaluated.

(2563) INVESTIGATION INTO NATURE OF LOSSES IN DIAPHRAGM VALVES (SAUNDER'S PATENT).

(b) Hills-McCanna Company, 3025 N. Western Ave., Chicago, Ill.
(c) Prof. V. L. Streeter, 322 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Experimental.
(e) Determination of contribution of various passage configurations to overall valve losses.

(2564) DETERMINATION OF MAXIMUM FLOODS ON ROUGE RIVER.

(b) Wayne County Road Commission.
(c) Prof. E. F. Brater, 320 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Analytical.
(e) To determine infiltration capacities and unit hydrographs for the Rouge River basin for the purpose of determining the magnitude of future floods and the effectiveness of various methods of reducing flood stages.
(g) Basic data being analyzed.

(2565) DETERMINATION OF EXTREME LEVELS OF LAKE ERIE.

(b) The Detroit Edison Co.
(c) Prof. E. F. Brater, 320 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Analytical.
(e) To relate wind velocities to wind tides and predict maximum and minimum levels of the west end of Lake Erie resulting from wind tides, long term variations and oscillatory waves.
(f) Preliminary study completed.
(g) The desired limiting design values were obtained.
(h) "University of Michigan Engineering Research Institute Report", July 1956.

(2566) DETERMINATION OF MAXIMUM FLOODS AT MIDLAND, MICHIGAN.

(b) The Dow Chemical Co.
(c) Prof. E. F. Brater, 320 W. Engineering Bldg., Ann Arbor, Michigan.
(d) Analytical.
(e) To determine the relationship between precipitation, watershed conditions and runoff for the purpose of predicting peak runoff.
(f) Completed.
(g) The unit hydrograph-infiltration procedure was verified and flood predictions were made.
(h) Report submitted to sponsor.

UNIVERSITY OF MICHIGAN, Department of Engineering Mechanics.

Inquiries concerning Projects Nos. 2567 to 2571, incl., and 2575 should be addressed to Prof. John S. McNown, Department of Engineering Mechanics, University of Michigan, Ann Arbor, Michigan.

(2567) EFFECT OF CONTAINER OSCILLATION ON FALL VELOCITY OF PARTICLES.

(b) National Science Foundation.
(d) Experimental and theoretical; basic research.
(e) Spherical particles are dropped along the axis of a cylindrical container which is oscillated vertically. The effects on the fall velocity are observed and predicted analytically.

(g) The vertical oscillation has only a very small effect on the fall velocity for Reynolds numbers up to 200.

(2568) MODEL STUDIES OF FLOW THROUGH A LIQUID METAL NUCLEAR REACTOR.

(b) Atomic Power Development Associates.
(d) Experimental.
(e) Tests are conducted with water flowing in a full scale model of one element of the proposed reactor. Comparative tests are being made of head losses, flow distribution, and diffusion for various parts of the element.

(2569) EFFECT OF UNSTEADINESS OF FLOW ON RESISTANCE.

(b) The Sandia Corporation.
(d) Experimental and theoretical.
(e) The variation with time has been observed for the force on various bodies placed in the nodal plane of a standing wave. Analytical results have been obtained for comparison.
(g) Changes in the wake affect significantly the coefficients of drag and virtual mass for bluff bodies placed in unsteady flow. Analytical prediction based on the free streamline theory are useful guides in interpreting the effect.
(h) "Drag in Unsteady Flow", to be published in the Proceedings of the IX International Congress of Applied Mechanics, Sept. 1956, Brussels, Belgium.

(2570) INVESTIGATION OF THE HIGH SPEED JETS IN PAPER MACHINES.

(b) Technical Association of the Pulp and Paper Industry, Research Project No. 92.
(d) Experimental.
(e) Preliminary investigations are being made of the stability and causes of disturbance associated with the formation of thin, two-dimensional jets with very high Froude numbers, and with the effects of subsequent drainage.

(2571) AXISYMMETRIC GRAVITY WAVES OF FINITE AMPLITUDE.

(b) Department research.
(d) Theoretical; PhD thesis.
(e) Investigation of the effect of amplitude on the period and wave form for axially symmetrical standing waves.

(2572) LAMINAR FLOW WITH SWIRL IN A CIRCULAR CONDUIT.

(b) Departmental research.
(c) Prof. Hadley J. Smith, Department of Engineering Mechanics, University of Michigan, Ann Arbor, Michigan.
(d) Theoretical and experimental; PhD thesis.
(e) A study of the effect of an axial rotation on the velocity distribution and stability of laminar flow in a circular pipe.
(g) Functions have been found for the description of laminar flow with an increasing or decreasing swirl component. The latter is shown to effect adversely the stability of the flow.

(2573) PROBLEMS OF HYDRODYNAMIC STABILITY.

(b) Departmental research.
(c) Dr. Chia-Shun Yih, Department of Engineering Mechanics, University of Michigan, Ann Arbor, Michigan.
(d) Theoretical (chiefly); and experimental.
(e) The stability of a viscous fluid in laminar flows or with thermal stratifications is investigated. Attention is currently focused on the influence of free surfaces and the curvature of flow and on the stability of heat producing liquids.

(g) Some sufficient conditions of laminar flows with a free surface have been obtained. These serve as a guide for the general behavior of the neutral stability curve. Stability of laminar flows in curved channels can be explained without involving the effects of boundary-layer growth.

(2574) HYDRODYNAMICS OF STRATIFIED OR ROTATING FLUIDS.

(b) Departmental research.
(c) Dr. Chia-Shun Yih, Department of Engineering Mechanics, University of Michigan, Ann Arbor, Michigan.
(d) Theoretical (chiefly); and experimental.
(e) The general characteristics of the flows of stratified or rotating fluids are investigated. One seeks to apply special methods or techniques previously developed to specific problems and to develop new methods or techniques of investigation.
(g) Two-layer potential flows with a common interface can be constructed by a conformal-mapping method.

(2575) HYDRAULIC TESTS OF FLOW SPREADER OF PAPER MACHINE.

(b) West Virginia Pulp and Paper Co., Charleston, S. C.
(d) Laboratory model study.
(e) Various models were built and tested to devise an efficient way of providing uniform efflux from a flow spreader for a high speed paper machine.
(f) Preliminary study completed.

UNIVERSITY OF MICHIGAN, Experimental Naval Tank.

Inquiries concerning Projects Nos. 1128, 1378 and 2349 should be addressed to Prof. L. A. Baier, 326 West Engineering Building, University of Michigan, Ann Arbor, Michigan.

(1128) COMMERCIAL VESSELS, 150 to 250 FEET IN LENGTH.

(b) Fairbanks, Morse, and Company.
(d) Experimental; design.
(e) A large family of hull forms is being tested in order to provide design data for the future design of commercial vessels, 150 to 250 feet in length.

(1378) VIBRATION ELIMINATION.

(b) Laboratory and field projects.
(d) Experimental; applied research.
(e) Design and testing of fins fitted to both single and multiple screw hulls in way of propeller in order to control feed water flow and eliminate fantail vibration. Recent emphasis placed on twin screw stern vibration in river towboats.

(2349) OIL BARGE DESIGN.

(b) Union Industrial of Astilleros Barranquilla, Colombia.
(d) Experimental.
(e) Determination of best barge form for flotilla operation under local conditions.
(f) 50% completed.

UNIVERSITY OF MINNESOTA, Department of Agricultural Engineering.

(2350) DRAINAGE OF AGRICULTURAL LAND BY PUMPING.

(b) Laboratory project.
(c) Prof. Curtis L. Larson, Department of Agricultural Engineering, University of Minnesota, St. Paul 1, Minnesota.
(d) Primarily field investigation; applied research.
(e) The project has three objectives: (1) To develop basic relations for planning pump drainage systems; (2) to study rates of underdrainage; and (3) to study factors affecting the efficiency and cost of drainage pumping plants.
(h) "Principles of Planning Pump Drainage Outlets", by Curtis L. Larson and Evan R. Allred, Agricultural Engineering, Vol. 37, No. 1, 3 pp. 1956.
"New Device for Measuring Gravity Flow from Pipes", by Curtis L. Larson and Lee F. Hermsmeier, submitted to Agricultural Engineering for publication.

(2576) CONSTRUCTION, DEVELOPMENT AND PUMPING OF SHALLOW WELLS FOR IRRIGATION.

(b) Field project.
(c) Prof. Evan R. Allred, Department of Agricultural Engineering, University of Minnesota, St. Paul 1, Minnesota.
(d) Field investigation; applied research and development.
(e) The objectives of the project are: (1) To study and develop inexpensive methods for construction of shallow irrigation wells, (2) determine hydraulic permeability and characteristics of various aquifers, and (3) to survey and determine extent and availability of shallow groundwater sources for irrigation in Minnesota.

(2577) TILE DRAINAGE HYDRAULIC STUDIES.

(b) Laboratory project.
(c) Prof. P. W. Manson, Agricultural Engineering, St. Paul Campus, University of Minnesota, St. Paul, Minnesota.
(d) Theoretical; basic research.
(e) Actual energy loss at a tile junction has long been a major unanswered question in the design of a tile drainage system. In order to make an investigation under simulated conditions, a laboratory study was set up at the St. Anthony Falls Hydraulic Laboratory at the University of Minnesota to determine junction energy losses when the lateral has the following area-ratios to the main; 1:1, 1:2, 1:4, 1:7, and 1:16. The entry angles were 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, and 165 degrees. The velocity of flow in the lateral and the main ranged from 2 to 15 fps. The pipes were flowing full at all times.
(g) The junction energy loss for a 90-degree junction angle, where the lateral size is the same as the main size, is insignificant from a practical standpoint and the 90-degree junction will give as satisfactory results for agricultural drainage systems as the more commonly recommended 45-degree junction. Research not completed for all ratios of lateral size to the main.
(h) "Energy Losses at Draintile Junction", Journal of the American Society of Agricultural Engineers, Vol. 37, No. 4, April, 1956.

MISSISSIPPI STATE COLLEGE, Engineering and Industrial Research Station.

Inquiries concerning Projects Nos. 4 and 1631 should be addressed to Dr. Harold Flinsch, Mississippi State College, Box 1516, State College, Mississippi.

(4) THE EFFECT OF WIND ON WAVES.

(b) Laboratory project.
(d) Experimental, theoretical and field investigation; basic research.

(e) Measurement of wave characteristics in wind-wave tunnel in laboratory; measurement of wind and waves in field (Gulf of Mexico); theoretical analysis.
(g) Off-shore wave height, interval, and direction measurements in Gulf of Mexico, with recording apparatus.
(h) "Conference on Coastal Engineering Instruments", Berkeley, California, Oct. 1955, preliminary report.

(1631) THE EFFECT OF WAVES ON BEACHES.

(b) Laboratory project.
(d) Experimental, theoretical, and field investigation; basic research.
(e) Beach material and contour measurements, under natural and laboratory conditions.
(g) Beach slope and contour formulas; effect of structures on contours and slope.

MISSOURI SCHOOL OF MINES AND METALLURGY, Department of Civil Engineering.

(317) VELOCITY STUDIES IN A VERTICAL PIPE FLOWING FULL.

(b) Laboratory project.
(c) Prof. Clifford D. Muir, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Mo.
(d) Experimental; basic research for master's thesis.
(e) Tests were conducted on vertical flow in 1/2 inch hard-drawn copper pipe to investigate flow with pipe flowing full and under positive pressure.
(g) The experimental results obtained were in agreement with theoretical computations. Continuing studies confirm the previous results.
(h) "Velocity Studies in a Pipe Flowing Full", R. F. Tindall. Master's Thesis, Missouri School of Mines, 1950. (Available on loan.)

(319) WEIR STUDIES.

(b) Laboratory project.
(c) Prof. E. W. Carlton, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Mo.
(d) Experimental; basic research for master's thesis.
(e) Tests on rectangular weirs were made to determine effect of velocity of approach on the relation between crest depth and critical depth of an imaginary open channel having same dimensions as the weir opening.
(g) Study produced a simple, accurate, and quick solution for plotting of M function. Relationship between the M function and the critical depth is logarithmic. This greatly simplifies determination of critical flow where the critical depth is known or vice versa. A relationship exists between M function of channels of same shape but different dimensions. The velocity of approach does not affect the relationship between physical depth and crest depth.
(h) "Calibration of Weirs by Means of Critical Flow and Specific Energy". R. A. Rapp, Master's Thesis, Missouri School of Mines, 1950. (Available on loan.)

(2133) COMPRESSIBLE FLOW.

(b) Laboratory project.
(c) Prof. Clifford D. Muir, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Mo.
(d) Experimental.
(e) This project is primarily a study of orifice coefficients using compressed air as the test fluid. It is felt that this project will confirm some proposed orifice coefficients and serve as a basis for an enlarged study of several orifice characteristics, such as head loss, shape effect, etc.
(f) Suspended.

(2578) CORRELATION OF WEIR CREST DEPTH AND WEIR FLOW CHARACTERISTICS.

(b) Laboratory project.
(c) Prof. Clifford D. Muir, Civil Engineering Department, Missouri School of Mines and Metallurgy, Rolla, Missouri.
(d) Experimental.
(e) Tests on several cipoletti weirs were made in order to determine the effect of weir thickness, H/P ratio, and Froude's Number on the ratio of crest depths to the critical depths of an imaginary open channel having the same dimensions as the weir flow section.
(g) This study indicated a definite relationship between the crest depth to critical depth ratio and the Froude Number of the imaginary channel. However, the ratio tended to become constant at either high or low Froude Numbers. The H/P ratio had no noticeable affect on this relationship.
(h) "Correlation of Weir Crest Depth Froude Number, H/P Ratio, and Weir Thickness", Paul Harrawood. Master's Thesis, Missouri School of Mines, 1956. (Available on loan.)

UNIVERSITY OF MISSOURI, Department of Civil Engineering.

(2134) HEAD LOSSES IN STORM DRAIN JUNCTION BOXES.

(b) Missouri State Highway Department in cooperation with U. S. Bureau of Public Roads.
(c) Prof. Horace W. Wood, 243 Engineering Building, University of Missouri, Columbia, Mo.
(d) Experimental; applied research, development.
(e) Model study of junction boxes for use in urban highway construction; methods for determining coefficients by which head losses in junction boxes can be accurately predetermined for various common configurations.
(g) Work completed for straight-through flow; lateral flow combining with straight-through flow; directly opposed, combining flow; offset opposed, combining flow; directly opposed and offset opposed flow modified by means of devices; flow through top grates. Square and round manholes are under investigation.
(h) "Head Losses in Storm Drain Junction Boxes", Horace W. Wood. Proceedings, Highway Research Board, Nov. 1956.

MONTANA STATE COLLEGE, Agricultural Experiment Station, Dept. of Agricultural Engineering.

Inquiries concerning Projects Nos. 2579 and 2580 should be addressed to Mr. O. W. Monson, Irrigation Engineer, Agricultural Experiment Station, Montana State College, Bozeman, Mont.

(2579) STREAM FLOW FORECASTING BASED ON SNOW SURVEYS.

(b) Cooperative with Soil and Water Conservation Research Branch, Agricultural Research Service.
(d) Experimental; to improve methods of forecasting stream flow and seasonal runoff for irrigation, power, flood control and other uses.
(e) A network of snow survey courses have been established on all the principal watersheds of Montana. Snow measurements are made at these points during the winter and spring months. The water equivalent of the snow is correlated with subsequent runoff from the watershed. Provisional forecasts are published as early as March of each year. Final forecasts are amended as necessary in April and May.
(g) Accuracies may be commonly expected between 5 and 10%.
(h) Published forecasts are sent to a selected list of agencies, libraries, and water users.

(2580) EFFICIENT APPLICATION OF IRRIGATION WATER.

(b) Cooperative with the U. S. Bureau of Reclamation.
(d) Experimental and field investigations.
(e) This study is an attempt to correlate the size of irrigation stream with the rate of infiltration of the soil and the length of run and the slope of field.
(g) It has been found that the use of a larger stream than necessary results in excessive application of irrigation water due to surface ponding.
(h) Annual reports prepared for cooperating agencies. No published reports.

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY.

Inquiries concerning Projects Nos. 123, 124, 896, 901, 1132, 1133, 1136, 2581, and 2582 should be addressed to Mr. C. H. Hancock, Hydraulic Laboratory, Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

(123) HYDRAULIC TURBINE TESTS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale model turbines, using either Francis or propeller type runners, are tested for power and efficiency at various speeds.

(124) METER CALIBRATION TESTS.

(b) Laboratory project.
(d) Experimental.
(e) To establish calibration curve for determining correction for various rates of flow. Meters are tested at various rates of flow by weighing tank method. Time is recorded electronically by decade counters.

(896) VANE MOMENT TESTS ON ADJUSTABLE BLADE RUNNERS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Tests are to determine vane moment diagrams. The turbine load is applied by an electrical dynamometer and the gate openings are controlled by a governor. The blades adjust automatically and the blade moment is measured by a spring dynamomemter.

(901) SHIP MODEL RESISTANCE TESTS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale ship models are towed to determine the effective horsepower, bare hull, required by the ship. Because of their small size, several models may be towed in a short period of time thus allowing much preliminary work to be done on the choice of lines. The final lines are checked by the David Taylor Model Basin. To eliminate a large portion of this preliminary testing, a schedule of systematic models was arranged in which the beamdraft ratio, the displacement-length ratio, and the prismatic coefficient are varied over a wide range. Towing of this set of models is continuing and when completed will provide design data for a standard offset series covering a wide range.

(1132) HYDRAULIC PUMP TESTS.

(b) Laboratory project.
(d) Experimental; for design data.

(e) Scale model pumps centrifugal and propeller types, are tested at constant speeds for head developed, power consumption, and efficiency at various rates of discharge. Cavitation tests are sometimes conducted by lowering the suction head to a point where the developed head and efficiency break down.

(1133) CAVITATION TESTS OF HYDRAULIC TURBINE MODELS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Scale model turbines are tested on cavitation stand to determine sigma at which cavitation starts. By the use of a Plexiglas throat ring and a Strobolux light synchronized with the shaft rotation, visual observations are made to determine the location on the blade where cavitation starts. Tests also run to determine runaway speeds at low sigma values.

(1136) WAVE TESTS ON SHIP MODELS.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Ship models are tested with scaled waves to determine the speed reduction in waves for the pull required for various still water speeds. Pitching periods and angles are determined from light trace photographs. Wave tests were conducted for the ICSH Seaworthiness Committee and the results were reported at the Seventh International Conference on Ship Hydrodynamics in Scandinavia in August 1954. These tests were made on a Todd-Forrest Series 60, Block 0.60 model, at three radii of gyration, at five towline pulls, in four wave lengths of a single wave height. Wave tests are being made in conjunction with the ATTC Seaworthiness Committee program. The parent model for these tests is the Todd-Forrest Series 60, Block 0.60. Tests have been completed on three models of a flare series, all models having the same shear line and radius of gyration. The models were tested at five towline pulls in five wave-lengths and two wave-height ratios. Shear and other variations will be tested as time permits.

(2581) PIVOTING TESTS ON JOHN SARGENT MODEL.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Model test to see if the adjustable blade propeller on the gas turbine powered ship JOHN SARGENT would cause any maneuvering hazard when the propeller blades were adjusted to give zero thrust. The pivoting rate and characteristics were measured at several drafts.
(f) Completed.

(2582) AIR TESTS ON HYDRAULIC TURBINE MODEL.

(b) Laboratory project.
(d) Experimental; for design data.
(e) Plexiglas hydraulic turbine model is tested with air. Smoke and tufts are used in the flow visualization studies. Velocity and pressure distribution studies are made using a sensitive differential manometer. The gate moments obtained from the pressure distribution will be checked with a strain gage dynamometer.

NEW YORK UNIVERSITY, Department of Chemical Engineering.

Inquiries concerning Projects Nos. 2135, 2583, and 2584 should be addressed to Prof. John Happel, Department of Chemical Engineering, New York University, Bronx 53, New York.

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(2135) EFFECT OF A CYLINDRICAL BOUNDARY ON STEADY VISCOUS FLOW PAST SINGLE SPHERES.

(b) Grant from Texas Company, laboratory project.
(d) Experimental; basic research for doctoral thesis.
(e) A study of the effect of a cylindrical boundary on steady flow past spheres as a function of Reynolds number, sphere-to-cylinder diameter ratio and distance of sphere from cylinder axis by measurement of drag on spheres and pressure drop caused by their presence.
(g) Experimental pressure drops measurements in "creeping motion" indicate very good agreement with existing theoretical treatments.

(2136) EFFECTS OF BOUNDARY PROXIMITY IN DILUTE, FLUIDIZED AND SEDIMENTING SYSTEMS OF UNIFORM SPHERICAL PARTICLES AT LOW REYNOLDS NUMBERS.

(b) Work initiated under a grant from the Research Corporation of America being continued under a grant from the National Science Foundation; laboratory project.
(c) Mr. Howard Brenner, Department of Chemical Engineering, New York University, Bronx 53, New York.
(d) Theoretical; basic research.
(e) An attempt to reconcile the theoretical and experimental discrepancies observed in the determination of pressure drop caused by slow viscous flow in bounded and unbounded media at identical voidages and velocities.
(g) An approximate theory for the behavior of multi-particle systems suspended in a viscous fluid is developed, based on a rigorous treatment for the case of a single sphere occupying any position in a cylindrical tube. The results obtained include estimates of the effect of the various parameters involved on the particle velocity and spatial distribution of particles in sedimenting and fluidized beds, as well as the pressure drop resulting from passage of fluid. The conclusions presented are in agreement with such experimental data as are available and furnish a basis for more exact treatment of these systems.
(h) "Motion of Spheres and a Fluid in a Cylindrical Tube" by John Happel and Howard Brenner. Presented at Christmas Symposium of the American Chemical Society, Division of Industrial and Engineering Chemistry, Dec. 27-28, 1956, Purdue University, Lafayette, Indiana.

(2583) EFFECT OF PARTICLE CONCENTRATION ON PRESSURE DROP AND SEDIMENTATION VELOCITY IN DILUTE BEDS OF PARTICLES.

(b) Grant from Texas Company; laboratory project.
(d) Theoretical; basic research for master's thesis.
(e) The slow translational motion of two arbitrarily oriented spheres in a vertical cylindrical tube through which a viscous fluid is flowing is being studied. This will ultimately enable a thoretical prediction of the effect of particle concentration on pressure drop and sedimentation velocity in beds of particles.

(2584) AN EXPERIMENTAL STUDY OF THE SLOW MOTION OF TWO SPHERES IN A VISCOUS FLUID.

(b) Grant from the American Petroleum Research Fund of the American Chemical Society; laboratory project.
(d) Experimental; basic research for master's thesis.
(e) Determination of the terminal settling velocity of two equal size spheres moving (1) parallel to their line of centers, and (2) perpendicular to their line of centers as a function of ratio of sphere diameter to center-to-center distance. An attempt to verify existing theoretical solutions of this problem for the case of "creeping motion" as well as a determination of the upper Reynolds number limit beyond which the theoretical treatment becomes invalid.

NEW YORK UNIVERSITY, Fluid Mechanics Laboratory.

(1912) DISCHARGE CHARACTERISTICS OF A SIDE WEIR.

(b) Laboratory project.
(c) Prof. A. H. Griswold, New York University, New York 53, N. Y.
(d) This is an applied research project in which a theoretical analysis is being checked experimentally.
(g) A test program has been completed that included tests of two widths of channel, two lengths of crest and two crest heights. The analysis of this data is underway.

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA, Department of Engineering Research.

(593) DYNAMIC SIMILARITY OF SMALL HYDRAULIC MODELS.

(b) Laboratory project.
(c) Prof. Leonard W. Long, Department of Engineering Research, North Carolina State College, Raleigh, N. C.
(d) Experimental and theoretical; basic research.
(e) Experimental determinations and theoretical studies and dynamic similarity of small hydraulic models by large scale ratios.
(h) "Tests of a Broad-Crested Weir with Two Different Surface Adhesion Conditions", by L. W. Long and N. W. Conner, Engineering School Bulletin No. 61, March 1956.

(1636) RAINFALL, INTENSITY, DURATION, FREQUENCY, CURVES FOR NORTH CAROLINA.

(b) Laboratory project.
(c) Prof. Charles Smallwood, Department of Engineering Research, North Carolina State College, Raleigh, N. C.
(d) Experimental.
(e) The collection and analysis of data pertaining to intensity, duration and frequency of rainfall in North Carolina.

NORTHWESTERN UNIVERSITY, The Technological Institute.

(2137) SPRAY DROPLET FORMATION AND VAPORIZATION.

(b) Laboratory project, supported in part by Project SQUID, Princeton University.
(c) Prof. William F. Stevens, Chemical Engineering Dept., Northwestern Technological Institute, Evanston, Ill.
(d) Experimental and theoretical; basic research, in part for thesis work.
(e) To understand more completely the operation of a spray nozzle, information is being sought concerning the mechanism of spray formation and vaporization. Studies are presently being carried out to determine drop-size distributions and to measure the rates of droplet evaporation.
(g) A unique drop-size distribution determination technique has been developed, in which the entire spray is captured in liquid nitrogen and the resulting solid particles sized by screening.
(h) "A New Technique for Drop-Size Distribution Determinations", Choudhury and Stevens, AIChE Meeting, Nov. 27-30, 1955 (copies available from author).
"Composition Change in Binary-Component Spray Vaporization at Atmospheric Pressure", Culverwell, Grounds, Lamb, and Stevens, AIChE Journal, Dec. 1956 (copies available from authors).

(2359) HEAT TRANSFER STUDIES IN THE FLOW OF FLUIDS THROUGH GRANULAR SOLIDS.

(b) Laboratory project.
(d) Experimental; basic research; doctoral thesis.
(e) Heat and momentum transfer studies have been made for the flow of gases through fixed beds consisting of solid metallic packings. The experimental technique employed in these studies made possible for the first time the procurement of gas film heat transfer data under steady state conditions and in the absence of mass transfer effects. Electric current was passed through the metallic particles of the bed creating within the particle a steady generation of heat which was continuously removed by gases flowing through the bed.
(f) Completed.
(g) Project will be continued.
(h) "Heat and Momentum Transfer in the Flow of Gases Through Packed Beds", M. B. Glaser and George Thodos. Submitted for publication to the Journal of the American Institute of Chemical Engineers.

(2361) FATE OF FISSION PRODUCTS IN SURFACE WATERS AT(11-1)-353.

(b) U. S. Atomic Energy Commission.
(c) Mr. C. G. Bell, Northwestern University, Evanston, Ill.
(d) Experimental; basic research.
(e) Study of the fate of fission products when injected into the Chicago Sanitary Ship Canal near Lemont, Ill.

(2585) MODEL STUDY ON SAVANNAH TIDAL ESTUARY.

(b) U. S. Atomic Energy Commission.
(c) Mr. C. G. Bell, Northwestern University, Evanston, Ill.
(d) Experimental; basic research.
(e) Study of feasibility of using a tidal model as an aid in the study of the fate of radioactive wastes in a tidal estuary.

(2586) DISPERSION OF FLUID IN POROUS MEDIA.

(b) Laboratory project.
(c) Prof. R. B. Banks, Civil Engineering Dept., Northwestern University, Evanston, Ill.
(d) Experimental and theoretical; thesis.
(e) Packed column apparatus permits sampling of fluid flow to determine effects of dispersion, diffusion and convection on the change in solute concentration.
(g) A theoretical analysis of the problem indicates that the phenomena is described by an equation similar to the heat conduction equation. Attempts are being made to correlate the dispersion coefficient in terms of a modified Reynolds number.

(2587) PROFILE DIMENSIONS IN ANNULAR TWO-PHASE FLOW.

(b) Laboratory project.
(c) Prof. H. N. McManus, Jr., Northwestern Univ., Evanston, Ill.
(d) Experimental and theoretical; for doctoral thesis.
(e) Annular profiles measured for air Reynolds Number 75,000 - 125,000. Surface disturbance heights measured.
(f) Completed.
(h) In preparation, Ph.D. Thesis, H. N. McManus, Jr., University of Minnesota, 1955.

(2588) GAS VELOCITY PROFILES IN ANNULAR TWO-PHASE FLOW.

(b) Laboratory project.
(c) Prof. H. N. McManus, Jr., Northwestern Univ., Evanston, Illinois.
(d) Experimental; applied research.
(e) Extension of film profile study, and measurement of gas velocity profile will be made.

UNIVERSITY OF NOTRE DAME, College of Engineering.

(1641) THE KINETIC ENERGY FACTOR FOR THE TRUE VELOCITY HEAD.

(f) Completed.
(h) "Methods of Determination of the Kinetic Energy Factor", by S. Kolupaila, The Port Engineer, 5 (1956), No. 1, Jan., pp. 12-18. Calcutta.

(2362) INVESTIGATION OF HYDROMETRIC (ANDERSON) SCREEN.

(b) Laboratory project.
(c) Dr. S. Kolupaila, Dept. of Civil Engineering, University of Notre Dame, Notre Dame, Ind.
(d) Design and experimental investigation.
(e) A carriage with a screen is installed in a 4' x 2.5' channel for discharge measurement; compared with volumetric and weir measurements.
(g) Corrections are determined for available limits of flow.

(2363) A STUDY OF CIRCULAR WEIRS.

(b) Laboratory project.
(c) Dr. S. Kolupaila, Dept. of Civil Engineering, University of Notre Dame, Notre Dame, Ind.
(d) Experimental investigation.
(e) Two sharp-edged weirs 4" and 12" in diameter are tested in a hydraulic flume 2.25' wide by 2.75' deep.
(g) Method of A. Staus (1930) checked, a table computed for English units.

(2364) VELOCITY DISTRIBUTION ACROSS A PIPE.

(b) Laboratory project.
(c) Dr. S. Kolupaila, Dept. of Civil Engineering, University of Notre Dame, Notre Dame, Ind.
(d) Experimental investigation.
(e) A pitometer is installed in a 4" diameter pipe for investigation of velocities of water flow and pulsation.
(g) The logarithmic and exponential laws of velocity distribution along two transverses are being adjusted; the relation between the average velocity and the maximum velocity is established.

(2589) DIFFERENTIATION AND INTEGRATION OF HYDROLOGIC DATA.

(b) Laboratory project.
(c) Prof. S. Kolupaila, College of Engineering, University of Notre Dame, Notre Dame, Ind.
(d) Experimental; applied research.
(e) Detailization of the unit discharge and its integration across the basin area.
(g) A practical method for detailed analysis of deficient data.
(h) A report for the 1957 Assembly of the Int. Union of Geodesy and Geophysics is in process.

PENNSYLVANIA STATE UNIVERSITY, Hydraulics Laboratory, Department of Civil Engineering.

Inquiries concerning Projects No. 2139 and 2590 should be addressed to Professor Sam Shulits, Hydraulics Laboratory, Department of Civil Engineering, Pennsylvania State University, University Park, Pennsylvania.

(2139) RECTANGULAR-THROAT VENTURI FLUME.

(b) Laboratory project.
(d) Experimental; basic research; master's thesis.
(e) Rectangular-throat flume installed in a 12-inch circular Transite pipe with invert slopes of 0.0014 to 0.0254 and discharges of 0.004 to 1.925 cfs, to check the theoretical rating and to determine the limits over which the flume will operate.

(f) Completed.
(g) A throat width approximately seven-tenths of the pipe diameter gave optimum results. The theoretical and actual rating curves for the slopes of 0.0014, 0.0053, 0.0110, and 0.0177 agreed up to a discharge of 1.2 cfs; beyond this the actual discharge exceeded the theoretical by amounts up to 9 per cent, increasing with the depth of flow upstream from the flume.
(h) "A Rectangular-Throat Venturi Flume as a Flowmeter in Circular Conduits", by Calvin E. Levis, M. S. Thesis, June 1956.

(2590) ARTIFICIAL SIDEWALL ROUGHNESS IN A RECTANGULAR FLUME.

(b) Laboratory project.
(d) Experimental; basic research; master's thesis.
(e) In a rectangular flume 1 foot wide and 20 feet long, square pegs (1/2 in.) will be fastened to the walls in various patterns. The wall roughness and peg distribution will be correlated with the velocity and pressure distribution and with the boundary shear.
(g) Experimentation to start February 1957.

PENNSYLVANIA STATE UNIVERSITY, Ordnance Research Laboratory.

(921) PROPELLERS FOR OPERATION IN SYMMETRIC WAKES.

(b) Bureau of Ordnance, Department of the Navy, (Contract NOrd 16597).
(c) Mr. J. J. Eisenhuth, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Theoretical and experimental; applied research.
(e) The problem concerns the design of optimum efficiency and cavitation-free propellers for operation behind bodies of revolution. It is being attacked through consideration of the mechanics of propeller action. Design methods resulting from the theory are tested by experiment on an 8-inch diameter model torpedo in the 48-inch water tunnel.
(g) Work with propellers designed for optimum efficiency and cavitation characteristics indicated that these two parameters can be predicted with reasonable accuracy.
(h) "A Study of Torpedo Propellers-Part Ia, B. W. McCormick, J. J. Eisenhuth, and J. E. Lynn, March 30, 1956, ORL Report NOrd 16597-5.

(1386) CAVITATION STUDIES.

(b) Laboratory project for the Office of Naval Research.
(c) Mr. J. W. Holl, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental; basic research.
(e) Investigation of cavitation scaling on two-dimensional hydrofoils. The size of the hydrofoil, water velocity, air content, surface roughness and water temperature are varied to determine their effect on the inception of cavitation.
(f) Completed.
(h) "Investigations of Scale Effects on Cavitation Inception", G. L. Calehuff, G. F. Wislicenus, April 16, 1956, ORL TM No. 19.4212-03.

(1387) STUDY OF TIP VORTEX CAVITATION.

(b) Laboratory project supported by the Office of Naval Research.
(c) Mr. J. H. Light, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental.
(e) Investigation of the scale effects on the cavitation inception index of a trailing vortex system behind a wing.
(f) Completed.
(g) Earlier work resulted in a semi-empirical method for the prediction of a minimum pressure in a trailing vortex section behind the wing. Present investigation concerns scale effects which are now being analyzed. Report will be issued.

(2368) INVESTIGATION OF HYDROELASTIC PHENOMENA.

(b) Laboratory project.
(c) Mr. J. H. McGinley, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental and theoretical; basic research.
(e) Investigation of the parameters affecting the hydrodynamic excitation of sympathetic vibrations of underwater vehicles including appendages and propulsers. Isolation and classification of various types of resonance such as singing, rumbling, etc. The aim of the program is to determine the nature of the hydrodynamic excitation forces which cause resonance, the vibration characteristics of the objects undergoing investigation, and laws governing such phenomena.
(f) Inactive.
(g) The "singing" characteristics of three fixed wings of different materials have been measured in a water tunnel. This type of resonance is caused by the hydrodynamic exciting forces of a Karman vortex street shed from the trailing edge of the wing. The frequency of the singing, the velocity of the flow and the trailing edge thickness of the wing correlate to each other in a Strouhal number relation. The different materials have shown that the singing is produced by resonance between the hydrodynamic excitation and the natural frequency of elastic vibration of the singing element.

(2369) TURBULENCE DETECTION THROUGH THERMISTORS.

(b) Laboratory project.
(c) Mr. A. F. Lehman, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental; developmental.
(e) Use of a thermistor in exploring the possibilities of using this device as a turbulence detector or as a means of measuring turbulence in water.
(g) Tests with a thermistor in the 48-inch water tunnel indicated the thermistor response detects the presence of the wake of a body and some indication is given as to the change in turbulence levels with a change in water velocity.

(2370) MASS TRANSFER DEVICE FOR MEASURING VELOCITIES AND TURBULENCE IN WATER.

(b) Laboratory project.
(c) Dr. W. E. Ranz, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental and theoretical; applied research.
(e) This study concerns the basic problem of measuring the turbulence in water and also concerns the investigation of flow conditions in water through a mass transfer phenomena.
(f) Completed.
(g) Velocities can be determined with an accuracy of plus or minus 5 per cent using rigid calibrations of the system. Tests indicate the present instrumentation is impractical because of its sensitivity to contamination together with a marked effect of small temperature variation on velocity and diffusity. The method has possible application as a device for measurement of air content of water. Paper in process.

(2591) FLOW VISUALIZATION IN WATER.

(b) Laboratory project for the Bureau of Aeronautics.
(c) Mr. A. F. Lehman, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Experimental.
(e) The basic objective of this program is to determine the feasibility of visually observing two-dimensional flow patterns in water.
(f) Completed.
(g) Water tunnel tests involving water-dye mixes, air bubbles and oil mixtures can be observed under certain conditions and provide good observation of streamline flow. The air bubbles and oil mixtures appear to be most promising from an observation standpoint both visually and photographically. Report now in process.

(2592) TUNNEL MODEL INTERFERENCE.

(b) Laboratory project for the Bureau of Ships.

(c) Mr. T. E. Peirce and Mr. J. H. Light, Ordnance Research Laboratory, University Park, Pa.
(d) Theoretical and experimental.
(e) Through the use of the method Von Karman developed for the calculation of the pressure distribution about airship hulls, tunnel liners can be designed which force the fluid to move around a model (three-dimensional) along the same stream surfaces as those which are formed during free stream testing. The use of the liner technique permits control of the pressure distribution over the model in the area of interest.
(g) This method has been successfully applied to the testing of a model up to one-half of the tunnel diameter without the use of slotted walls. Report in process.

(2593) DESIGN AND TESTING OF A BODY SHAPE WITH REDUCED DRAG.

(b) Laboratory project.
(c) Mr. A. F. Lehman, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Theoretical and experimental.
(e) Design of a reduced drag body through reduction of the friction drag over the forward part of the body by keeping the flow laminar, and minimizing the turbulent wake from the afterbody through the use of one or several "trapped" ring vortices.

(2594) SCALE EFFECTS ON THE INCIPIENT CAVITATION CONNECTED WITH LOCAL SURFACE IRREGULARITIES.

(b) Laboratory project sponsored by the Office of Naval Research.
(c) Mr. J. W. Holl, Ordnance Research Laboratory, University Park, Pennsylvania.
(d) Theoretical and experimental.
(e) An investigation of the effect of the ratio of the roughness height to the boundary layer thickness as isolated from the effect of the overall shape of the parent body. Investigations will be performed on a flat plate spanning the center of the 48-inch diameter working section of the high-speed water tunnel.

PURDUE UNIVERSITY, Agricultural Experiment Station.

(2371) DRAINAGE PROPERTIES AND PROBLEMS OF VIGO, CLERMONT AND STENDAL SOILS.

(b) Laboratory project.
(c) Prof. John R. Davis, Agr. Engr. Dept., Purdue University, Lafayette, Indiana.
(d) Field investigation; applied research.
(e) Following previous groundwater and drawdown measurements and determination of soil physical characteristics, an installation of surface and subsurface drainage facilities will be installed. Surface bedding, tile with bedding, tile with vertical mulching, tile with bedding with vertical mulching and tile will be the major drainage practices considered. Also included in the project is a study of the effectiveness of various backfill materials as filters around tile lines.

(2595) MODEL STUDY OF BREATHERS AND RELIEF WELLS FOR TILE DRAINS.

(b) Laboratory project.
(c) Prof. John R. Davis, Agr. Engr. Dept., Purdue University, Lafayette, Ind.
(d) Experimental; applied research for master's thesis.
(e) The effect of an air breather or relief well on the hydraulic characteristics of steeply sloping pipe lines will be determined in this model study. Variable factors include grades above and below changes in grade, discharge and pressure in the line. Some field measurements of tile line pressures will be made.

(2596) THE DEVELOPMENT AND USE OF A RAINFALL SIMULATOR FOR SOIL AND WATER MANAGEMENT STUDIES.

(b) Agricultural Research Service, SWC, USDA and Purdue University.
(c) Mr. L. Donald Meyer, ARS, Agr. Engr. Bldg., Purdue University, Lafayette, Indiana.
(d) Experimental; development.

(e) Methods of simulating rainfall, particularly the kinetic energy, have been investigated. A portable apparatus, using commercial spray nozzles, has been designed and constructed. This apparatus is capable of intensities of two or more inches per hour on common erosion study plots of approximately 0.02 acre, with adaptation to other sizes readily possible. Studies with the simulator will be designed to evaluate qualitatively the various soil, water, topographic, crop, and management factors that affect runoff, erosion, and infiltration under controlled field conditions.

(2597) THE EFFECTS OF TILLAGE ON RUNOFF AND EROSION.

(b) Laboratory project.
(c) Prof. Helmut Kohnke, Agronomy Department, Purdue University, Lafayette, Ind.
(d) Field investigation; applied research.
(e) Runoff and soil erosion will be measured from 15 watersheds in five different tillage systems. These systems involve two surface soil treatments and three subsoil treatments, including subsoil fertilization and vertical mulching. A complete hydrologic analyses of these small watersheds will be used to evaluate the effects of tillage on soil moisture, evapo-transpiration, crop growth and yield, water and soil losses.

PURDUE UNIVERSITY, School of Chemical and Metallurgical Engineering.

(2372) STATIC PRESSURE DISTRIBUTION IN THE FREE TURBULENT JET.

(b) Fellowship supplied by the Barrett Division of the Allied Chemical and Dye Corporation and by the Purdue Research Foundation.
(c) Prof. E. W. Comings, Head, Department of Chemical and Metallurgical Engineering, Purdue University, Lafayette, Indiana.
(d) Experimental and theoretical investigation; basic research for Ph.D. thesis.
(e) Two experimental systems were investigated. The first of these consisted of a single vertical slot nozzle discharging air at a velocity of about 80 feet per second into ambient room air isothermally. The second system consisted of a parallel pair of vertical slot nozzles joined by a solid boundary preventing inter-nozzle entrainment. The nozzle velocity was approximately the same as for the single jet. Measurements in both cases consisted of mean velocities and longitudinal turbulent intensities taken with a hot wire anemometer and static pressures taken with a specially designed static pressure probe. In the case of the dual nozzle system additional measurements included flow direction measurements in the converging flow region and several impact tube traverses in the merged flow region.
(f) Completed.
(g) The results are examined in terms of the unsimplified equations of fluid motion and comparisons are drawn with the common assumptions and simplifications of free jet theory. Appreciable deviations from isobaric conditions exist and the deviations are closely related to the local turbulent stresses. Negative static pressures were encountered everywhere in the mixing field with the exception of the potential wedge region immediately adjacent to the nozzle. These measurements do not substantiate the common assumptions and simplifactions of free jet theory. Lateral profiles of mean longitudinal velocity conformed closely to an error curve at all stations further than 6 slot widths from the nozzle mouth.
(h) "Static Pressure Distribution in the Free Turbulent Jet", David R. Miller and Edward W. Comings. Submitted for presentation at the Chemical Engineering Symposium sponsored by the Division of Industrial and Engineering Chemistry of the American Chemical Society, Purdue University, December 27-28, 1956.

(2598) PRESSURE DROP IN AIR-SOLID FLOW SYSTEMS.

(b) The Texas Company and the Purdue Engineering Experiment Station.
(c) Mr. J. M. Smith, Department of Chemical Engineering, Purdue University, Lafayette, Ind.
(d) Experimental investigation; applied research for Ph.D. thesis.

(e) The pressure drop was measured for the vertical and horizontal transport of glass beads with air in a standard one-half inch pipe. Two sizes of microspheres were used having average diameters of 97 and 36 microns. Average particle velocity data were also obtained over a range of air velocities and solid flow rates.
(f) Completed.
(g) The results of both the pressure drop and particle velocity measurements suggest that the flow pattern of the solid particles changes with their size. The pressure drop data were correlated by a modified Fanning type equation which included the particle velocity and solids flow rate. The equation defines a mixture friction factor which varies with the fluid Reynolds number in a manner similar to the results for homogeneous flow. Mixture friction factors were independent of the direction of flow (vertical or horizontal) and solids flow rate, but dependent upon the fluid Reynolds number and the particle size. More generally it is expected that the friction factor would be affected by all the properties of the particles which influence the turbulence in the flowing stream.
(h) "Pressure Drop in Air-Solid Flow Systems", N. C. Mehta, J. M. Smith, and E. W. Comings. Submitted for presentation at the Chemical Engineering Symposium sponsored by the Division of Industrial and Engineering Chemistry of the American Chemical Society, Purdue University, December 27-28, 1956.

PURDUE UNIVERSITY, School of Civil Engineering.

(1391) INVESTIGATION OF THE FUNDAMENTAL THEORIES OF SEDIMENTATION IN A TANK.

(b) United States Public Service, Federal Security Agency.
(c) Prof. D. E. Bloodgood, Civil Engineering, Purdue University, Lafayette, Indiana.
(d) Experimental research of basic factors affecting sedimentation, for doctoral thesis.
(e) The project is an investigation of the basic factors affecting the sedimentation of solids in water and sewage. Emphasis is given to the effect of influent turbulence on solid removal in settling tanks. Sedimentation studies were carried out in the laboratory to substantiate Hazen's theory that sediment removal is dependent upon surface area and independent of depth. The results showed that the removal of sediment was dependent upon the force of incoming water. A relationship between length of tank required for stilling and influent force for the experimental tank was found.
(f) Completed.
(g) The Hazen theory on sedimentation has been verified experimentally.
(h) "Sedimentation Studies", D. E. Bloodgood, W. J. Boegly, Jr., and C. E. Smith, Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 82, Paper 1083, October 1956.

(2599) MODEL STUDY OF A PORTION OF THE WHITE RIVER.

(b) Indianapolis Power and Light Company, Indianapolis, Indiana.
(c) Dr. J. W. Delleur, Civil Engineering, Purdue University, Lafayette, Indiana.
(d) Experimental; for design, for masters theses.
(e) Investigation and improvements in the hydraulic flow patterns of the White River in the vicinity of the Harding Street Power Plant of the Indianapolis Power and Light Company. Alternations of the stream bed and installation of groins are being tested in order to eliminate the continual deposition of sediments in the vicinity of the intake. Recirculation and density currents are also considered.
(g) Satisfactory dredging and groin locations have been found.
(h) Private progress reports.

PURDUE UNIVERSITY, Jet Propulsion Center, School of Mechanical Engineering.

(2600) A STUDY OF THE MECHANISM OF GOVERNING TWO-PHASE ANNULAR FLOW IN TUBES.

(b) Office of Naval Research under the direction of Project SQUID.
(c) Prof. M. J. Zucrow, Jet Propulsion Center, Purdue University, West Lafayette, Ind.
(d) Experimental and theoretical.
(e) The overall problem is related to the study of the liquid film-cooling of tubes through which high temperature gases are flowing. The objectives of the study are to obtain an understanding of the interaction between a high velocity gas stream and a liquid film flowing along a wall. At present a study is being conducted of the velocity, frequency and thickness of the waves existing upon the surface of the liquid film as it flows vertically downward on the inside of a glass tube.

REED RESEARCH INCORPORATED.

(2375) ON THE CODIFICATION OF HYDRAULICALLY ROUGH SURFACES.

(b) Office of Naval Research, Department of the Navy, (David Taylor Model Basin Technical Supervision).
(c) Mr. R. Taggart, Reed Research, Inc., 1048 Potomac Street, N. W., Washington 7, D. C.
(d) Experimental; applied research.
(e) Direct measurements of wall shear stress are made on a series of 4" square plates containing randomly distributed projection-type roughness elements. Velocity distributions are measured at the downstream end of the plate. The roughness effect of each of 16 roughened surfaces is being studied by measuring the downward shift of the logarithmic region of the velocity distribution from that of a smooth case. Experiments are being carried out in a rectangular water channel (aspect ratio 9:1) and the range of Reynolds numbers is from $R = 1.1 \times 10^5$ to $R = 7.5 \times 10^5$ (based on tunnel size).

(2376) FLOW VISUALIZATION.

(b) Office of Naval Research, Department of the Navy (David Taylor Model Basin Technical Supervision).
(c) Mr. R. Taggart, Reed Research, Inc., 1048 Potomac Street, N. W., Washington 7, D. C.
(d) Experimental.
(e) By using neutrally buoyant globules of anisole (methoxybenzene) along with a fluorescent dye (rhodamine-b), a study is made of paths traced out by these indicators when the flow in a rectangular channel passes through the transition region. The facility is a 2" x 8" x 20' - 0" long lucite tunnel and the method of visualization is by motion pictures.
(f) Completed.
(g) Still photographs have been taken of the flow around a half-sphere and a half-cone. Excellent motion pictures have been made of a single anisole bubble deforming and finally breaking up into smaller diameter bubbles as the flow changes from laminar to turbulent. The interfacial tension of the anisole may be varied by the addition of a suitable detergent. The rhodamine-b dye and the anisole are shown to be optically superior to other dyes and oil drops.
(h) Report submitted and accepted.

(2601) MEASUREMENT OF NOISE CREATED BY UNDERWATER EMISSION OF AIR BUBBLES.

(b) Office of Naval Research, Department of the Navy, (David Taylor Model Basin Technical Supervision).
(c) Mr. Robert Wallis, Reed Research, Inc., 1048 Potomac Street, N. W., Washington 7, D. C.
(d) Experimental.

(e) A quiet 12,000 gpm flow facility is being constructed for the purpose of measuring the noise created by underwater emission of air bubbles, at various water velocities. The fundamental requirement for this facility is that it provide a quiet flow of water up to a speed of twenty knots through a one foot diameter test section into which the experimental devices can be inserted. Hydrophones will be placed, out of the flow, in an acoustically and optically transparent enclosure, to measure the waterborne noise. Photographs will also be taken of the bubbles.

ROCKY MOUNTAIN HYDRAULIC LABORATORY.

(2140) EVALUATION OF OPEN-CHANNEL FRICTION LOSSES.

(b) National Science Foundation, cooperative with U.S. Geological Survey, State University of Iowa, Ohio State University, and Colorado A and M College.
(c) Prof. C. J. Posey, Director, Rocky Mountain Hydraulic Laboratory, Allenspark, Colorado (summer), State University of Iowa, Iowa City, Iowa (winter).
(d) Experimental, basic.
(e) Variable-slope flume long enough to permit accurate evaluation of open-channel friction losses will be tested at slopes into the steep range. Roughness and shape variables will also be investigated.
(g) Summer 1956 tests in the 400 ft. ninety-degree V-shaped flume with smooth surface included over a hundred runs at discharges up to about 30 cfs and slopes up to about 0.013. The channel will be roughened for 1957 tests.
(h) Report on smooth channel tests in preparation.

(2602) TESTS OF EROSION AROUND MODELS OF SUBMERGED OIL-DRILLING BARGES.

(b) Bethlehem Steel Company, Shipbuilding Division, Beaumont, Texas.
(c) Prof. C. J. Posey, Director, Rocky Mountain Hydraulic Laboratory, Allenspark, Colorado (summer), State University of Iowa, Iowa City, Iowa (winter).
(d) Experimental, applied.
(e) To determine comparative erosion resistance of various barge designs.
(f) Completed.
(h) "Tests of Erosion Around Models of Submerged Oil-Drilling Barges", by C. J. Posey and R. G. Warnock, Rocky Mountain Hydraulic Laboratory, Nov. 1956.

ST. ANTHONY FALLS HYDRAULIC LABORATORY, University of Minnesota.

Inquiries concerning Projects Nos. 100, 1665, 1669, 1928, 2141, 2142, 2143, 2144, 2148, 2379, 2381, 2383, 2384 and 2603 to 2612 incl., should be addressed to Dr. Lorenz G. Straub, Director, St. Anthony Falls Hydraulic Laboratory, Hennepin Island, Minneapolis 14, Minnesota.

Inquiries concerning Projects Nos. 111, 1168, 1398, and 2386, which are conducted in cooperation with the Agricultural Research Service, should be addressed to Mr. Fred W. Blaisdell, Project Supervisor, Watershed Hydrology Section, Soil and Water Conservation Research Branch, Agricultural Research Service, St. Anthony Falls Hydraulic Laboratory, Minneaplis, Minnesota.

Projects Nos. 194, 412, 985, 1206, 1977, 2199, 2424, 2425, 2669 to 2672 incl., which are conducted at the St. Anthony Falls Hydraulic Laboratory in cooperation with the Corps of Engineers, St. Paul District, St. Paul, Minn., are listed on pages 139 and 140.

(100) AIR ENTRAINMENT RESEARCH.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental.
(e) Investigation of self-aeration of high velocity open-channel flow. Air concentrations distributions in the flow have been measured for equilibrium aeration conditions in smooth channel for discharges up to 10 cfs and slopes up to 45° and in artificially roughened channels for discharges up to 15 cfs and slopes up to 75°.
(g) Air concentration distribution in both smooth and rough channels indicates that the flow consists of two parts: (1) Open channel flow in lower region with air distributed by turbulent mixing, (2) an upper region consisting of water particles or spray carried through a surface by intense transverse velocity fluctuations. Roughness coefficient for aerated flow decreases with increasing air concentration which depends primarily upon slope and less upon discharge.

(111) CLOSED CONDUIT SPILLWAY.

(b) Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for development and design.
(e) Tests have been made on three different sizes of lucite pipe set on slopes ranging from 2.5% to 30% to verify the similarity relationships. Information on discharges, pressures, and flow conditions has been obtained. Characteristics, performance, losses, and pressures in the hood drop inlet are currently being studied.
(g) Theory has been developed, verified, and published. Generalized methods for analysis and reporting results have been developed. Pipe culverts laid on steep slopes will flow completely full even though the outlet discharges freely. Entrained air did not invalidate the Froude model law. A conduit on either steep or flat slopes will flow full if the hood inlet is used, the hood being formed by cutting the pipe so that the crown projects beyond the invert by 3/4 of a pipe diameter.
(h) "The Hood Inlet for Closed Conduit Spillways and Highway Culverts", by Fred W. Blaisdell and Charles A. Donnelly, Agricultural Engineering, Vol. 37, No. 10, pp. 670-672, Oct. 1956.

(1168) A STUDY OF CANTILEVERED OUTLETS.

(b) Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for design.
(e) Pipe outlet conduits for small spillways are frequently cantilevered beyond the toe of the earth dam. Attempts will be made to determine quantitatively the size of the scour hole to be expected under various field conditions.
(f) Suspended.

(1398) STRAIGHT DROP SPILLWAY.

(b) Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for design.
(e) Spillway is used as a grade control structure in ditches and streams. Study will result in general design rules for the spillway and outlet. Outlet studies have been completed. Present studies are to determine spillway performance and capacity with various approach channel shapes.
(f) Suspended.
(g) No method has yet been found by which the discharge coefficient can be related to the variables.

(1665) LOW VELOCITY WIND INSTRUMENTATION.

(b) U. S. Army Signal Corps.
(d) Experimental design and development.

(e) Development studies on a thermal anemometer for measuring speed and three-dimensional direction of atmospheric movements from 1 to 50 fps and from ground to 1000 ft elevation using moored balloon supporting system.

(1669) EXPERIMENTAL INVESTIGATION OF BASIC EQUIPMENT AND METHODS ASSOCIATED WITH LABORATORY WAVE STUDIES.

(b) David Taylor Model Basin, Department of the Navy.
(d) Experimental; basic and applied.
(e) Investigation of absorbers and filters for use in laboratory wave studies.
(g) Performance of an absorber was dependent on the slope, porosity and volume of the absorber and upon the steepness and length-to-depth ratio of the waves. A permeable layer on the surface of the absorber was very beneficial, regardless of slope. Filter tests indicated that high attenuations could be achieved; if improperly constructed the filter would produce objectionable reflections.

(1928) DEPRESSED TEMPERATURE STUDIES.

(b) Missouri River Division, Corps of Engineers.
(d) Basic research; analytical and experimental.
(e) An investigation of the effect of temperature changes on the total sediment load in natural streams. The experimental program includes the measurement in a flume of the amount and size distribution of the suspended and bed load sediment in water at various controlled temperatures.
(g) Both sediment size and concentration of suspended sediment are notably affected by temperatures, both increasing with lowering of temperature. The effect of a temperature decrease of 40° (to about 35° F) was to increase the suspended sediment concentration by a factor of between 2 and 4 depending on the relative depth. For this same temperature range, the median sediment size increased 35 per cent or 2.5 times by weight.

(1929) DRAIN TILE JUNCTION LOSSES.

(b) Minnesota Agricultural Experiment Station in cooperation with the Agricultural Research Service, U. S. Department of Agriculture and the St. Anthony Falls Hydraulic Laboratory.
(c) Prof. Philip W. Manson, Professor of Agricultural Engineering, University of Minnesota, St. Paul Campus, St. Paul, Minnesota.
(d) Experimental; generalized applied research for design.
(e) The junction losses in drain tile flowing full are determined for laterals of different sizes entering mains of different sizes at various angles.
(g) Tests have been completed on sharp edged junctions entering the main at angles varying in 15 degree increments from 15 degrees to 165 degrees. Both the lateral and the main are completely full. The tests cover all possible combinations of discharge in the lateral and the main. Laterals having areas 1/1, 1/2, and 1/4 that of the main have been tested. The results are presented in the form of dimensionless curves. Tests are continuing using smaller laterals.
(h) "Energy Losses at Drain Tile Junctions", by P. W. Manson and F. W. Blaisdell, Agricultural Engineering, Vol. 37, No. 4, pp. 249-252, 257, April 1956.

(2141) TACONITE HARBOR BREAKWATER STUDY.

(b) Erie Mining Company.
(d) Experimental design.
(e) Investigation of the design of the breakwater for Taconite Harbor on the Minnesota Shore of Lake Superior. Purpose of the study was to determine the stability of the proposed design and of an interim breakwater for use during the construction stage.
(f) Completed.
(g) The studies indicated that the armor layer of the final design was stable for anticipated range of wave conditions but an improvement could be effected by extending armor layer farther down the lake side. It was also found that fine core material could be leached out through openings in the armor layer unless coarse core material was placed in the outer zones of the core. The model of the interim breakwater indicated that the armor layer was unstable when exposed to moderate wave action.

(h) "Report on Experimental Design Studies, Taconite Harbor", by Lorenz G. Straub, prepared for Erie Mining Co., Dec. 1955.

(2142) THE ABSORPTION OF ULTRASONIC RADIATION BY SUSPENDED SEDIMENT IN WATER AS A MEASURE OF PARTICLE SIZE AND CONCENTRATION.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) The absorption of a 25 megacycle plane wave of sound in water was measured for concentrations of suspended sediment of 100 - 2200 parts per million by volume for a size range of 44 - 500 microns: investigation is intended to indicate potentialities of sound absorption as an analysis technique for suspended sediment.
(f) Completed.
(g) Experimental work indicates that sediment particles in the above size range and for this sonic frequency behaved as rigid spheres giving a sound absorption coefficient proportional to their projected area. Influence of particle chemical composition appeared unimportant. Resolution of equipment used was approximately 100 parts per million by volume.
(h) "The Measurement of Sediment Properties by the Scattering of Ultrasonic Radiation in Water" by John Killen, Master's Thesis, Jan. 1956, on file at the University of Minnesota Library.

(2143) EXPERIMENTAL STUDIES OF SURFACE WAVE ABSORPTION.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) Procurement of quantitative data on wave attenuation produced by pneumatic and hydraulic breakwaters.
(f) Completed.
(g) Data obtained in small-scale tests of both pneumatic and hydraulic breakwaters indicated that large attenuation could be achieved for waves with length-to-depth ratios between 1 and 2. Also, it was found that horizontal hydraulic jets were superior to vertical hydraulic jets. Large-scale tests provided quantitative data on the power requirements of the hydraulic system and indicated that scale effects were of minor importance for the range covered in the studies. Large-scale tests on the pneumatic system have not been undertaken.
(h) "Experimental Studies of Hydraulic Breakwaters" by John B. Herbich, Jurgen Ziegler and C. E. Bowers, St. Anthony Falls Hydraulic Laboratory Project Report No. 51, June 1956.

(2144) EXPERIMENTAL AND ANALYTICAL STUDIES OF HYDROFOILS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental and analytical; basic research.
(e) Objective of the study is to provide information on the basic mechanism of ventilation of surface-piercing bodies, such as circular cylinders and streamlined shapes, particularly with regard to scale effect.
(g) Fundamental studies of the ventilation of semi-submerged circular cylinders were made to determine the effect of the Weber, Froude, and Reynolds numbers on ventilation, in an effort to arrive at a solution to the problem of scale effect that appears to be associated with this phenomenon. It was found that several combinations of these numbers were required to satisfactorily define ventilation, the particular choice depending on rod diameter and submergence. This phase of the program has been completed, and current investigations include the ventilation study of vertical, semi-submerged struts of streamlined shape at angles of yaw. Significant results have not yet been obtained.

(2148) AIR-WATER MIXTURES IN CLOSED CONDUITS.

(b) David Taylor Model Basin, Department of the Navy.
(f) Suspended. Will be resumed in 1957.
Note that other information on this project may be found in the 1955 entry.

(2379) CRITICAL TRANSPORTING VELOCITY OF PARTICLES ON THE BED OF AN OPEN CHANNEL.

(f) Completed.
(g) The critical transporting velocity is a function of the size of the particles and their specific weight. Equation for critical transporting velocity was verified.
(h) "Critical Velocity of Flow over a Bed of Coarse Non-Cohesive Material" by Vo Ba Phuoc, Master's Thesis, University of Minnesota, April 1956. (Available on inter-library loan.)

(2381) SCOUR BY A JET.

(f) Completed.
(g) The extent of scour is a semi-logarithmic function of time. An expression for the limiting size of the scour hole was obtained and verified by experiment.
(h) "Scour below a Submerged Sluice Gate" by Zal S. Tarapore, Master's Thesis, University of Minnesota, June 1956. (Available on inter-library loan.)

(2383) DRAG FORCES ON SILLS AND BLOCKS.

(b) Laboratory project.
(d) Experimental and analytical; master's thesis.
(e) To measure and to analyze drag forces on sills and blocks for generalized design criteria of stilling basins.
(f) Experimental apparatus completed. Investigation of forces on sills in supercritical flow completed.
(g) Drag force coefficients for different height of sills experimentally established.
(h) "Measurement of Forces on Sills in Supercritical Flow, Using a Specially Designed Dynamometer" by Alexander B. Rudavsky, Master's Thesis, University of Minnesota, July 1956. (Available on inter-library loan.)

(2384) MAYFIELD MODEL STUDIES.

(b) City of Tacoma, Washington Department of Public Utilities, Light Division.
(d) Experimental; design and operation.
(e) A 1:72 scale model of the Mayfield Power Development Project on the Cowlitz River is reproduced to study the hydraulic characteristics of the spillway, intake system and the downstream channel.
(f) Completed.

(2386) GENERALIZED DESIGN OF TRANSITIONS FOR SUPERCITICAL VELOCITIES.

(b) Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for development and design.
(e) Studies will be made to develop a transition and to determine the rules for its design. The transition will be used to change the flow cross section from circular to rectangular when the velocities are supercritical.
(f) Suspended.

(2603) WATER TUNNEL AIR CONTENT STUDIES.

(b) David Taylor Model Basin, Department of the Navy.
(d) Analytical and experimental.
(e) Determination of improved method for controlling content of air contained in water of a cavitation tunnel. System involves separation and extraction of large circulating air bubbles followed by reinjection in small sizes.

(2604) FULL-SCALE CULVERT TESTS.

(b) State Road Department of Florida.
(d) Experimental; applied.

(e) Procure experimental data on friction coefficient for 24-inch and 36-inch concrete culverts with rough and smooth joints, for both machine-made and Vibra-cast pipe.
(g) Results incomplete.

(2605) CALIBRATION OF LARGE VENTURI METERS.

(b) E. I. du Pont de Nemours and Company.
(d) Experimental; applied.
(e) Calibrate large Venturi Meters.
(g) No results available.

(2606) PRIEST RAPIDS MODEL STUDIES.

(b) Public Utility District of Grant County, Ephrata, Washington.
(d) Experimental; design and operation.
(e) A 1:120 scale model of the Priest Rapids Development Project on the Columbia River is reproduced to study the hydraulic design of the spillway, powerhouse and fish facilities.
(g) Study not completed.

(2607) PRIEST RAPIDS (COFFERDAM MODEL).

(b) Harza Engineering Co., Chicago; Grant County Public Utility District, and Merritt Chapman and Scott, contractors.
(d) Experimental; design and operation.
(e) A distorted model, scale 1:60 vertical and 1:180 horizontal is used to determine the placement of the various stages of cofferdam construction. Measurements of channel velocities. Made to assure passage of fish migrants during all phases of construction.

(2608) SEEPAGE THROUGH EMBANKMENTS.

(b) Laboratory project.
(d) Experimental and basic; for master's thesis.
(e) Measurements of flow through a non-cohesive embankment were compared to theoretically computed discharge using experimentally determined resistance coefficient.
(f) Completed.
(g) Good agreement was obtained between measurements and computations when capillary flow was taken into account.
(h) "Experimental Studies of Seepage Flow through Embankments" by Akira Mizuno, Master's Thesis, University of Minnesota, Oct. 1956. (Available on inter-library loan.)

(2609) STUDY OF DISCHARGE VORTICES.

(b) Laboratory project.
(d) Experimental and basic; master's thesis.
(e) Observations were made of the nature of the vortices forming in the headwater pool due to the flow into a vertical culvert inlet.
(f) Completed.
(g) The relationship between the head-discharge curve and the creation of a vortex was observed. The creation of a vortex is delayed if the residual circulation in the inlet is reduced. A reduction in surface tension also delays the formation of a vortex.
(h) "A Study of Discharge Vortices" by Gerald H. Nelson, Master's Thesis, University of Minnesota, Sept. 1956. (Available on inter-library loan.)

(2610) LABORATORY WAVE PROFILE RECORDER.

(b) David Taylor Model Basin.
(d) Experimental; applied.
(e) Study of sonic-ranging type wave profile recorder for specialized laboratory use.
(g) No results available.

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(2611) VISCOUS FLOW IN OPEN CHANNELS.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) Development of instrument and measurement of velocity profiles in laminar flow in a triangular channel of 120 degrees vertex angle.
(f) Completed.
(g) An instrument was developed for measuring small velocities up to within 0.06 inches of a wall with an accuracy of about ± 5 per cent. Measurements agreed roughly with computed laminar velocity profiles for the above channel, and measured bulk friction factor agreed well with the computed one.
(h) "Laminar Flow Velocity Distribution in a 120° Triangular Channel" by Harry M. Howe, Master's Thesis, Dec. 1956, on file at the University of Minnesota Library. A summary of previous thesis work on the title subject was published as: "Some Observations on Open Channel Flow at Small Reynolds Numbers" by Lorenz G. Straub, Edward Silberman and Herbert C. Nelson, American Society of Civil Engineers, Proc. Paper No. 1031, July 1956.

(2612) MODEL STUDY OF INTAKES FOR DEMOPOLIS AND WARRIOR LOCKS, TOMBIOBEE RIVER.

(b) Mobile District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) Models simulating the Demopolis Lock and the contemplated Warrior Lock were built at a scale of 3 to 100 with intakes in the gate sill and the approach walls. Tests were conducted to develop modifications for the Demopolis Lock which would eliminate the vortical disturbance over the intakes and to develop a satisfactory intake design for Warrior Lock.
(f) Testing completed.
(g) The intake manifold design and channel walls were modified to reduce vortical activity in the approach to Demopolis Lock. Warrior Lock approach functioned satisfactorily.
(h) Final report in preparation.

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

(895) COMPILATION OF RESISTANCE AND PROPULSION DATA.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Klemme M. Jones, Technical Coordinator, The Society of Naval Architects and Marine Engineers, 74 Trinity Place, New York 6, New York.
(d) The project is concerned with the effective and systematic presentation of existing experimental data on ship model resistance and propulsion.
(e) Ship model resistance data for models of various types are assembled on standard data sheets designed for ready reference and aimed towards further analysis to determine the influence of hull form on wavemaking resistance. Standard data sheets for reporting data on self-propelled models and model propellers are also devised, and representative data presented thereon. The dual purposes of this compilation work are to foster the adoption of standard forms for reporting model data and to facilitate the analytical analysis to determine the influence of geometry on resistance and propulsion.
(g) One hundred sixty data sheets are now published. Three self-propelled data sheets and three propeller data sheets - one single screw, one twin screw, one quadruple screw for each - have been completed and will be published. Additional resistance data sheets will be compiled to the extent that the ONR contract permits. Six summary sheets listing twenty-five model resistance data sheets per sheet have been published to provide condensed, tabular information regarding the sheets.

(h) "Model Resistance Data Sheets",

Sheets 1-50	$10.00 to members	$11.00 to non-members
Sheets 51-100	10.00 to members	11.00 to non-members
Sheets 101-150	10.00 to members	11.00 to non-members
Sheets 151-160	2.00 to members	3.00 to non-members

Single sheets -- $1.00 each, six summary sheets for sheets 1-150, listing 25 models per sheet, are available at a cost of 50 cents per sheet. They are furnished without charge with orders to complete sets of Data Sheets.

(2387) SEAKEEPING MONOGRAPH.

(b) Sponsored jointly by the Society of Naval Architects and Marine Engineers and the Ship Structures Committee.
(c) Mr. Klemme M. Jones, Tech. Coordinator, Society of Naval Architects and Marine Engineers, 74 Trinity Place, New York 6, New York.
(d) The project is mainly a literature survey of both theoretical and experimental work in the field of applied research.
(e) The project is to prepare a monograph reporting the results of a critical evaluation of the present state of the art concerning the seakeeping characteristics of ships, and is intended to establish the basis for planning further research in this field. The monograph will include essentially four parts: Waves; Forces; Rigid body response; Elastic body response.
(f) Completion is now expected to be prior to 30 June 1957.

(2613) VIRTUAL MASS IN HORIZONTAL SHIP VIBRATIONS.

(b) Laboratory project to be conducted by Dr. Louis Landweber, Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa.
(c) Mr. Klemme M. Jones, Technical Coordinator, The Society of Naval Architects and Marine Engineers, 74 Trinity Place, New York 6, New York.
(d) A theoretical investigation in the basic problem of the added mass of a ship vibrating horizontally.
(e) The project will be an investigation of added mass with the following aims: (1) To devise a method for determining the added mass of a two-dimensional form vibrating horizontally in a free surface; (2) to apply the method to families of ship-shape forms; (3) to develop corrections for the three-dimensionality of the flow for various modes of vibration, since such corrections will probably not coincide with those for vertical vibrations; and (4) to devise an alternative method for obtaining the added mass of a three-dimensional form directly, without recourse to two-dimensional coefficients. If successful, this would also give a more accurate solution for the case of vertical vibrations.

STANFORD UNIVERSITY, Department of Civil Engineering.

Inquiries concerning Projects 1944, 1945, and 1946 should be addressed to Prof. Ray K. Linsley and Projects 2150, 2151, and 2614 to Prof. John K. Vennard, Stanford University, Stanford, California.

(1944) STUDY OF METHODS OF ESTIMATING RESERVOIR EVAPORATIONS.

(b) U. S. Weather Bureau.
(d) Field investigations; applied research.
(e) A small-scale radiation integrator patterned after the Cumming's model is being designed and tested.
(g) Previous field work at campus reservoir is complete. Analysis of data underway. Tentative analysis of reservoir study indicates no significant difference from conclusions of Lake Hefner study.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETERS.

(b) U. S. Bureau of Public Roads.
(d) Statistical analysis; applied research.
(e) Hourly rainfall intensities in northern California for a 2-year period are correlated with various topographic and climatological parameters.
(f) Complete except for preparation of intensity map for northern California.
(g) A relation having a correlation coefficient of 0.88 and standard error of 0.07 in. per hour was derived.
(h) "The Relation Between Rainfall Intensity and Topography in Northern California", R. K. Linsley, Stanford University, Dept. of Civil Engineering, Research Report No. 1. (Available on request.)

(1946) SYNTHESIS OF HYDROGRAPHS FOR SMALL AREAS.

(b) Jointly by U. S. Bureau Public Roads, Agricultural Research Service, and Stanford University.
(d) Theoretical and field investigation; basic and applied research.
(e) An attempt to develop a universal method for estimating the runoff hydrographs from small areas.
(f) Analysis continuing.
(g) Theoretical study of flow profiles for equilibrium and non-equilibrium conditions complete.
(h) "Fundamental Hydraulics of Overland Flow", Eugene Richey, Stanford University. Ph. D. thesis, 1954. (Available from University Microfilms, Ann Arbor, Mich.)

(2150) STUDY OF FLOW FROM A SLOTTED PIPE.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Extension of manifold port problem to a continuous slot.
(g) Experimental work completed; thesis being written.

(2151) MODEL STUDY OF PETERS DAM CHUTE SPILLWAY.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Comparison of spillway performance and design predictions.
(g) Experimental work completed; thesis being written.

(2614) PIPE FRICTION IN UNSTEADY FLOW.

(b) Laboratory project.
(d) Experimental and analytical; Ph. D. thesis.
(e) Comparison of friction processes for steady and unsteady states.
(g) Apparatus under construction.

STEVENS INSTITUTE OF TECHNOLOGY, Experimental Towing Tank.

Inquiries concerning projects should be addressed to the following all at Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
Nos. 1410, 2155, 2387, 2390 and 2393 ..... to Mr. Edward V. Lewis
Nos. 2156, 2389, 2392, and 2615 ..... to Dr. Paul Kaplan
Nos. 2391, 2616, 2617, and 2618 ..... to Dr. John P. Breslin

(340) PLANING SURFACES.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Daniel Savitsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.

(d) Theoretical and experimental; basic research.
(e) A continuous series of theoretical and experimental studies of the basic hydrodynamic processes involved in the planing action of seaplane hulls and high-speed surface craft. In particular, the pressure distribution, wake, and main spray formation are being studied.
(g) Investigations have extended from elementary planing surfaces of several deadrises, through surfaces in the shape of Vee planform; also surfaces planing parallel to each other and combinations of forebody with an afterbody planing in its wake.
(h) Fifteen papers on the results of research conducted under the subject contract have been prepared and published. Two reports are presently in preparation. One is concerned with the main spray of planing surfaces and the other with the two step planing of seaplane hulls.

(1410) SELF-PROPELLED TESTING.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental; developmental research.
(e) To determine if successful self-propelled testing can be conducted using models of less than 12-foot length, and to determine causes of scale effect in propulsion factors.
(f) Completed.
(g) Open-water tests have been completed on three different-sized models of a propeller designed by the Netherlands Model Basin for the Victory type cargo ship. Hull models of the Victory ship, 7-1/2 feet and 9 feet in length, have been tested self-propelled. This work is being carried out in cooperation with the Netherlands Model Basin where models 9 feet long and above are being tested.
(h) "Comparison of the Resistance and Thrust Measurements on Small Victory Ship Models with Those of the Van Lammeren Series," by Edward V. Lewis. Paper presented at the 11th American Towing Tank Conference, Washington, D. C., Sept. 1956 (Experimental Towing Tank Technical Memorandum No. 113).

(2152) PLANING SURFACES IN ROLL AND YAW.

(b) National Advisory Committee for Aeronautics.
(c) Mr. Daniel Savitsky, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Experimental; basic research.
(e) To conduct an exploratory investigation to define generally the nature of the flow in unsymmetrical planing, the magnitude of steady-state forces and moments, and their variation with yaw and roll angle.
(g) Tests have been conducted on two simple machined planing surfaces of zero deadrise and 20° deadrise. Resistance, side force, pitching moment, yawing moment, and planing area were measured simultaneously over the following range of independent variables: trim, 6° to 30°; roll, 0° to ± 15°; yaw, 0° to 20°; speed coefficient C_V, 7.0 to 17.5; load coefficient, C_Δ, 2.5 to 49.0. The large amount of collected test data are presented in simplified plots. Planing conditions are defined which result in the flow clinging to the chine edges of the flat planing surface.

(2153) EVALUATION OF WAKE FRACTION AND THRUST DEDUCTION OF A SHIP PROPELLER.

(b) Office of Naval Research, Department of the Navy (DTMB Technical Supervision).
(c) Prof. B. V. Korvin-Kroukovsky, Stevens Institute of Technology, 711 Hudson St., Hoboken, New Jersey.
(d) Theoretical; basic research.
(e) Traditionally the wake fraction and thrust deduction for design of a ship propeller are obtained by means of model tests of a specific ship form and its propeller. The general dependence of these characteristics on ship form is known only empirically. In the attempts at rational solution, the mathematical difficulties required drastic simplifying assumptions as to physical conditions, which undermine the practical value of the results. In the present project the wake fraction and thrust deduction is obtained by computational methods as functions of the hull form and the thrust distribution over the propeller disk. While the expression of many hydrodynamical relationships involved in the problem in a compact mathematical form proved to be prohibitively difficult, these relationships are basically simple and are amenable to computational procedure, treating one aspect of the problem at a time. In this approach to the problem the physical conditions are realistically represented.

(g) An introductory investigation of a body of revolution with a hypothetical propeller and the investigation of the effects of circumferentially non-uniform inflow are completed. The work is continued with calculation of the properties of VICTORY Ship form.
(h) "Stern Propeller Interaction with a Streamline Body of Revolution", by B. V. Korvin-Kroukovsky, ETT Report No. 544, published in International Shipbuilding Progress. "Circumferentially Non-Uniform Propeller Inflow", ETT Report, No. 595.

(2154) INVESTIGATION OF SHIP MOTIONS.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical and experimental basic research.
(e) The development of a method of calculation for predicting ship motions caused by head or following seas. Towing tank tests of ship forms differing widely from the forms currently used in practice, in search of considerable improvement in seakeeping qualities of ships.
(g) Derivation of coupled equations of motion, and computations of motions for two models in two wave lengths have been completed. This included the derivation of expressions for the forces and moments exerted on the ship by waves, taking into account the ship-wave interaction. These computations were compared with experimental measurements and good agreement was obtained. Most of the towing tank tests on models of a sailing yacht and of a fishing trawler were completed.

(2155) INVESTIGATION OF THE SEAKEEPING QUALITIES OF SHIPS, WITH PARTICULAR REFERENCE TO MOTIONS IN IRREGULAR HEAD SEAS.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Theoretical and experimental; basic research.
(e) A method of producing realistic irregular long-crested waves in the model tank has been developed and applied to the comparative study of the motions in head seas of two ship models of the same proportions but different forebody form. Results are compared with the motions calculated by recently developed methods from model performance in regular waves of a wide range of frequencies. Work is being extended to a third high-speed hull form, and to model performance over a range of headings to regular waves.
(f) First phase completed; work continuing.
(g) Good agreement has been obtained between observed and predicted motions in moderate irregular seas, fair agreement in high irregular seas where non-linear effects become pronounced.
(h) "Irregular Seas -- A New Towing Tank Problem," by Prof. B. V. Korvin-Kroukovsky. Paper presented at the 11th American Towing Tank Conference, Washington, D. C., Sept. 1956 (Experimental Towing Tank Technical Memorandum No. 112).
"Planning for Three-Dimensional Research in Waves," by Edward V. Lewis. Paper presented at the 11th American Towing Tank Conference, Washington, D. C., Sept. 1956 (Experimental Towing Tank Technical Memorandum No. 109).

(2156) MOTION AND STABILITY OF HYDROFOIL SYSTEMS.

(b) Office of Naval Research, Department of the Navy (DTMB Technical Supervision).
(d) Theoretical; basic research.
(e) To determine the longitudinal stability characteristics of tandem hydrofoil configurations in waves, including the effects of unsteady forces and moments. The resulting motions of the system and the loadings on the foils can then be determined.
(g) A theoretical analysis of motion in smooth water has been completed. An analysis of the forces and moments in waves has been completed and tests have been made, the results of which compare well with the theory. The results have been incorporated into a study of motions in waves.
(h) "The Forces and Moments Acting on a Tandem Hydrofoil System in Waves," by Paul Kaplan, Experimental Towing Tank Report No. 506.

(2387) BENDING MOMENTS OF SHIPS IN WAVES.

(b) Society of Naval Architects and Marine Engineers.
(d) Analytical.
(e) Calculation of bending moments in waves, taking into account dynamic effects of ship motions and forward speed, for comparison with experimentally determined bending moments. Use is made of new methods developed by Prof. B. V. Korvin-Kroukovsky. Prediction of bending moments in irregular waves and comparison with irregular tank wave results.
(f) Completed.
(g) Fairly good agreement has been obtained between calculated and observed bending moments, giving theoretical confirmation of reduction of moments under dynamic conditions of forward speed and pitching and heaving motions.
(h) Two reports completed; to be published in near future.

(2389) PERFORMANCE AND DYNAMIC CHARACTERISTICS OF HYDROFOIL CRAFT.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical; applied research.
(e) To investigate the scaling of performance of hydrofoil craft of different sizes in different seas and to develop a general method for the evaluation of the stability of various hydrofoil configurations while in the preliminary design state.
(g) Two different scaling methods have been applied to representative craft, and a measure of their performance in different seas has been obtained. Derivation of the equations of longitudinal and lateral dynamic stability has been accomplished for tandem systems employing flat foils. An analysis of the drag of dihedral hydrofoils has been made, based on linearized free surface theory, but with no numerical comparison with experimental data.
(h) "The Drag of Dihedral Hydrofoils Below a Free Surface," by Paul Kaplan, Experimental Towing Tank Note No. 381, presented before the Fluid Dynamics Division of the American Physical Society, Pasadena, Calif., March 19-21, 1956.

(2392) FORCES AND MOMENTS ON SPINNING BODIES.

(b) Bureau of Ordnance, Department of the Navy.
(d) Experimental; basic and applied research.
(e) To measure the forces and moments acting on spinning underwater missiles, including Magnus terms. Static and dynamic (due to angular velocity) coefficients (stability derivatives) will be obtained using the rotating arm facility at E.T.T.
(g) Experiments to determine all coefficients on one model have been completed and analyzed. Similar work will be carried out for another model. Also, induced effects due to roll orientation will be studied.

(2390) CONTROLLED FINS FOR REDUCING SHIP PITCHING.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental and analytical.
(e) To determine the most desirable action of controlled fins at bow or stern of a ship to reduce pitching in regular and irregular seas.

(2391) THEORETICAL STUDY OF THE HYDRODYNAMIC PRESSURE FIELD NEAR A ROTATING PROPELLER BLADE AND FORCES APPLIED TO CERTAIN SIMPLE, NEARBY BOUNDARIES.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(d) Theoretical; applied research.
(e) Theoretical studies of the hydrodynamic field about propeller-like singularities have been undertaken because of the increasing concern of naval architects with propeller-excited ship vibration. Theoretical calculations for the force produced on a flat plate in the presence of a two-dimensional traversing vortex have been made and, in addition, the force on the same plate in the presence of a three-dimensional rotating bound vortex have been made through the use of a strip theory.

(f) Completed; final report submitted to David Taylor Model Basin.
(g) Good correlation of computed oscillatory pressures at moderate distances from a model of a three-bladed ship propeller has been obtained with data supplied from model tests conducted at the David Taylor Model Basin; theoretical decay of the force on the plate in the presence of a two-dimensional traversing vortex is found to be a rather slowly changing function of axial clearance. In contrast, decay of the force produced by the rotating bound vortex is found to be quite rapid with increasing axial clearance.
(h) "The Unsteady Pressure Field Near a Ship Propeller and the Nature of the Vibratory Forces Produced on an Adjacent Surface," Experimental Towing Tank Report No. 609, by J. P. Breslin, June 1956.

(2393) BENDING MOMENTS OF SHIPS IN WAVES.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental and analytical.
(e) Measurements of deflection of a jointed model of a high-speed naval vessel (third model in 2155) to determine external bending moment underway in regular and irregular waves; comparison with analytically determined bending moments.
(g) Basic model tests have been completed and are being analyzed.
(h) "Measurement of Bending Moments on Models in Waves," by Edward V. Lewis, paper presented at the 11th American Towing Tank Conference, Washington, D. C., Sept. 1956 (Experimental Towing Tank Technical Memorandum No. 115).

(2615) FORCES AND MOMENTS ON SUBMERGED BODIES BELOW WAVES.

(b) Office of Naval Research, Department of the Navy (DTMB Technical Supervision).
(d) Experimental; basic and applied research.
(e) To measure the forces and moments acting on submerged bodies moving obliquely to the crests of regular waves.

(2616) THEORETICAL STUDY OF THE TRANSIENT FORCES PRODUCED BY A SHIP PROPELLER.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(d) Theoretical; applied research.
(e) Theoretical study of the forces produced by a rotating propeller as represented by rotating bound vortices in the neighborhood of bodies representable by doublet distributions and source-sink distributions; analysis limited to first order effects.

(2617) THEORETICAL STUDY OF THE VIBRATORY THRUST PRODUCED BY A SHIP PROPELLER OPERATING IN THE WAKE OF A HULL.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(d) Theoretical; applied research.
(e) Existing methods for computing the axial, vibratory thrust produced by a ship propeller operating in a circumferentially variable wake. Assume that the forces on the blade elements are developed instantaneously, i.e., only quasi-steady forces are considered. This study will attempt to determine the influence of unsteady effects on the accuracy of the predictions of existing methods.

(2618) THEORETICAL STUDY OF THE IMPACT ON SHIP APPENDAGES.

(b) David Taylor Model Basin, Bureau of Ships, Department of the Navy.
(d) Theoretical; applied research.
(e) A comprehensive review of the literature concerned with impact of two and three-dimensional bodies with the purpose of determining the applicability of existing formulations to the problem of estimating certain ship appendages during impact in a seaway. Analysis also made of the susceptibility of locations on the ship to impact and rough upper bounds for the combined ship motions are given.
(f) Completed; final report submitted to David Taylor Model Basin, Dec. 1956.

(g) Shapes which are amenable to simple calculations are found and the formulas for estimating the impact forces are listed. Applications to the force to be expected on the gun emplacement on an attack cargo ship and the force on a submarine bow plane under certain conditions are presented as design examples to illustrate the use of the theory.
(h) "Methods for Estimating Impact Forces on Ship Appendages," Experimental Towing Tank Report No. 616, Dec. 1956, by Lawrence W. Ward.

UNIVERSITY OF TENNESSEE, Hydraulic Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 2159 and 2619 should be addressed to Dr. Harry H. Ambrose, Department of Civil Engineering, University of Tennessee, Knoxville 16, Tenn.

(2159) DISCHARGE COEFFICIENTS FOR TAINTOR GATES ON SPILLWAYS.

(b) Cooperative with the Tennessee Valley Authority.
(d) Experimental; for master's thesis.
(e) Discharge coefficients were determined for a generalized model of a taintor gate on a spillway. The effect of the trunnion location was investigated as well as that of the relative head and of the relative gate opening.
(f) Experimental work completed, thesis in preparation.
(g) Measurement of the various discharge rates corresponding to the maximum practical range of heads was made for a series of positions of the gate lip. These positions were standardized with respect to longitudinal distance along the spillway face, distance outward along the normal to the spillway, and angle of inclination. Graphical analysis of the resulting head-discharge curves is being made in an attempt to isolate the several effects upon the discharge coefficient.

(2619) BOUNDARY-ROUGHNESS EFFECTS UPON TURBULENT FLOW.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) This project is, in effect, a continuation of Project No. 944. Measurements of velocity distributions and head losses will be made with the same flow facility for both discrete and continuous types of artificial roughness to several geometrical scales. Results of the flow in the pipe will be compared with corresponding measurements for free-surface flow over the same roughnesses in a specially constructed flume.

TEXAS A AND M COLLEGE, Department of Oceanography and Meteorology.

(2620) WAVE FORCE EXPERIMENTS ON CYLINDRICAL PILES IN THE GULF OF MEXICO.

(b) Bureau of Yards and Docks, Contract NOy-27474.
(c) Prof. Robert O. Reid, Project Supervisor, Texas A and M College, College Station, Texas.
(d) Field investigation, experimental and analytical; basic and applied research.
(e) Determination of actual wave forces on a vertical cylindrical steel test pile of 8-inch diameter in mean water depths of 12 and 15 feet at two locations, one 12 miles off the Louisiana coast near Eugene Island, the other about 1 mile off the Texas coast near Caplen. Test pile was attached to oil platform or pier and suspended from two reaction points above water level: horizontal and vertical reactions to wave pressures were measured electronicly and results analyzed in relation to physical characteristics of the waves.
(f) Initiated October 1951; completed, January 1956.

(g) Analysis attempted to determine values of drag coefficient and coefficient of virtual mass, justifying the expression of wave force in terms of drag and inertial components. Theoretical considerations were invoked and numerical prediction techniques utilized with the aid of high speed digital computers for evaluating best-fit values of the drag and mass coefficients.

(h) "Surface Waves and Offshore Structures", by R. O. Reid and C. L. Bretschneider, Technical Report No. 38-0, Texas A and M Research Foundation, Oct. 1953, 36 pp. and 11 plates.
"Wave Force Experiments at Atchafalaya Bay, Louisiana" by R. O. Reid, et. al., Tech. Report No. 38-1, Texas A and M Res. Fdn., Feb. 1954, 56 pp. and 20 plates.
"Effects of Vibrations on the Measurement of Wave Forces", by B. W. Wilson and R. O. Reid, Tech. Report No. 38-2, Texas A and M Res. Fdn., Dec. 1955, 42 pp. and 12 plates.
"Laboratory Study of Impact of Cylindricial Objects on a Fluid Surface", by R. P. Savage, Tech. Report No. 38-3, Texas A and M Research Fdn., Jan. 1956, 23 pp. and 10 plates.
"Analysis of Wave Force Experiments at Caplen, Texas" by R. O. Reid, Final Tech. Report No. 38-4, Texas A and M Res. Fdn., Jan. 1956, 49 pp. and 25 plates with 39 pp. of original data.

(2621) WAVE FORCE EXPERIMENTS ON 16-INCH AND 30-INCH DIAMETER PILES IN 40 FEET MEAN WATER DEPTH.

(b) Gulf Oil Corporation.
(c) Dr. B. W. Wilson, Project Supervisor, Texas A and M College, College Station, Texas.
(d) Field investigation, experimental and analytical; basic and applied research.
(e) Determination of actual wave forces on vertical cylindrical test piles of 16-inch and 30-inch diameter in mean water depths of 40 feet at an oil platform 40 miles from the Louisiana coast near Eugene Island. Each test pile was attached to the oil platform at two reaction points above water level; horizontal and vertical reactions to wave pressures were measured electronicly and results analyzed in relation to physical characteristics of the waves.
(g) Analysis initially has attempted to determine values of drag coefficient and coefficient of virtual mass for selected wave data on the basis that wave force mainly comprises drag and inertial components. In another approach filtering techniques employing high speed digital computers were used to separate out harmonic components in the waves and wave forces and assess the correlating coefficients. The latest approach seeks to correlate an overall resistance coefficient with appropriate Reynolds and Iversen numbers applicable to the fluid flow round the pile. Numerical prediction techniques, utilizing high speed digital computers, are being used to predict water particle velocities and accelerations from surface elevations.
(h) "Wave Force Experiments on a 16-inch Diameter Pile in 40 Feet Mean Water Depth", by C. L. Bretschneider, et. al., Tech. Report No. 55-1, Texas A and M Res. Fdn., Jan. 1955.
"Analysis of Waves and Wave Forces by a Filtering Technique", by R. Blumberg, Tech. Report No. 55-2, Texas A and M Res. Fdn., May 1955, 23 pp. and 8 plates.
"An Evaluation of Inertial Coefficients in Wave Force Experiments", by C. L. Bretschneider, Tech. Report No. 55-3, Texas A and M Res. Fdn., Sept. 1955, 10 pp. and 6 plates with appendices.

(2622) WAVE ENERGY LOSS IN SHALLOW WATER OCEAN WAVES.

(b) Beach Erosion Board, Contract No. DA-49-055-Eng-18.
(c) Mr. C. L. Bretschneider, Project Supervisor, Texas A and M College, College Station, Texas.
(d) Field investigation, experimental and analytical; basic and applied research.
(e) To determine the losses in wave energy arising from propagation of waves in shallow water. To extend the wave forecasting techniques of deep water to the case of shallow water where bottom friction, shoaling and refraction are complicating factors.
(f) Initiated April 1952; completed, May 1954.
(g) Wave data from five recording stations in the Gulf of Mexico were analyzed to provide statistical information of the effects of bottom friction along paths of wave travel. Modification of wave height from bottom friction, percolation and refraction formed the subject of a theoretical study. The results of these enquiries were used in developing a procedure for forecasting wave heights under continuous wind generation in shallow water.

(h) "Modification of Wave Height due to Bottom Friction, Percolation and Refraction" by C. L. Bretschneider and R. O. Reid, Tech. Memo No. 45, Beach Erosion Board, Oct. 1954, 36 pp. "Field Investigation of Wave Energy Loss in Shallow Water Ocean Waves" by C. L. Bretschneider, Tech. Memo. No. 46, Beach Erosion Board, Sept. 1954, 21 pp. with appendix. "Generation of Wind Waves over a Shallow Bottom" by C. L. Bretschneider, Tec. Memo No. 51, Beach Erosion Board, Oct. 1954, 24 pp.

(2623) WAVE STATISTICS FOR THE GULF OF MEXICO.

(b) Beach Erosion Board, Contract DA-49-055-eng-45.
(c) Dr. B. W. Wilson, Texas A and M College, College Station, Texas.
(d) Field investigation; applied research.
(e) To determine the significant wave heights and periods in different water depths at five locations in the Gulf of Mexico (Brownsville, Caplen, Burrwood, Apalachicola and Tampa) from hindcasts based on statistical weather data over the Gulf covering a 3-year period.
(g) Wind velocities, wind duration, fetch and decay distances for hindcasting wave characteristics by the Sverdrup-Munk-Bretschneider method were determined from 12-hourly synoptic weather charts for the Gulf of Mexico. Hindcasts of swell were made for deep water locations only. Wave refraction diagrams were developed to assess wave refraction coefficients in water depths of 96, 48, 36, 24 and 12 feet. Frequency diagrams of wave and wind conditions have been derived. Continuing work includes hindcasts of wave conditions generated by typical severe hurricanes occurring in the Gulf of Mexico in the last 50 years.
(h) "Graphical Approach to the Forecasting of Waves in Moving Fetches" by B. W. Wilson, Tech. Memo No. 73, Beach Erosion Board, April 1955, 31 pp.
"Wave Statistics for the Gulf of Mexico off Brownsville, Texas" by C. L. Bretschneider and R. D. Gaul, Tech. Memo No. 85, Beach Erosion Board, Sept. 1956, 25 pp. with Appendices.
"Wave Statistics for the Gulf of Mexico off Caplen, Texas" by C. L. Bretschneider and R. D. Gaul, Tech. Memo, No. 86, Beach Erosion Board, Sept. 1956, 25 pp. with Appendices.
"Wave Statistics for the Gulf of Mexico off Burrwood, Louisiana" by C. L. Bretschneider and R. D. Gaul, Tech. Memo No. 87, Beach Erosion Board, Oct. 1956, 25 pp. with Appendices.
"Wave Statistics for the Gulf of Mexico off Apalachicola, Florida" by C. L. Bretschneider and R. D. Gaul, Tech. Memo No. 88, Beach Erosion Board, Oct. 1956, 25 pp. with Appendices.

(2624) EXPERIMENTAL STUDY OF IMPACT OF CYLINDRICAL OBJECTS ON A FLUID SURFACE AND OF THE FLUID RESISTANCE TO CYLINDERS IN ACCELERATED MOTION.

(b) Bureau of Yards and Docks, Contract NOy-27474.
(c) Professor R. O. Reid, Texas A and M College, College Station, Texas.
(d) Experimental; basic research; for master's thesis.
(e) To determine the characteristics of the motion on impact of a falling horizontal cylinder with a free water surface and hence the fluid resistance offered the cylinders in accelerated motion.
(f) Initiated 1954; completed, January 1956.
(g) High speed motion picture photography was used to follow the movements of falling cylinders into a tank of water. Time was measured by photographing the dial of a 1 revolution per second timer. Measurements of picture frames yielded displacement-time relationships. Good experimental confirmation of theoretical values of impulse and ultimate velocity at the end of impact as given by Lamb was obtained.
(h) "Laboratory Study of Impact of Cylindrical Objects on a Fluid Surface" by R. P. Savage, Tech. Report No. 38-3, Texas A and M Res. Fnd., January 1956, 20 pp. and 10 plates.

(2625) FLUID FORCES ON CIRCULAR CYLINDERS.

(b) Department project.
(c) Dr. B. W. Wilson, Texas A and M College, College Station, Texas.
(d) Experimental; basic and applied research; for master's thesis.
(e) To determine the resistance to accelerated motion of a cylinder in a fluid at rest.
(f) Initiated 1955; completed 1956.

(g) A short length of cylinder immersed in a tank of water and suspended from an overhead trolley in air was towed along the tank by application of a known force. Continuous measurements were made of the displacement of the cylinder with time whence velocities and accelerations were derived. Values of drag and inertia coefficients were correlated with Reynolds and Iversen numbers.
(h) "Fluid Forces on Circular Cylinders" by R. G. Dean, M. S. Thesis, Dept. of Oceanography and Meteorology, A and M College of Texas, May 1956.

(2626) EFFECTS OF A NON-RIGID IMPERMEABLE BOTTOM ON PLANE SURFACE WAVES IN SHALLOW WATER.

(b) Department project.
(c) Professor R. O. Reid, Texas A and M College, College Station, Texas.
(d) Theoretical and experimental; basic and applied research; for master's thesis.
(e) To determine the relative interactions resulting from propagation of a shallow water wave over a viscous impermeable bottom in a canal of uniform depth.
(f) Initiated 1955; completed September 1956.
(g) Hydrodynamical theory was applied to the motion of a long wave in shallow water overlying a viscous medium of finite depth above a rigid bottom. Experiments were run in a small wave tank using a solution of sugar in water for the lower medium and kerosene for the upper medium. Good general confirmation of the theory was obtained.
(h) "Effects of a Non-Rigid Impermeable Bottom on Plane Surface Waves in Shallow Water" by H. G. Gade, M. S. Thesis, Dept. Oceanography and Meteorology, A and M College of Texas, Sept. 1956.

(2627) DYNAMICAL FLEXURE OF A VERTICAL CYLINDRICAL PILE IN SOFT MARINE SEDIMENTS.

(b) Office of Naval Research, Project NR 083-036, Contract N7 onr-487 T. O. II.
(c) Professor R. O. Reid, Texas A and M College, College Station, Texas.
(d) Experimental and analytical; basic and applied research, for master's thesis.
(e) To determine the flexural properties of a vertical cylindrical pile embedded in soft marine sediment when subject to pulsating horizontal load at the mudline.
(f) Initiated 1955; completed December 1956.
(g) A model cylindrical pile embedded in mud was flexed at the mudline by a horizontal reciprocating load. Determination of bending moment along the length of the pile were made by resistance wire strain gages. For the particular frequency used in the tests (corresponding to 15 second waves in nature) the maximum dynamic bending moment were shown to be only about half the static values under the full load. Use of a constant soil modulus in analytical computations was shown to give results in good agreement with dynamical experiments.
(h) "Stress-Strain Characteristics of a Dynamically Laterally Loaded Pile in Soft Marine Sediments" by R. Gaul, Tech. Report, Ref. 56-31T, Texas A and M Res. Fnd., October 1956. (Also Master's Thesis, Department of Oceanography and Meteorology.)

(2628) MEASUREMENT OF WIND SET-UP ON AN OPEN COAST.

(b) Office of Naval Research, Project NR 083-036, Contract N7 onr-48702; Bureau of Ships, Contract NE 120219-5.
(c) Professor R. O. Reid, Texas A and M College, College Station, Texas.
(d) Experimental and analytical; basic and applied research.
(e) To determine the set-up or superelevation of the mean sea surface over a finite fetch near Galveston, due to wind stress, and correlate it with the wind speed.
(f) Initiated February 1954; completed August 1956.
(g) Measurements of the set-up over an 1880-foot fetch length of ocean normal to the open coast near Caplen, Galveston, Gulf of Mexico, were achieved by recording the difference (electrically) between water levels at opposite ends of the fetch. Correlation with wind velocity up to 26 mph showed a non-linear relationship. The wind stress-wind velocity relationship took the non-linear form found by other investigators but stress values exceeded those found by laboratory investigators.
(h) "Measurement of Wind Set-Up on an Open Coast" by W. H. Clayton, Tech. Report, Ref. 56-25T, Texas A and M Res. Fnd. August 1956, 49 pp. 9 plates. (Also Ph. D. Thesis, Department of Oceanography and Meteorology.)

UNIVERSITY OF TEXAS, Department of Civil Engineering.

Inquiries concerning Projects Nos. 948, 2162, 2396, 2397, and 2629, should be addressed to Dr. Walter L. Moore, Department of Civil Engineering, University of Texas, Austin 12, Texas.

(948) DIFFUSION OF A TWO-DIMENSIONAL SUBMERGED JET.

(b) Laboratory project.
(d) Experimental; basic research.
(e) An investigation is being made of the diffusion of momentum in a two-dimensional jet as influenced by the proximity to a plane boundary. Apparatus was constructed for measuring the velocity field in the diffusion region of an air jet 0.05 ft. thick and 3.0 ft. wide with a plane parallel boundary at various distances from the axis of the jet.
(f) Inactive.
(g) Measurements are complete covering a range of boundary distance from 0 to 1.8 ft. Results indicate that the boundary has a stabilizing influence and tends to reduce the rate of diffusion. As the distance to the plane boundary is increased the diffusion increases. Mean flow streamlines obtained in the diffusion region defined a stable eddy between the jet and the boundary and indicated a linear spread of the jet downstream from the eddy. Velocity profiles in the zone of linear spread were all reducible to a single dimensionless curve. Measurements of static pressure in the stable eddy indicated significant negative pressures according to a systematic pattern. Checks of momentum and energy flux gave reasonable values.
(h) Unpublished annual report to National Science Foundation is available on two weeks loan. One phase of project is nearly complete.

(2161) CHARACTERISTICS OF A HYDRAULIC JUMP AT AN ABRUPT CHANGE IN BOTTOM ELEVATION.

(b) University of Texas Research Institute and Bureau of Engineering Research.
(c) Prof. C. W. Morgan, Department of Civil Engineering, University of Texas, Austin 12, Texas.
(d) Experimental.
(e) Experimental determinations will be made of the flow characteristics at two-dimensional channel drops and rises. The velocity distribution and surface profile will be determined (1) throughout the length of the jump for various relative changes in bottom elevation. The longitudinal location of the jump in relation to the change in bottom elevation will be varied over a broad range in distinction to previous related investigations in which relative location of the jump was held constant.
(g) Results for the abrupt drop are complete and a paper is being submitted to Proceedings ASCE. For a given entering Froude number lying between 2 and 8 three types of jump may form, the type and its longitudinal location depending only on the relative downstream depth. The velocities near the bottom below the drop are always less than the mean velocity in the downstream channel for the jump type of maximum height. Experimental measurements have just begun on the related investigation for an abrupt rise.

(2162) HYDROLOGIC STUDIES, WALLER CREEK WATERSHED.

(b) Cooperative with U. S. Geological Survey.
(d) Field investigation; applied research.
(e) Measurements of rainfall and runoff for a 4 square mile and a 2 square mile portion of the Waller Creek watershed will be made to provide basic information for estimating runoff from small urban watersheds in the Southwest area. Studies of the correlation between runoff, rainfall, and the characteristics of the drainage basin will be made from time to time on the data accumulated. Two streamflow stations and a rain gage net are in operation.

(2396) RESISTANCE OF PIERS IN FREE SURFACE FLOW.

(b) Laboratory project.
(d) Theoretical and experimental; (thesis).

(e) An investigation is being made of the drag resistance of piers as a function of shape, relative submergence, spacing, and Froude numbers. The pier resistance is being correlated with the head loss for flow in a channel.
(g) A phase of the investigation has been completed for Froude numbers less than 0.5 with cylindrical piers at various submergence and spacing. An investigation of the resistance of H sections piers at various orientations and longitudinal spacings has been completed. Another phase has been completed which demonstrates that the velocity gradient along a cylindrical pier affects the drag coefficient. The local drag coefficient decreases along the pier in the direction toward the end of the pier where the velocity is high. The reduction in drag coefficient is related to a dimensionless measure of the velocity gradient along a cylinder.
(h) "The Relationship Between the Head Loss at Bridge Piers and the Drag Resistance of the Piers", Jerry Garrett, M. S. Thesis, Jan. 1956.

(2397) EFFECT OF UPSTREAM DEVELOPMENT ON THE RUNOFF FROM SMALL WATERSHEDS IN THE SOUTHWEST.

(b) Laboratory project.
(d) Field investigation; (thesis).
(e) For a selected watershed rainfall and runoff relations before the period of upstream development are being analyzed. The relations obtained for this period will be applied to the rainfall records after the upstream development and the predicted runoff compared with the actual runoff.
(g) Sources of data have been located and the available information tabulated.

(2629) A MECHANICAL TURBULENCE INDICATOR FOR LIQUIDS.

(b) Bureau of Engineering Research, University of Texas.
(d) Experimental instrument development.
(e) There is need for a relatively simple device to give a quantitative measure of the degree of turbulence in a flowing fluid. Electrical instruments commonly measure the root mean square of the turbulent fluctuations as an indication of the intensity. The instrument being developed measures the maximum turbulent fluctuation as an indication of the intensity. The instrument is similar to a 1/2 inch diameter Prandtl velocity tube except that it has two stagnation openings; the conventional one which gives the mean stagnation head and an additional one which leads through a sensitive check valve and accumulator to a manometer tube. The check valve and accumulator elements are located in the tube less than 3/8 of an inch from the stagnation opening to minimize inertia effects.
(g) The instrument has been built and a membrane for the check valves developed. Preliminary tests look promising.

UTAH STATE AGRICULTURAL COLLEGE, Agricultural Experiment Station.

(151) LINING OF IRRIGATION CANALS AND DITCHES.

See U. S. Department of Agriculture, Agricultural Research Service, Page 115.

(359) DRAINAGE OF IRRIGATED LANDS.

(b) Laboratory and field project.
(c) Mr. A. Alvin Bishop, Irrigation Department, Utah State Agricultural College, Logan, Utah.
(d) Field studies; applied research and masters theses.
(e) The major purposes are to find low cost, effective methods of drainage of arid-region waterlogged saline and alkali lands. In the past year work has been concentrated in Utah and Weber Counties with preliminary studies being made in Cache County.
(g) Piezometers were used to measure the hydraulic head in the area affected by the Hooper Pilot Drain and flow patterns were constructed for conditions before construction of the drain and after the drain was completed. The effect of the drainage construction on the ground water flow pattern was significant.

(1686) CONSUMPTIVE USE OF WATER AND IRRIGATION REQUIREMENTS.

(b) Laboratory project, cooperating with Agricultural Research Service, Utah State Engineer, and the Utah Water and Power Board.
(c) Prof. Wayne D. Criddle, Department of Civil and Irrigation Engineering, Utah State Agricultural College, Logan, Utah.
(d) Field investigation; applied research.
(e) To obtain basic information regarding the consumptive use of water by agricultural crops, pastures, and native vegetation. To determine irrigation water requirements of crops under different cropping systems, methods of water application, and climatic conditions.
(g) Results being obtained are used currently in administration of water rights on the streams of the state and in the division of water between states. Such data are basic in the design and operation of irrigation and drainage systems for making full and most economical use of available water supplies.

(1955) A STUDY OF SPRINKLER IRRIGATION EQUIPMENT AS RELATED TO OPERATIONAL CHARACTERISTICS AND COSTS, LABOR REQUIREMENTS, AND ADEQUACY.

(b) Laboratory project, cooperative with Reynolds Metals Company.
(c) Mr. Jay M. Bagley, Department of Civil and Irrigation Engineering, Utah State Agricultural College, Logan, Utah.
(d) Field investigation; applied research.
(e) To evaluate effectiveness and operation of irrigation equipment being used in the field and to develop design criteria for future use.
(f) Completed.
(g) More than 40% of the sprinkler systems studied were inadequately designed to meet peak water use requirements. Many were not meeting these demands because of improper operation. Farmers are not generally applying sufficient water each irrigation for optimum growth and minimum operational cost.
(h) "Evaluation of Sprinkler Irrigation Systems in Northern Utah", Jay M. Bagley and Wayne D. Criddle, Utah Agricultural Experiment Station Bulletin No. 387, June 1956.
"What About Sprinkler Irrigation in Utah", Jay M. Bagley and Wayne D. Criddle, Farm and Home Science, 17:2, June 1956.

(2163) WATER RESOURCES PHASE OF INDUSTRIAL SURVEY SOUTHWESTERN UTAH TRI-COUNTY AREA (KANE, IRON, AND WASHINGTON COUNTIES).

(b) Utah Committee on Industrial and Employment Planning.
(c) Prof. Wayne D. Criddle, Department of Civil and Irrigation Engineering, Utah State Agricultural College, Logan, Utah.
(d) Field investigation; basic research.
(e) The purpose of this study is to provide complete inventory of all water resources of the area as well as water use. The extent and economic value of losses, shortage, and wastes are being examined. The study is also attempting to develop methods of estimating water supplies on small watersheds where stream flow data are meager or entirely lacking.
(g) Results of this study will be used in long range planning for the development of water and other natural resources in the area.

(2164) EVALUATION OF FACTORS AFFECTING WATER YIELDS FROM HIGH WATERSHEDS.

(b) Laboratory project.
(c) Mr. Gregory L. Pearson, Soil Conservation Service, Salt Lake City, Utah.
(d) Field investigations, statistical studies; applied research.
(e) The purpose of the project is to improve the accuracy of prediction of summer irrigation water supplies based on snow and rainfall measurements, base-stream flow, soil moisture conditions, etc. These predictions provide a basis for efficient water and farm management, including reservoir operation, cropping practices, and flood control.

(g) As a consequence of these studies, it is now possible to estimate summer streamflow on many Utah streams within 10 percent, and on some streams within 5 percent, as compared to actual U.S.G.S. streamflow measurements.
(h) "Federal-State Cooperative Snow Surveys and Water Supply Forecasts for Utah", published annually in mimeographed form. Available: Soil Conservation Service, Salt Lake City, Utah or Utah Agricultural Experiment Station, Utah State Agricultural College, Logan, Utah.

THE STATE COLLEGE OF WASHINGTON, Division of Industrial Research.

Inquiries concerning Projects Nos. 1689, 1690, 2165, 2166, 2398, 2399, 2400, 2630 to 2634 incl., should be addressed to Dr. E. Roy Tinney, Head, Hydraulic Research Laboratory, Division of Industrial Research, State College of Washington, Pullman Washington.

(1689) STUDY OF FLUID FLOW IN PIPE NETWORKS.

(b) Designers and managers of water and gas distribution systems.
(d) Analyses by an analogue computer.
(e) Studies of distribution systems by the McIlroy Pipeline Network Analyzer. Analyses have been made of the water supply systems for over 25 cities. Gas systems have also been analyzed as well as the cooling system of a large hydro plant.
(h) "Pipeline-Network Problems on the McIlroy Analyzer", by Iury L. Maytin. Bulletin No. 277, Washington State Institute of Technology, 1955.

(1690) PLACEMENT OF AIR VENTS IN IRRIGATION PIPE LINES.

(b) Concrete Products Association of Washington.
(d) Experimental; applied research for design.
(e) Some of the breakages in irrigation pipelines have been shown to be the result of water hammer generated as air is released through vents. Studies on the rise velocity of air bubbles, on the minimum distance that an air vent is to be placed from the inlet of a pipeline, and on the spacing of the expansion joints.
(f) Completed.
(h) "Studies of Breakage Problems in Concrete Irrigation Pipe", by J. A. Roberson, E. Roy Tinney, and Earl A. Sibley, Bulletin No. 225, Washington State Institute of Technology, 1956.

(2165) THE INFLUENCE OF LOGGING OPERATIONS ON RUN-OFF FROM PRECIPITATION.

(b) Division of Industrial Research.
(d) Analytical with field investigation.
(e) The run-off from water sheds on which extensive logging has been made is being conducted to determine the correlation between run-off and logging in regions where the rainfall is heavy and regrowth rapid.
(h) "The Effect of Logging on the Run-off of a Stream Near the Columbia River Estuary", presented at the Seattle Conference of the American Geophysical Union, November 1956. This paper is now being prepared for publication.

(2166) NOXON RAPIDS HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Incorporated, for Washington Water Power Company.
(d) Experimental; design.
(e) A 1:50 model of this development has been constructed to study cofferdam construction procedures, spillway capacity, training wall design, diversion sluice capacity, and tailrace excavation. A 1:70, two dimensional model of the spillway has been made to study various dentated sills as well as a 1:30 model of the penstock intake to study entrance losses. A distorted model, vertical scale 1:100 and 1:250 was built of the Clark Fork River to determine the scour pattern in the realigned river for a new bridge crossing.
(h) Progress reports to the Ebasco Services, Inc.

(2398) PLEASANT VALLEY HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Incorporated for the Pacific Northwest Power Co.
(d) Experimental design.
(e) A 1:50 model of the 534 foot high arch dam has been made to study conditions at the base of the free over-fall. Of particular importance are the waves and the surges along the powerhouse walls, the design of outlet works, and the rating of the free over-fall spillway. A pilot model, at a scale of 1:175, has been constructed to aid in selecting the best overall design.

(2399) PRIEST RAPIDS HYDROELECTRIC DEVELOPMENT.

(b) Harza Engineering Company for the Grant County Public Utility District.
(d) Experimental; design.
(e) A 1:38 model of the spillway has been constructed in a 4 foot wide glass-sided flume. Studies of the spillway buckets and the fish-passing characteristics are being made.
(f) Completed.
(h) Final report submitted to client.

(2400) SEDIMENT TRANSPORTATION STUDIES.

(b) Division of Industrial Research.
(d) Analytical and experimental.
(e) The roughness characteristics of movable beds are being studied. Work thus far is analytical, utilizing published data.

(2630) BROWNLEE HYDROELECTRIC DEVELOPMENT.

(b) International Engineering Company for the Idaho Power Company.
(d) Experimental; design.
(e) A 1:70 comprehensive model of the complete development has been constructed. Detailed tests have been made on the intake channel, the low level outlets, the spillway chute, and the spillway bucket. Comparisons have been made on the advantages of flip buckets, cascade type spillways, and a partially submerged horizontal apron. Particular attention has been given to eliminating erosion occurring at the toe of the dam. In addition, a 1:35 model of the spillway crest and low level outlets has been constructed in a 4 foot wide glass sided flume. Studies have been made on the pressures on the crest, on the piers, and on the roof, invert and sides of the low level outlets. Tests have also been made to determine the discharge capacity and to determine the most suitable method of eliminating the disturbance at the junction of the outlet and spillway crest flows.

(2631) ROCKY REACH HYDROELECTRIC DEVELOPMENT.

(b) Chelan County Public Utility District No. 1.
(d) Experimental; design.
(e) A 1:75 model 109 feet by 40 feet has been constructed of 7500 feet of the Columbia River to study construction phases and the operation of the complete development of the Rocky Reach site. Studies are in progress on the feasibility of the cofferdam layouts and the fish passage characteristics of the obstructed channel.

(2632) PRIEST RAPIDS PENSTOCK GATE STUDIES.

(b) Pacific Coast Engineering Company.
(d) Experimental; design.
(e) A 1:18 model of fixed wheel intake gates for the Priest Rapids Hydroelectric Project is being constructed to determine the hydraulic downpull for several lip designs. A generalized study has also been initiated to study various designs of intake gates with a view toward more economical design of gates and gantry cranes.

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(2633) WATER WALL.

(b) General Electric Company, Hanford Atomic Products Operation.
(b) Experimental; design.
(e) A 1:3 model of a large manifold has been constructed to determine the hydraulic stability, flow patterns, and pressure losses.

(2634) KARNAFULI HYDROELECTRIC PROJECT.

(b) International Engineering Company for the Government of Pakistan.
(d) Experimental; design.
(e) Model investigation at a scale of 1:70 of the spillway of the Karnafuli project. Particular attention will be paid to the discharge capacity of the spillway and the wave and erosion patterns at the toe of the dam.

UNIVERSITY OF WASHINGTON, Department of Civil Engineering.

(1705) A HYDROGRAPHIC SUMMARY OF THE STREAMS IN THE STATE OF WASHINGTON.

(b) State of Washington Department of Fisheries.
(c) Prof. Harold K. Moritz, Hydraulics Laboratory, University of Washington, Seattle 5, Wash.
(d) Field investigation, operation.
(e) Comparative hydrographic study of streams in the state on basis of high year, low year, and mean year.
(f) Completed.
(g) Hydrographs are on file at the State of Washington Department of Fisheries.

(2401) SURFACE DISTRIBUTION OF FLOW FROM BURIED PIPE ORIFICES.

(b) State of Washington Department of Fisheries, Stream Improvement Division.
(c) Prof. Harold K. Moritz, Hydraulics Laboratory, University of Washington, Seattle 5, Wash.
(d) Experimental.
(e) An outdoor laboratory study of the flow through gravel to facilitate the design of salmon spawning areas.
(f) Completed.
(g) Results are on file at the State of Washington Department of Fisheries.

(2403) HYDRAULIC MODEL TESTS OF FISHWAY STRUCTURES FOR COWLITZ RIVER POWER DEVELOPMENT.

(b) City of Tacoma, Light Division, Department of Public Utilities.
(c) Dr. E. P. Richey, Asst. Prof. of Civil Engineering, University of Washington, Seattle 5, Washington.
(d) Experimental; applied research for design.
(e) One model, scale 1:10 to facilitate the design of structures for the transport of upstream migrants through the power house to a collection pool. A second model scale 1:3, for design of a screening device to safely collect the downstream migrants with the most economical use of attraction water.
(f) Completed.
(g) Information was obtained which was pertinent to the design of fishways.
(h) "The Ladder and Powerhouse Collection Channel, a Part of the Upstream Migrant System, Mayfield Fish Facilities, Hydraulic Model Investigation", by Dr. Eugene P. Richey and Prof. H. H. Chenoweth.
"The Skimmer, a Part of the Downstream Migrant System, Mayfield Fish Facilities", by Dr. Eugene P. Richey. On file at City of Tacoma Department of Public Utilities, Light Division.

(2635) ESTABLISHMENT OF FLOW IN A RECTANGULAR CLOSED CONDUIT.

(b) Laboratory project.
(c) Prof. H. H. Chenoweth, Univ. of Washington, Seattle 5, Washington.

(d) Experimental and theoretical; basic research for master's thesis.
(e) Influence of approach conditions on flow in a non-circular test section of closed conduit flowing full.
(f) Completed.
(g) Experiments verify the author's theory.
(h) Thesis will be on file at the University of Washington library by the end of March.

(2636) RATE OF FLOW THROUGH HORIZONTAL AND SLOPING SCREENS AT END OF FLUME WITH RESPECT TO DISTANCE ALONG THE SCREEN.

(b) Laboratory project.
(c) Dr. Eugene P. Richey, University of Washington, Seattle 5, Washington.
(d) Experimental and theoretical; for thesis.

(2637) INFLUENCE OF PROXIMITY OF ORIFICES TO EACH OTHER ON THEIR DISCHARGE.

(b) Laboratory project.
(c) Prof. Harold K. Moritz, University of Washington, Seattle 5, Washington
(d) Experimental; for thesis.
(e) Discharge of orifices placed close together compared to similar orifices placed remotely from each other.

WOODS HOLE OCEANOGRAPHIC INSTITUTION.

(2408) OCEAN WAVE MEASUREMENTS.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Harlow G. Farmer, Research Associate, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.
(d) Field investigations; applied research.
(e) Observations of the sea surface elevation and slope, both up-downwind and crosswind, were made using a Woods Hole Oceanographic Institution Wave Pole adapted with resistance wire sensing elements. Analysis of data included bivariate distributions of the elevation and slopes, and a statistical distribution of the individual distributions.
(g) Definite asymmetry in the waves is apparent. The wave crests are found to be more peaked and the troughs shallow and flat. Downwind slopes are on the average greater than the upwind slopes. The general trend of the root-mean-square positive and negative slopes and their difference is to increase with decreasing elevation, crest toward trough.
(h) "Some Recent Observations of the Sea Surface Elevation and Slope," by Harlow G. Farmer, Woods Hole Oceanographic Institution Technical Report No. 56-37.

(2409) LABORATORY INVESTIGATIONS OF THE GENERAL CIRCULATION OF THE ATMOSPHERE.

(b) Office of Naval Research, Department of the Navy, and Geophysics Research Directorate, Air Force Cambridge Research Center.
(c) Mr. Alan J. Faller, Research Associate, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.
(d) Experimental; basic research.
(e) An experimental attempt to reproduce the effects of rotation and heating as fundamental causes of the general circulation of the atmosphere. Isolation of the effects of seasonal variations, zonal asymmetries, topography, and external influences.
(g) Reproduction of the character of the atmospheric circulation including fronts, cyclones, and jet streams.

(2410) LABORATORY STUDIES OF THE OCEAN CIRCULATION.

(b) Woods Hole Oceanographic Institution, Woods Hole, Mass., under contract with the Office of Naval Research.
(c) Dr. William S. von Arx, Woods Hole Oceanographic Institution, Woods Hole, Mass.

(d) Experimental, basic research.
(e) An experimental evaluation of factors influencing the oceanic general circulation. Study concerned at present with the effects of heating and baroclinity on the time of response of the ocean circulation to changes of wind stress at seasonal and higher frequencies and of the character of inertial instabilities in the flow.
(g) The climatological mean ocean circulations have been reproduced in homogeneous water under the influence of zonal wind stresses, together with the effects of the rotation and meridional curvature of the earth. Preliminary experiments with wind-driven models of the northern and southern hemispheres and measurements of the skin friction coefficient for air moving over smooth water surfaces have been completed.
(h) "A Laboratory Study of the Wind-Driven Ocean Circulation", W. S. von Arx; Proc. Conf. on Geophysical Models, Johns Hopkins Univ., Sept. 1953.

WORCESTER POLYTECHNIC INSTITUTE, Alden Hydraulic Laboratory.

Inquiries concerning Projects Nos. 1712, 1713, 1961, 1963, 2170, 2411, 2638 to 2647, inclusive should be addressed to Prof. L. J. Hooper, Director, Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester 2, Mass.

(1712) CROMBY MOVEABLE BED MODEL.

(b) Philadelphia Electric Company.
(d) Experimental; for design.
(e) A distorted model (1:15 vertical scale, 1:45 horizontal scale) was constructed of a section of the Schuylkill River including provision for heating water pumped through the condensers. Studies were made of recirculation of hot water discharged from condensers.
(f) Inactive - work will be continued.

(1713) LITTLETON HYDROELECTRIC DEVELOPMENT.

(b) Connecticut River Power Company.
(d) Experimental; for design.
(e) A 1:60 model was constructed of the chute spillway and section of the Connecticut River to study flow conditions in the chute and in the river adjacent to the chute.
(f) Completed. Model kept in readiness to check details during construction.

(1961) HOGBACK DAM WATER SUPPLY DEVELOPMENT.

(b) The Water Bureau, Hartford, Conn.
(d) Experimental; for design.
(e) A 1:50 model of the dam, spillway, diversion tunnel, Mill Brook diversion and adjacent river topography was constructed to study flow conditions for diversion and flood flows. Water surface profiles in diversion tunnel and spillway channel were determined.
(f) Completed. Model maintained to provide information during construction.

(1963) METER CALIBRATION.

(b) Foxboro Co., Foxboro, Mass.
(d) Experimental for design.
(e) Weighing tank calibration of 1, 2, 4, 6, 8, 10, 12" Magnetic Flow Meters.

(2170) TITEFLEX COUPLINGS.

(b) Titeflex Corporation.
(d) Experimental; for design.
(e) Quick disconnect couplings in the 2-1/2" and 3" diameter sizes were tested for head loss to extend previous work with smaller sizes.

(2411) METER CALIBRATION.

(b) Foster Engineering Co., Union, N. J.
(d) Experimental; for design.
(e) Calibration of several designs of Gentile meters in 4" to 18" dia. range.

(2638) METER CALIBRATION.

(b) Penn Instrument Co., Philadelphia, Pa.
(d) Experimental; for design.
(e) Calibration of several types of flow meter in 4" to 20" dia. range.

(2639) SAVILLE DAM SPILLWAY CHUTE MODEL.

(b) The Water Bureau, Hartford, Conn.
(d) Experimental; for design.
(e) A 1/80 model of a section of the spillway chute and the river bed downstream of the chute was constructed. The purpose of the tests was to study flow conditions in the chute and the pool at the end of the chute.
(f) Complete.
(g) Report submitted.

(2640) BAKER RIVER HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corp., Boston, Mass.
(d) Experimental; for design.
(e) A 1/50 scale model of the intake structure including transition to two penstocks was set up in 3 foot glass sided flume to study flow conditions in transition and around dividing structure.
(g) Test completed. Final arrangement in place.
(h) Report in preparation.

(2641) BAKER RIVER HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corp., Boston, Mass.
(d) Experimental; for design.
(e) A 1/40 scale model of the spillway section, chute and river topography was constructed to study the operation for various design arrangements.
(g) Tests in progress.

(2642) PELTON HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services Inc.
(d) Experimental; for design.
(e) A 1/60 model of a section of the arch dam, the spillway, the spillway chute, the powerhouse and a section of the river bed was constructed. The flow for a range of discharges was studied.
(f) Completed.
(h) Report in preparation.

(2643) NORTH FORK HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services Inc.
(d) Experimental; for design.
(e) A 1/60 model including the arch dam, powerhouse, sluice gates, spillway, spillway chute and a section of the river bed was constructed. Studies are being made on the performance of the various flow conditions.
(g) Tests in progress.

(2644) ROCKY REACH HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corporation.
(d) Experimental; for design.
(e) A 1/60 model of a section of the spillway including 3-1/2 gates has been set up in the 8 ft. wide flume with a section of river topography both upstream and downstream represented. Flow studies are being made of various aprons, wall, gates, etc.
(g) Tests in progress.

(2645) ELMHURST DAM - WATER SUPPLY.

(b) Thomas H. Wiggin.
(d) Experimental; for design.
(e) A 1/50 model of the original spillway, section of dam, new spillway and river bed downstream was constructed. Flow studies were conducted on walls, deflectors and energy dissipators.
(g) Tests in progress.

(2646) ELMHURST DAM - WATER SUPPLY.

(b) Thomas H. Wiggin.
(d) Experimental; for design.
(e) Several 1/10 models of sections of both the present and proposed crests were installed in the 3 ft. glass sided flume for calibration and determination of necessary excavation upstream.
(f) Completed.
(h) Report submitted.

(2647) SHERMAN HYDROELECTRIC DEVELOPMENT.

(b) New England Power Service Co.
(d) Experimental; for design.
(e) A 1/40 model of the dam, spillway, spillway chute, powerhouse and river bed are being constructed. Studies will include means of increasing capacity of spillway and allied structures as well as results of same.
(g) Model under construction.

UNIVERSITY OF CALIFORNIA, College of Agriculture, Department of Irrigation.

(21) STUDY OF HYDRAULICS OF SPRINKLING SYSTEMS.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott, Department of Irrigation, Univ. of California, Davis, California.
(d) Experimental; operation.
(e) Studies include water distribution and irrigation efficiency in orchards and field crops, cost analysis of sprinkler irrigation operation, causes of aluminum pipe corrosion and frost protection by sprinklers. Attention is also being given to methods for minimizing pattern distortion by winds, and to plant interception and evaporation losses.
(g) Wind does have a decided influence on distribution particularly in excess of 6 miles per hour. Closer sprinkler and lateral spacing improve distribution under windy conditions. Thirty foot spacing of medium capacity sprinklers appear to give best distribution with greater choice of lateral spacing. Plant interception may account for a major part of the water loss during application.
(h) "Sprinkler Irrigation", California Agr. Exp. Sta. Cir. 456, by V. H. Scott, 1956.

(23) HYDROLOGY OF IRRIGATION SUPPLIES IN CALIFORNIA.

(b) California Agricultural Experiment Station.
(c) Prof. R. H. Burgy, Department of Irrigation, Univ. of California, Davis, California.

(d) Experimental and field investigation; applied research and operation.
(e) Studies are being continued on the hydrologic effects of various watershed practices in study areas established in 9 locations on typical range and brush lands throughout California. Small plots and watersheds have been equipped to measure precipitation, runoff, erosion and other hydrologic effects. Data are being collected on an individual storm basis to determine correlations between precipitation intensity runoff and soil movement. Studies of the magnitude and scope of modifications of the hydrology of these areas are being continued.
(g) The study of the behavior of water as it concerns watershed management for water conservation, runoff and erosion relationships, stream measurement and the development of springs should be of great benefit to the vast rural and urban areas confronted with limited water supplies. Annual increases in water yield of from 1 to 3 acre inches per acre have been measured on small watersheds treated to vegetative manipulations. Preliminary studies of control of riparian vegetation along streams have indicated increases of surface flows during dry weather. This work is being extended to larger areas.
(h) "Some Effects of Heat and Brush Burning on the Physical Properties of Certain Upland Soils that Influence Infiltration", V. H. Scott and R. H. Burgy, Soil Sci. 82 (1):63-70, July.
"Relative Infiltration Rates of Burned and Unburned Upland Soils", V. H. Scott, A.G.U. Trans., Vol. 37, No. 1, Feb. 1956.

(24) MEASUREMENT OF IRRIGATION WATER AND IMPROVEMENT IN FARM IRRIGATION STRUCTURES.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott, Department of Irrigation, Univ. of California, Davis, California.
(d) Experimental; design.
(e) Studies of farm irrigation systems for the improvement of design and efficiency of irrigation equipment are being continued. The installation, operation and maintenance of various materials used as linings for ditches and reservoirs are being evaluated under field conditions. Study of relationship between the length of the converging section and the free flow equation for a Venturi flume used in open channels. Methods of grading land for surface irrigation have been studied in detail.
(g) Information is available on the seepage and vegetative control and general application of certain prefabricated materials for linings of small farm ditches on the best methods of grading land for surface irrigation, and on water spreading on agricultural lands for recharging underground water reservoirs. Seepage control of 5 to 7 times that of unlined sections have been obtained.
(h) "Estimating Irrigation Border Flow", W. A. Hall, Agr. Engin. 37(4)263-265, April 1956.
"Prefabricated Linings for Small Irrigation Ditches", V. A. Scott, A.S.A.E., Vol. 37, pp. 113-116, 119, Feb. 1956.
"What's New in Irrigation Equipment", W. A. Hall, and V. H. Scott, What's New in Crops, Vol. 8, No. 5, Feb. 1956.
"The Relationship Between Length of Converging Section and the Free Flow Equation for the Venturi Flume", V. L. Hauser, M.S. Thesis. Under preparation.

(25) PHYSICAL AND CHEMICAL FACTORS AFFECTING SOIL INFILTRATION RATES.

(b) California Agricultural Experiment Station.
(c) Dr. L. D. Doneen, University of California, Davis, California.
(d) Experimental and field; basic and applied research.
(e) Studies on the permeability of different soils are being continued. Factors affecting accumulation of salines in soil from irrigation water, the effect of quality of water on infiltration of water into soils, treatment of irrigation waters to increase water penetration into soils, and cultivation in relation to soil structure and soil compaction are being investigated.
(g) The effect of mineral composition of irrigation waters on rate of infiltration depends on the soil and the basic cause is being sought. Extensive areas have been found in which slow water penetration is caused by the lack of water stability of the soil, and tests are being developed to facilitate diagnosis of this condition. Compressibility of different soils is being studied in relation to other physical characteristics in an attempt to predict expected behavior under compaction. The degree of compaction and permeability of soils is being studied in relation to the soil moisture content at the time force is applied.

(1819) DRAINAGE IN RELATION TO IRRIGATION.

(b) California Agricultural Experiment Station.
(c) Dr. J. N. Luthin, Department of Irrigation, University of California, Davis, California.
(d) Experimental and field investigation; basic and applied research.
(e) Field work is in progress in several areas of California for the purpose of improving drainage design. Observation wells and water stage recorders have been located in selected sites, and drainage systems have been designed on individual farms. Methods of measuring soil permeability are being investigated. Water pressures in the ground water zone are being measured by means of piezometers placed in the soil below a water table.
(g) Some of the mathematical procedures and concepts used to obtain solutions to drainage problems have been described. Of considerable importance, as related to crop yield, will be the results of studies on the proper depth of drainage required to prevent salt accumulation on the soil surface. Information concerning water table elevations, soil permeability and effectiveness of existing drains should alleviate the varied drainage problems existing in many areas of California.
(h) "Soil Drainage Investigations", J. N. Luthin and V. H. Scott, California Agriculture, Vol. 10, No. 5, pp. 8 and 14, May 1956.
"Soil Drainage Near Guadalupe", J. N. Luthin and H. Hall, California Agriculture, Vol. 11, No. 1, page 7, January 1957.

(2055) THE PHYSICS OF SOIL MOISTURE MOVEMENT.

(b) California Agricultural Experiment Station.
(c) Dr. J. N. Luthin, Department of Irrigation, Univ. of California, Davis, California; Dr. Paul R. Day, Department of Soils, Univ. of California, Berkeley, California.
(d) Laboratory and theoretical studies; basic research.
(e) Studies of the falling water table in soil columns and on the development of electronic methods of measuring and recording soil moisture tension above a water table are under way. Numerous factors involved in water entry into tile are also being investigated.
(g) A suitable theory based on numerical solution of the differential equation of flow has been developed. Laboratory and field methods have been developed to evaluate soil hydraulic conductivity -- the basis for rational drainage design. It has been found in problems of agricultural hydrology involving lateral ground water flow at shallow depths below the ground surface that the amount of water flowing in the capillary region above the water table may represent an appreciable proportion of the total flow.
(h) "A Numerical Solution of the Differential Equation of Flow for a Vertical Drainage Problem", Paul R. Day and J. N. Luthin, Soil Sci. Soc. Amer. Proc. 20:443, 1956.

(2056) THE HYDRAULIC CHARACTERISTICS OF WELL CASING PERFORATIONS.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott, Department of Irrigation, Univ. of California, Davis, California.
(d) Experimental; applied research.
(e) Studies on the analysis of flow through well casing perforations conducted in the laboratory and field to determine (1) head loss characteristics of various perforation shapes, and (2) the influence of the gravel pack on the hydraulic performance of the perforations.
(f) Inactive.
(g) Head loss coefficients have been determined for a selected number of punched and chiselled perforations. Significant differences in the effect of the size distribution and shape of the gravel surrounding these perforations have been detected.

U. S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, Soil and Water Conservation Research Branch.

Eastern Soil and Water Management Section.

(1966) SOIL AND WATER MANAGEMENT STUDIES.

(b) Cooperative with the following state Agricultural Experiment Stations and other agencies for use throughout the 31 Eastern States: Alabama, Georgia, Illinois, Indiana, Iowa, Maine, Maryland, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, and Wisconsin. Since the general type of studies conducted at different locations within the listed states are quite similar except for variations in soils, climate cropping and management, they are being consolidated under a single heading. Some of the studies are reported in more detail as cooperative research under the respective states.

(c) Dr. L. B. Nelson, Eastern Soil and Water Management Section, Plant Industry Station, Beltsville, Maryland.

(d) Field and laboratory investigations; basic and applied research for design purposes.

(e) The studies involve hydrologic measurements for determining the effects of land management practices on runoff, soil moisture, erosion and modification of land slope patterns. Research is continuing on measurement of silt and trash-laden flows from plots and small agricultural areas under different covers and under different management systems. The investigations are designed to determine the (1) effects of different land use and farming practices upon surface runoff, soil losses and ground water supply and movement; (2) soil characteristics that are basically related to soil and moisture conservation principles as a basis for designing conservation practices; (3) relation of water runoff and soil erosion to the topography and to climatic conditions; (4) design of effective and economical structures and cultural practices for erosion control, water disposal and moisture conservation.

(f) Runoff and erosion measurements are continuing in a number of the states. Wide variations in the amount, distribution and intensity of rainfall from year to year together with temperature and wind effects make it necessary to continue measurements for a period of years in order to be sure of application of results.

(g) A summary analysis of the runoff and soil loss data from more than thirty locations and on areas representing different slopes, soils, covers and varying cultural and management practices are currently underway.

(h) "Land Forming Moves East", T. W. Edminster, Soil Conservation",Vol. XXI, No. 7, pp. 151-3, Feb. 1956.
"How to Store More Moisture in the Soil", V. C. Jamison, What's New in Crops and Soils, Vol. 8, No. 5, Feb. 1956.
"The Effect of a Dense Soil Layer and Varying Air Water Relations on the Growth, Root Development, and Nutrient Uptake of Cotton in Commerce Silt Loam", V. C. Jamison, and C. W. Domby, Soil Science Proceedings. In press.
"Study of Soil Compaction on Mississippi River Delta Soils",W. A. Raney, I. L. Saveson, and W. R. Gill, International Congress, Soil Science Proceedings, 6th Congress, D:521-524, 1956.
"Subsoiling Results at the Delta Station in 1955", Perrin Grissom, E. B. Williamson, O. B. Wooten, F. E. Fulgham, and W. A. Raney, Mississippi Farm Research. In press.
"Water in Agriculture", John R. Carreker, Bulletin of the Georgia Academy of Science. In press, 1956.
"Minimum Tillage for Soil and Water Conservation", George R. Free, Agr. Engr. Jour. In press, 1956.
"Spacing of Level Terraces on Coarse Loess Soils of Western Iowa", E. W. Larson, Agr. Eng. Journal. In press, 1956.
"Soil Management for the Southern Uplands", R. W. Pearson, and L. E. Ensminger, 1957 USDA Yearbook, 1956.
"Mechanics of Sheet Erosion", D. D. Smith, and W. H. Wischmeier, Transactions of AGU. In press, 1956.
"Protecting Your Soil", C. A. Van Doren, and L. E. Gard, Illinois Agr. Exp. Sta. Circular No. 667, 28 pp. (1956) illus.

"The Effect of Crop Residues on Soil and Water Losses from Corn and Winter Wheat", C. A. Van Doren, L. E. Gard, and A. A. Klingebiel, Soil Science Society of America Proceedings, 20:279-283, 1956, illus.
"Progress Report of Committee on Soil Compaction", T. W. Edminster, Agr. Eng. Journal. In press, 1956.

(2413) DRAINAGE REQUIREMENTS AND PRACTICES FOR CROP PRODUCTION.

(b) Cooperative with the following state Agricultural Experiment Stations and other agencies throughout, the 31 Eastern States: Florida, Georgia, Illinois, Iowa, Louisiana, Maryland, Minnesota, Mississippi, New York, New Hampshire, North Carolina, Ohio, South Carolina, Vermont, Virginia and Wisconsin. Determinations are made of the drainage requirements of various soils for production of important truck and field crops. Since the general type of studies conducted at the different locations within the listed states are quite similar except for variations in soils, climate and cropping they are being consolidated under a single heading. Some of the studies under this project are reported in more detail as cooperative research under the respective states.
(c) Dr. L. B. Nelson, Head, Eastern Soil and Water Management Section, Plant Industry Station, Beltsville, Maryland.
(d) Field and laboratory investigations; basic and applied research for design purposes.
(e) Investigations are conducted of tile, mole and surface drainage systems of varying designs and materials with respect to their efficiency and effectiveness in providing adequate drainage. Special attention is being devoted to the possible use of plastics and other materials as a cheaper and more economical way of providing surface drains. Studies are directed toward developing improved engineering designs and techniques for establishing and maintaining controlled water table levels under both organic and mineral soils. The studies are directed toward determining (1) ways to improve farm drainage systems in the Mississippi Delta area which will permit high level crop production and more effective use of modern farm machinery; (2) the relationship and effect of the physical characteristics of soils upon the drainage capabilities and drainage design requirements of soils in the Coastal Plain and the North Central areas; (3) better ways of investigating and diagnosing the drainage problem characteristics of Upland Valley areas and of developing pre-planning survey techniques and drainage methods; (4) through controlled hydraulic laboratory techniques, the hydraulic design characteristics of various drainage structural forms and systems for use in making more effective and economical drainage system designs.
(g) Data are being obtained on effectiveness of various systems of designs for managing excess water. Valuable data have been obtained on the hydraulics of tile junctions.
(h) "Use of Land Leveler Aids in Drainage and Improves Crop Stands", E. G. Diseker, Land Improvement Publication, March 31, 1956. (Copy available in branch files).
"Drainage in Humid Areas", T. W. Edminster, and G. O. Schwab, ASA Drainage Monograph, March 31, 1956. In press.
"Precision Surface Drainage for Cane Land", I. L. Saveson, Sugar Journal 18 (11):29-31 (1956), illus.
"Approximate Solutions to Drainage Flow Problems", Jan Van Schilfgaarde, Agronomy Monograph, Sec. VI of Chapter 11.
"Drainage", T. W. Edminster, and R. C. Reeve, 1957 USDA Yearbook. Approved May 29, 1956.
"Drainage in the Lower Southeastern Coastal Plain", L. R. Green, E. A. Schlaudt, and Simon Krock, Journal ASAE. In press, 1956.

(2414) IRRIGATION REQUIREMENTS AND PRACTICES FOR CROP PRODUCTION.

(b) Cooperative with the following State Agricultural Experiment Stations and other agencies throughout the 31 Eastern States; Florida, Georgia, Illinois, Iowa, Louisiana, Maryland, Minnesota, Mississippi, Missouri, New Hampshire, New York, North Carolina, South Carolina, Pennsylvania, Puerto Rico and Virginia. Determinations are made of the water requirements of crops under various conditions of evapo-transpiration and plant environment and crop response and water use under different amounts, times and methods of water application and depth of water penetration. Since the general type of studies conducted at different locations are similar except for variations in soils, climate, and cropping, they are consolidated under a single heading. Some of the studies are reported in more detail as cooperative research under the respective states.

(c) Dr. L. B. Nelson, Head, Eastern Soil and Water Management Section, Plant Industry Station, Beltsville, Maryland.
(d) Field and laboratory investigations; basic and applied research for design purposes.
(e) Studies are made of soil, crop and management factors that affect the sound engineering design, operation and maintenance of irrigation equipment and systems. Determinations are made of the (1) water requirements for irrigation in different sections of the East; (2) best sources of irrigation water and how it may be most economically stored and applied to the land; (3) best techniques for measuring and evaluating the infiltration rates, permeability, and water holding characteristics of the wide range of soils in the 31 Eastern States; (4) principles underlying the flow of water into and through soils and (5) essential requirements in design, operating characteristics and performance for the effective use of irrigation equipment and systems.
(g) Data were obtained and evaluated during the past year on the amount and timing of irrigation water applications for corn, cotton, tobacco, soybeans and forages under both sprinkler and surface systems.
(h) "Studies on Supplemental Irrigation of Potatoes in New Jersey", G. R. Blake, G. D. Brill, and J. C. Campbell, American Potato Journal, Vol. 22, No. 9, 327-331.
"Quality of Irrigation Water (Committee on Water Quality, Soil Conservation Society of America)", C. H. Wadleigh, M. H. Gallatin, and L. V. Wilcox, Journal Soil and Water Conservation Vol. 11, No. 1, Jan. '56.
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"Agricultural Drought in North Carolina", C. H. M. Van Bavel, and F. J. Verlinden, N. C. Agr. Exp. Sta. Tech. Bull. 122:60 pp., 1956. In press.
"Irrigation of Tobacco, Peanuts and Soybeans", D. M. Whitt, and C. H. M. Van Bavel, USDA Yearbook of Agr. 1955, Water pp. 376-381, 1955.
"Irrigation Methods and Practices for the Humid Region", T. H. Quackenbush, and M. D. Thorne, USDA Yearbook, 1957. In press.
"Irrigation Just One of Practices that must be Integrated with Others to Return Profit", W. A. Raney, Cotton Trade Journal, 56(14)1, 1956, illus.
"Cylinder Infiltrometers for Determining Irrigation Application Rates", C. S. Slater, SSSA Journal. In press, 1956.
"Estimating Soil Moisture Conditions and Time for Irrigation with the Evapotranspiration Method", C. H. M. Van Bavel, ARS 41-11; 16 pp., 1956, illus.
"Water Uptake Under Systems of Moisture Content and Moisture Tension", D. B. Peters, SSSA Proceedings. In press, 1956.
"Evaluation of Evaporatranspiration in Field Plots", W. A. Raney, Agr. Eng. Journal. In press, 1956.

Soil-Plant Relationships Section.

(26) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

See University of California, College of Agriculture, Division of Irrigation and Soils, Page 6.

(1194) PRINCIPLES UNDERLYING THE MOVEMENT OF AIR AND WATER INTO AND THROUGH SOILS.

(b) Laboratory project.
(c) Mr. R. C. Reeve, U. S. Salinity Laboratory, P. O. Box 672, Riverside, Calif.
(d) Experimental; applied research.

(e) To investigate the factors that influence the flow of water and air into and through soils.
(h) "The Effect of Various Exchangeable Cations Upon the Physical Condition of Soils", R. H. Brocks, C. A. Bower, and R. C. Reeve, Soil Sci. Soc. Amer. Proc. 20:1955 325-327, illus. "Measurement of Air and Water Permeability of Soils by Laboratory Methods", R. H. Brooks and R. C. Reeve, Agricultural Engineering 1956 (submitted for publication).

(2172) MOVEMENT AND DISTRIBUTION OF WATER AND SALTS IN UNSATURATED SOIL.

(b) Laboratory project.
(c) Dr. L. A. Richards, P. O. Box 672, Riverside, California.
(d) Field investigation; applied research.
(h) "Physical Processes Determining Water Loss from Soil", L. A. Richards, W. R. Gardner and Gen Ogata, Soil Sci. Soc. Amer. Proc., 1956. 20:310-314, illus.
"Materials for Retainer Plates and Their Use for Retentivity Measurements", L. A. Richards, Gen Ogata, Soil Sci. Soc. Amer. Proc., 1956. 20:303-306, illus.
"Sample Retainers, for Measuring Water Retention by Soil", L. A. Richards, Soil Sci. Soc. Amer. Proc., 1956. 20:301-303, illus.
"Retention and Transmission of Water in Soil", L. A. Richards, Yearbook of Agriculture (USDA), pp. 144-151, illus., 1955.
"Water Content Changes Following the Wetting of Bare Soil in the Field", L. A. Richards, Soil Sci. Soc. of Florida, Proceedings 15:142-148, 1955.
"Soil Moisture", L. A. Richards and S. J. Richards, Yearbook of Agriculture, (USDA)1957. In press.

(2173) MOVEMENT OF WATER AND SALTS FROM A WATER TABLE.

(b) Laboratory project.
(c) Dr. W. R. Gardner, P. O. Box 672, Riverside, Calif.
(d) Theoretical and experimental; basic and applied research.
(e) Equations describing evaporation from a water table have been formulated and solved. Data on evaporation from laboratory soil columns agree very well with theory.
(h) Manuscript in preparation.

(2174) MATHEMATICAL THEORY FOR THE MOVEMENT OF SOLUBLE SALTS BY LEACHING.

(b) Laboratory project.
(c) Dr. W. R. Gardner, P. O. Box 672, Riverside, California.
(d) Theoretical and experimental; basic and applied research.
(e) Purpose is to derive a mathematical theory for the leaching of soluble salts from soils. The soil properties which govern the amount of leaching are determined. Mathematical results are checked experimentally in laboratory soil columns.
(f) Completed.
(g) Good agreement between theory and laboratory and field plot results.
(h) "A Descriptive Theory of Leaching", W. R. Gardner and R. H. Brooks, Soil Sci. In press.

(2648) EVALUATION OF THE LEACHING REQUIREMENT THEORY FOR CONTROLLING SOIL SALINITY.

(b) Laboratory project.
(c) Mr. R. C. Reeve, U. S. Salinity Laboratory, P. O. Box 672, Riverside, Calif.
(d) Experimental; applied research.
(e) Involves the measurement of both inflow and outflow of both water and salt from soil columns in lysimeters in which crops are grown under varying water table depths and irrigation regimes. To test the validity of the leaching requirement theory for controlling soil salinity and to determine the effects of soil salinity and water table conditions on the growth of crops.

Watershed Hydrology Section.

(150) EXPERIMENTAL WATERSHED STUDIES.

See also Stanford University Project 1946, page 88, and U. S. Weather Bureau Project 2437, page

(b) Cooperative with State Agricultural Experiment Stations, Soil Conservation Service, U. S. Weather Bureau, U. S. Geological Survey, U. S. Bureau of Public Roads, Stanford University, University of Iowa, St. Anthony Falls Hydraulic Laboratory, Central and Southern Florida Flood Control District, and the Wisconsin Valley Improvement Company.

(c) Mr. Austin W. Zingg, Watershed Hydrology Section, Plant Industry Station, Beltsville, Md.

(d) Experimental; field and laboratory; for design of Watershed Protection and Flood Prevention Projects and general information in planning farms for soil and water conservation.

(e) Rainfall and runoff are measured on watersheds ranging from 1 to 75,000 acres. In addition to rainfall and runoff measurements, studies are made on small Government-operated areas of evapo-transpiration, moisture storage, moisture transmission through the soil, hydrologic effect of physiography, tillage, and ground surface conditions, vegetal covers and soils and geology, and the effect of conservation farming on runoff and erosion, as well as the characteristics of flood runoff from agricultural watersheds. Hydrologic records of various kinds are being obtained on some 115 watersheds at: Safford and Tombstone, Arizona; Ft. Lauderdale and Vero Beach, Florida; Watkinsville, Georgia; Iowa City, Iowa; College Park and Hagerstown, Maryland; East Lansing, Michigan; Oxford, Mississippi; McCredie, Missouri; Hastings, Nebraska; Albuquerque and Santa Rosa, New Mexico; Cohocton and Dutchess County, New York; Coshocton, Ohio; Stillwater, Oklahoma; Riesel (Waco), Texas; Blacksburg, Virginia; Colby,Fennimore and LaCrosse, Wisconsin; Montpelier, Vermont. Other studies include (1) analysis and interpretation of accumulated records and (2) development of procedures for generalizing synthetic unit hydrographs for watersheds primarily under 3000 acres in size.

(g) Daily rainfall and runoff amounts and amounts of runoff during selected time intervals from 1 hour to 7 days are being compiled for 366 agricultural watersheds, ranging in size from less than 5 acres to 256 square miles, at 60 locations in 27 states. The information on daily rainfall and runoff amounts, with watershed descriptions, is being processed for publication in 1957.

(h) "Yield of Water from Small Agricultural Watersheds--Analytical Methods", L. L. Harrold. Approved for publication in Trans. Amer. Geophys. Union 1956.
"Yields from Semi-Arid Watersheds", R. B. Hickok. Approved for publication in Agr. Eng. 1956.
"Behavior of Water on Land", L. L. Harrold, Jour. Soil and Water Conser., Vol. 10, No. 6, Nov. 1955.
"A Study of Rain Storm", L. L. Harrold, Soil Conservation Magazine, Nov. 1955.
"Upstream Surface-Water Supplies--Need for Facts", L. L. Harrold, Jour. Soil and Water Conser., Vol. 11, No. 4, July 1956.
"Patterns and Classes of Rainfall at East Lansing, Michigan, and their Effect upon Surface Runoff", James L. Smith, and Geo. A. Crabb, Jr., Mich. Agr. Expt. Sta. Quarterly Bul. Vol. 39, No. 1, pp. 47-62, Aug. 1956.
"Average Monthly Percolation from the Coshocton Monolith Lysimeters, 1938-55", F. R. Dreibelbis. Approved for publication in What's New in Crops and Soils, 1956.
"The Basis of Sound Conservation Planning--Research", L. L. Harrold, Land and Water. Vol. 1, No. 4, Winter issue, 1955.
"Studies in Soil and Water Conservation, a Station Tour Guide", L. L. Harrold. Ohio Soil Conser. Committee, ARS, Ohio Agr. Expt. Sta., May 1956.
"Improved Tension Board for Measuring Aeration Porosity", F. R. Dreibelbis, Agron. Jour. 48:243, 1956.
"A Short Method of Obtaining Mean Weight-Diameter Values of Aggregate Analysis of Soils", R. E. Youker, and J. L. McGuinness. Approved for publication in Soil Sci. Soc. Amer. Proc. 1956.
"Irrigation: Soil and Water Fundamentals", L. L. Harrold, Water Well Jour., June 1956.
"Discussion of the Displacement of Calibration Curves for Electrical Soil Moisture Units by Remson and Fox", F. R. Dreibelbis. Trans. Amer. Geophys. Union, Vol. 37, No. 4, August 1956.

(1723) THE HYDRAULICS OF CONSERVATION STRUCTURES.

See St. Anthony Falls Hydraulic Laboratory Projects Nos. 111, page 81; 1168, page 81; 1398, page 81; 1929, page 82; and 2386, page 84.

(b) Cooperative with the Oklahoma and Minnesota Agricultural Experiment Station, the St. Anthony Falls Hydraulic Laboratory, and Colorado A and M College, Department of Civil Engineering.
(c) Mr. Austin W. Zingg, Watershed Hydrology Section, Plant Industry Station, Beltsville, Md.
(d) Experimental; applied research for development and design.
(e) Research dealing with the design, construction, and testing of structures for controlling and conserving soil and water are carried out under this project. Field studies are made to determine the causes of deterioration of drainage ditches, terrace outlets, and hydraulic structures that have failed in service. Laboratory experiments in methods of preventing such deterioration are supplemented by field tests of those measures or devices that appear promising. Models of hydraulic structures are built and tested in the laboratory; and when the design has been developed to seemingly satisfactory operation, full-scale structures are tested before they are recommended for field use. At the Stillwater, Oklahoma Outdoor Hydraulic Laboratory tests are being made to establish friction coefficients of various crops for use in the Manning channel flow formula, and studies are being continued on the use of highway culverts for measuring flow rates. At the St. Anthony Falls Hydraulic Laboratory studies were continued on the capacity and performance of the hood inlet to the closed conduit spillway and on the hydraulic design characteristics of drain tile. Tests were continued at Colorado A and M College to develop the optimum dimensions of cantilever outlets for circular discharge conduits from water retardation structures.
(g) Tests showed that a hood inlet, formed by cutting the pipe so that the crown projects beyond the invert by three-fourths of a pipe diameter, caused circular pipe culverts to flow full on either steep or flat slopes even though the outlet discharged freely. The development promises an economical replacement for the drop inlet now in general use on thousands of spillways constructed annually for farm and ranch ponds and flood-water retarding dams. Tests were made on a channel vegetated with Bermuda and Reed's Canary grass to determine the hydraulic characteristics and the effect of prolonged wetting such as results when channels are used to drain surplus irrigation as well as flood flows. Immediately following the interplanting of Reed's Canary grass in an established Bermuda waterway, a flow was maintained for a period of 72 days. The grass mixture thrived despite a continuous flow about one inch deep and when subsequently tested under flood conditions withstood velocities in excess of 8 feet per second and remained in excellent condition. Tests in static water canals on residues of aquatic herbicides, consisting of 100 ppm of herbicides of which 30 ppm is chlorinated benzenes, showed that within 24 hours after treatment the concentration of chlorinated benzenes fell to 0.5 ppm or less. Within 3 days the concentration in the water was 0 ppm. It was also found that the chlorinated benzenes do not accumulate in the mud of canal bottoms.
(h) "The Box Inlet Drop Spillway and its Outlet", Closing Discussion, Fred W. Blaisdell, and C. A. Donnelly, Proc. Amer. Soc. Civ. Eng. Vol. 81, paper 841, pp. 1-2, Nov. 1955.
"Equation of the Free-Falling Nappe", Closing Discussion, Fred W. Blaisdell, Proc. Amer. Soc. Civ. Eng. Vol. 81, Separate 794, Sept. 1955.
"The Hood Inlet for Closed Conduits and Highway Culverts", Fred W. Blaisdell, and Chas. A. Donnelly. Approved for publication in Agr. Eng. 1956.
"Energy Losses at Draintile Junction", P. W. Manson, and Fred W. Blaisdell, Journal of the Amer. Soc. of Agri. Eng., April 1956.

(2175) SEDIMENTATION IN RESERVOIRS, STREAMS AND VALLEYS.

(b) Cooperative with State Agricultural Experiment Stations in Mississippi, Nebraska and New York, and with the University of Mississippi.
(c) Mr. Austin W. Zingg, Watershed Hydrology Section, Plant Industry Station, Beltsville, Md.
(d) Experimental; field and laboratory, for design of Watershed Protection and Flood Prevention Projects and general information in planning farms for soil and water conservation.

(e) Field studies are made to determine sediment sources in watersheds, the character and amount of sediment carried out of watersheds, the nature and rate of movement in channels, the nature and rate of stream-bank erosion, and the nature and rate of deposition of sediment in channels, on flood plains and in reservoirs and harbors. Field studies generally are confined to watersheds of less than 100 square miles in area. Evaluation studies are made of various types of control measures to determine their effectiveness in reducing sedimentation damages. The work is oriented to meet the immediate and specific needs for information for planning and design of watershed treatment programs in connection with soil conservation and flood prevention work. Studies are being carried on from field headquarters at Oxford, Miss.; Lincoln, Neb.; and East Aurora, N. Y.

(g) The work in Mississippi has been reoriented and greatly expanded by the initiation of intensive erosion and sedimentation studies in Pigeon Roost Creek watershed, a tributary having a drainage area of about 120 square miles, in the Yazoo-Little Tallahatchie River Basin. The project, comprehensive in nature and scope is now being developed in detail but will include studies of sediment yield in relation to rainfall and watershed characteristics; channel stability; sediment transportation; reservoir trap-efficiency; basic erosion rates of soils; sediment sources. Studies in methods of streambank stabilization included consideration of the forces and resistances to erosion in the channel of a small stream near Guilford, New York where maximum fluid shear stress at the bed of the channel was almost exactly equal to the critical shear stress for movement of the median sized stones in equilibrium on the bed surface. During the year a pre-cast concrete block of cellular design was developed and experimental installations made as a possible alternative revetment material to quarried stone rip-rap.
Studies were continued in the Missouri River Basin states with primary emphasis on sediment yields in relation to watershed characteristics. Additional data showing the wide variation in density of reservoir sediment were obtained which further emphasize the importance of securing the best possible measurement of sediment density when results of reservoir sedimentation surveys are to be used as an index to sediment yield from watersheds.

(h) "Sediment Problems in Streams and Valleys of the Yazoo Watershed", Russell Woodburn, and John Kozachyn, Mississippi Farm Research, Vol. 19, No. 5, Agricultural Experiment Station, State College, Miss. May 1956.
"Importance of Sheet Erosion as a Source of Sediment", L. M. Glymph, Jr. Approved for publication in Trans. Amer. Geophys. Union, 1956.
"Needed Research in Sedimentation", W. C. Ackermann. Approved for publication in Trans. Amer. Geophys. Union, 1956.

Western Soil and Water Management Section.

(55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.

See Colorado A and M College, page 14.

(151) LINING OF IRRIGATION CANALS AND RESERVOIRS.

(b) Laboratory project; Agricultural Research Service, Utah State Agricultural College, and Bureau of Reclamation cooperating.
(c) Dr. C. W. Lauritzen, Agricultural Research Service, Box 177, College Hill, Logan, Utah.
(d) Experimental; basic and applied research.
(e) Linings for irrigation canals and reservoirs are being tested to develop more effective and lower cost methods of reducing seepage losses in irrigation systems. The investigation includes: (1) evaluation of physical properties of lining materials; (2) model testing of linings in an outdoor laboratory; and (3) field testing at selected sites to determine relative durability under varying subgrade and climatic conditions.
(g) This year, emphasis has been on the use of plastic films and soil stabilizers. Linings of Polyethylene and Polyvinyl chloride film as thin as 8 mils, it appears, can be used successfully to control seepage losses from reservoirs. The indications are that these films should be employed as buried liners in most instances. Considerable care must be exercised in making the installation, but once properly installed, these film liners are extremely effective and show promise of continued effectiveness over a long period of time. Some difficulties have been encountered in the use of chemical soil stabilizers for canal linings, but the results of preliminary tests and laboratory studies are promising for stabilizer AM 955.

(h) "Plastic Film for Controlling Seepage Losses in Farm Reservoirs", C. W. Lauritzen, F. W. Haws and A. S. Humphrey, Utah Agricultural Experiment Station Bulletin 391, 1956. "Plastics Prevent Water Loss", F. W. Haws and C. W. Lauritzen, Utah Farm and Home Science, 1956.

(287) PERFORMANCE OF WELL SCREENS.

(b) Colorado Agricultural Experiment Station, Agricultural Research Service, and various well screen manufacturers.
(c) Mr. A. R. Robinson, Agricultural Research Service, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied research; for master's thesis.
(e) (1) Measurement of loss of head in different types of well screens for discharges suitable for each screen. (2) Determination of the size of opening in well screens, diameter of screen, thickness of gravel envelope, and size and gradation of sand or gravel for most effective control of flow of sands of different finenesses into the well with least loss of head. (3) Determination of the size of openings in well screens and diameter of screen for most efficient operation in natural sands and gravels of a given classification.
(f) Suspended.
(g) Tests were conducted to study the specific effect of the uniformity of gravel as a factor in controlling the movement of sand in the wells. The results of these tests have not yet been fully evaluated.
(h) "Gravel Filters for Water Wells", Allan D. Halderman, Master's Thesis, June 1955.

(820) THE STUDY OF SEEPAGE LOSSES FROM IRRIGATION CHANNELS.

(b) Agricultural Research Service, Bureau of Reclamation, Colorado Agricultural Experiment Station.
(c) Mr. A. R. Robinson, Agricultural Research Service, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental and field investigation; applied research.
(e) To study the factors influencing seepage from irrigation channels and to perfect methods for making pre-investigations of seepage for the purpose of determining the seepage from existing canals, and predicting the seepage from proposed canals. Methods of measuring seepage were evaluated to determine the limitations and advantages of each. The effect of depth to ground water as well as effect of temperature on the seepage rate was also investigated.
(f) Completed.
(g) A report is in progress describing the results of the experiments. Several methods of measuring seepage were evaluated and the relative merits of each method were determined. The seepage rate was found to decrease as the ground water approached the ground surface. In some cases, the seepage rate was found to vary inversely as the temperature of the water.
(h) Final report in progress.

(1686) CONSUMPTIVE USE OF WATER AND IRRIGATION REQUIREMENTS.

See Utah State Agricultural College, page 99.

(2067) MODEL STUDY OF A TILE INTERCEPTOR DRAIN.

(f) Suspended.

(2177) WATER REQUIREMENTS IN THE IRRIGATED AREAS OF THE PACIFIC SOUTHEAST.

(b) Field project in cooperation with Western States' Agricultural Colleges, State Engineer, Soil Conservation Service, and Bureau of Reclamation.
(c) Mr. Harry F. Blaney, 1509 Post Office and Court House Bldg., Los Angeles, California.
(d) Field experiments and office analysis.

(e) (1) To determine the consumptive use of water by agricultural crops and native vegetation and water requirements for irrigated crops. (2) To compile and prepare for publication available data relating to irrigation requirements and consumptive use as determined by field experiments. (3) To estimate water requirements from climatological and other data.
(g) Normal rates of consumptive use and water requirements have been estimated and provisional reports are prepared for several western states and Colorado River Basin. These values have been computed by the Blaney-Criddle formula; U = KF. Where U is a consumptive use in inches, K is an empirical coefficient based on experimental measurements and F is a factor determined from monthly mean temperatures and percent day-time hours.

(2178) DETERMINATION OF THE CHARACTERISTICS OF THE SUSPENDED SILT LOAD OF TEXAS STREAMS.

(f) Suspended.

(2179) EVAPORATION AND CONSUMPTIVE USE OF WATER INVESTIGATIONS IN THE SAN FRANCISCO BAY AND ADJACENT AREA.

(b) Field study conducted as a cooperative venture with Division of Water Resources, State of California, and the Corps of Engineers, San Francisco Bay District, U. S. Army.
(c) Mr. Dean C. Muckel, P. O. Box 180, Berkeley, Calif.
(d) Primarily applied with some field tests.
(e) To determine rates of evaporation from fresh water surfaces, the consumptive use of fresh water by marshland vegetation (tules and cattails), and the consumptive use of water by salt grass at varying depths to water table in the San Francisco Bay and adjacent areas.
(f) First stage of work is now completed. The project is being continued and expanded to include the Delta areas of the Sacramento-San Joaquin Rivers.
(h) "Evaporation and Evapo-transpiration Investigations in the San Francisco Bay Area", by H. F. Blaney and D. C. Muckel, Transactions American Geophysical Union, Vol. 36, No. 5, October 1955.
"Rates of Evaporation and Consumptive Use in the San Francisco Bay and Adjacent Areas", by D. C. Muckel and H. F. Blaney, Final Report to California State Engineer, January 1955. (Mimeographed).
"First Progress Report on Evaporation Investigations in the San Francisco Bay Region, California", by D. C. Muckel, mimeographed report to the Corps of Engineers, U. S. Army, November 1, 1955.

(2180) EVAPORATION LOSSES FROM RESERVOIRS.

(b) Field project in cooperation with State of California and County Flood Control Districts.
(c) Mr. Harry F. Blaney, 1509 Post Office and Court House Bldg., Los Angeles, California.
(d) Experimental; compilation and data.
(e) To determine evaporation losses from reservoirs and lakes in California and compile and prepare for publication reliable evaporation and related data measured since 1945 in cooperation with the State Engineer of California. Field measurements are being made in cooperation with the State and local agencies on 15 stations ranging in elevation from -240 feet below sea level at Salton Sea to 9,194 feet at Kaiser Pass in the Sierra-Nevada mountains.
(g) Monthly evaporation from pans, temperature, humidity, wind movement, and precipitation are being compiled for the various stations. Evaporation from Lakes' surface is being computed by reduction factors. In the mountain areas, records are being kept at Shaver Lake (elevation 5,376 feet); Huntington Lake (elevation 6,954 feet); Florence Lake (elevation 7,345 feet); Kaiser Pass (elevation 9,194 feet).
(h) "Bulletin No. 54-B, Evaporation from Water Surfaces in California", by H. F. Blaney and G. L. Corey, California Division of Water Resources, October 1955.

(2181) STORAGE OF WATER UNDERGROUND FOR IRRIGATION IN CALIFORNIA.

(b) Laboratory and field project.
(c) Mr. Leonard Schiff, P. O. Box 513, Bakersfield, Calif.
(d) Experimental; applied research.

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(e) To determine the factors affecting the percolation rate on water-spreading areas, and to devise ways and means to increase the percolation rate. In some soils the percolation rate decreases during spreading, and the objectives are to determine the cause of the decrease and to find practical methods of maintaining the high initial rates. Field tests are being made on test ponds and strips.

(h) "Replenishing Underground Water Supplies for Irrigation Purposes", D. C. Muckel and L. Schiff, Proceedings 6th International Congress of Soil Science, 1956.
"The Darcy Law in the Selection of Water-Spreading Systems for Ground-Water Recharge", L. Schiff, Proceedings of the International Assoc. of Hydrology, IUGG, France, Sept. 1956.
"The Status of Water Spreading for Ground-Water Replenishment", by Leonard Schiff, Transactions Am. Geophysical Union, Vol. 36, No. 6, December 1955.
"Infiltration Rates of Water Spreading Areas as Influenced by Soil Types and Mechanical Composition of the Soil", E. S. Bliss, 1955 (Mimeographed).
"Spreading Water to Conserve It", L. Schiff and C. E. Johnson, Soil Conservation, July, 1955.

(2184) DRAINAGE OF IRRIGATED LAND IN THE UPPER COLORADO RIVER BASIN.

(b) Cooperative project; Colorado Agricultural Experiment Station, Soil Conservation Service and Soil and Water Conservation Research Branch, ARS.
(c) Dr. Minoru Amemiya, P. O. Box 786, Grand Junction, Colorado.
(d) Experimental and field investigation; applied research.
(e) (1) To develop procedures for making drainage investigations involving the source, amount and distribution of excess water, and (2) to evaluate the effects of water logging on soil permeability and crop response.
(h) "Reclamation of Saline-Alkali Soils in the Upper Colorado River", M. Amemiya, N. A. Evans, W. D. Kemper, M. M. Hastings, and C. E. Robinson, Colo. Agr. Exp. Sta. Gen. Ser. Paper No. 619, July 1955.
"Stratum Survey Techniques for Drainage Investigation on Irrigated Land", Norman A. Evans. Agricultural Engineering (submitted for publication).

(2185) SPRINKLING AS A METHOD OF APPLYING WATER TO IRRIGATED FARM LANDS, ITS PROBLEMS AND LIMITATIONS.

(b) Field project.
(c) Mr. Claude H. Pair, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) The objectives of this study are: (1) To obtain more precise information for the design, layout, installation and operation of sprinkler irrigation systems on various soil types, slopes and crops under various weather conditions; (2) to determine the effect of sprinkling upon various soils and crops; (3) to determine the economic limitations in the use of sprinkler irrigation systems; and (4) to assist in the development and testing of better sprinkler equipment and more efficient operating procedures. Work is continuing on items (1) and (2) of (e) along with testing pressure regulating valves for use in sprinkler systems.
(h) "Developments in Sprinkler Irrigation", Claude H. Pair, Agricultural Engineering (submitted for publication).

(2186) RELATIONS BETWEEN SOIL CHARACTERISTICS AND PROPER IRRIGATION PRACTICES.

(b) Field project.
(c) Mr. Claude H. Pair, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) The objectives of this study are: (1) To obtain more precise information on the design, layout, construction, and operation of farm irrigation systems on new and old irrigated lands; (2) to determine the irrigation efficiencies and water requirements for those irrigated lands; and (3) to determine procedures to assist in adequate land classification on proposed and existing irrigation projects.
Work is continuing on items (1) and (2) listed in the objectives above.
(f) Completed.

(h) "Annual Progress Report, Cooperative Surface and Sprinkler Irrigation Investigations", by Claude H. Pair, December 1955.

(2279) LABORATORY AND FIELD STUDY OF THE VORTEX TUBE SAND TRAP.

(b) Agricultural Research Service, Colorado Agricultural Experiment Station.
(c) Mr. A. R. Robinson, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied research; field evaluations; for design.
(e) Tests are in progress in the Hydraulics Laboratory on a full scale vortex tube. Efficiencies of trapping are being determined under a range of operating conditions. Tubes of different sizes and shapes will be tested. Field evaluations are being planned for tests on existing sand trap installations.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

(b) Agricultural Research Service, Colorado Agricultural Experiment Station.
(c) Mr. A. R. Robinson, Agricultural Research Service, Colorado A and M College, Fort Collins, Colorado. Mr. R. W. Nelson, Agricultural Research Service, Colorado A and M College, Fort Collins, Colorado.
(d) Experimental; applied research for field design.
(e) Both field and laboratory studies are being made to determine the relationship of discharge, farm water supply, physical features of the drain systems, and drainage characteristics of the soil. Another objective is to check the theoretically derived relationships between soil drainage properties and the shape of the water table after drainage. Work is under way to determine if a detailed knowledge of the geometry and hydraulic conductivities of the soil system in a small area can be extrapolated to a large area to enable the rational design to be made. This study makes use of electric analog technique.
(h) "Model Study of Interceptor Drains", Jack Keller, Master's Thesis, August 1955.

(2650) EFFECT OF WATER TABLE DEPTH OF IRRIGATION REQUIREMENTS AND YIELD OF LAHONTAN ALFALFA.

(b) Cooperative project; Nevada Agricultural Experiment Station, and Western Soil and Water Management Section, ARS.
(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.
(d) Experimental; applied research.
(e) In field lysimeters the water use and growth of alfalfa as related to varying water table depths and irrigation regimes are being evaluated.

(2651) DRAINAGE INVESTIGATIONS IN THE NORTH SHORE AREA OF CARSON LAKE, NEVADA.

(b) Cooperative project; Nevada Agricultural Experiment Station, Western Soil and Water Management Section, ARS, Soil Conservation Service, and Truckee-Carson Irrigation District.
(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.
(d) Field investigation; applied research.
(e) Drainage investigations are being conducted in an irrigated area north of Carson Lake to determine the causes for drainage problems in the study area and to develop improved equipment and procedures for conducting investigations and methods for alleviating drainage problems.

(2652) UTILIZATION OF AVAILABLE WATER SUPPLIES IN THE COLORADO RIVER BASIN OF NEVADA.

(b) Cooperative project; Nevada Agricultural Experiment Station, Soil Conservation Service, and Western Soil and Water Management Section, ARS.
(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.
(e) A study to determine the present disposition of water in the Colorado River Basin within Nevada and to evaluate the potential water supply available for beneficial use in this basin.

(2653) CONSUMPTIVE USE, WATER SUPPLY AND IRRIGATION STUDIES IN SANTA BARBARA COUNTY, CALIFORNIA.

(b) Laboratory and field project.
(c) Mr. Paul Nixon, USDA Agricultural Research Service, Lompoc, California.
(d) Basic and applied research.
(e) Objectives are: (1) To obtain basic data on consumptive use of water by irrigated crops and native vegetation; (2) to determine the contribution of rainfall and return waters from irrigation to the ground water supply; (3) to make irrigation efficiency studies to improve irrigation practices. This project is cooperative with the U.S.B.R., U.S.G.S., and the Santa Barbara County Water Users Association.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Alaska Forest Research Center.

(2654) EFFECT OF LOGGING ON PHYSICAL CHARACTERISTICS OF SALMON STREAMS IN SOUTHEAST ALASKA.

(b) Laboratory project.
(c) Mr. R. F. Taylor, Forester in Charge, Alaska Forest Research Center, Box 740, Juneau, Alaska.
(d) Field investigation; applied research.
(e) In developing the timber resources of the region, it is essential that adequate steps be taken to safeguard the important fisheries resource. The objective is to determine whether logging, carried out in accordance with provisions required by the Forest Service to protect salmon spawning streams, causes physical changes to the watershed and stream regimen which might be harmful to the stream for salmon production. The following factors are being investigated: (a) Changes in the stream regimen; (b) erosion and sedimentation; (c) stream channel change; (d) accumulation of debris in streams; (e) change in stream bottom material; and (f) water temperature.
(g) The first, or calibration, phase of this study has resulted in information on the hydrological characteristics and other factors, such as water temperatures, accumulation of debris, stream bottom changes of undisturbed streams in a heavily glaciated region with extreme precipitation.
(h) "The Relationship between Precipitation and Stream Flow on a Typical Southeast Alaska Stream", G. A. James, Alaska Forest Research Center Tech. Note No. 24, 3 pp., illus., 1955.
"The Physical Effect of Logging on Salmon Streams of Southeast Alaska", Alaska Forest Research Center Sta. Paper No. 5, 49 pp., illus., 1956.
"A Practical Stream Gauge Recorder House", L. W. Zach, Jour. of Forestry Vol. 48(7) 491-493, 1950.
"Effect of Rainfall on Stream Flow in Southeast Alaska", Alaska Forest Research Center Tech. Note No. 4, 3 pp., 1950.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, California Forest and Range Experiment Station.

(261) WATERSHED MANAGEMENT RESEARCH, SOUTHERN CALIFORNIA.

(b) Laboratory project.
(c) Dr. Goerge M. Jemison, Director, California Forest and Range Experiment Station, P. O. Box 245, Berkeley 1, California.
(d) Experimental; field investigations; basic and applied research.
(e) Purposes are (1) to determine how watersheds function: what happens to the precipitation, and how water and soil movement are influenced by conditions of vegetation, soil, geology, and topography; and (2) to develop methods of watershed management, including treatment of areas denuded by fire, to insure maximum yield of usable water and satisfactory flood runoff and soil erosion control. Major work center is the San Dimas Experimental Forest situated in the San Gabriel Mountains of southern California. Here rainfall, runoff, and erosion are measured on two major drainage areas, on 10 large and 7 small watersheds within these areas, and on 24 experimental plots. Vegetation cover on the watersheds is

mostly mature brush or chaparral, unburned for 36 years or more. However, in 1953 about one-third of one large watershed was burned-over by wildfire and in 1938 one-fourth of another large watershed, 3 small watersheds, and 9 plots were denuded by wildfire. Fifteen other plots are equipped to obtain detailed information on the disposition of rainfall from annual ryegrass, native scrub oak-chaparral, and a 28-year-old Coulter pine plantation. Twenty-six large lysimeters furnish comparisons of water use and surface runoff control by five species of native shrubs, one species of pine, and a bunchgrass association. Climatic data are obtained from several meteorological stations. Ways of improving the native vegetation cover to reduce soil movement on mountain slopes are being studied in the Los Angeles River watershed. Measurements to determine kinds, rates, and volumes of soil movement (soil, rock, and organic debris) are made on eight study sites representing typical watershed soil and vegetation conditions. After normal erosion rates have been established, the above sites will be used to evaluate effects of promising cover improvement practices upon soil stability.

(g) Analyses of weekly mean streamflow records from Big Dalton Watersheds VIII, IX. and X for 15 hydrologic years (1938 through 1956) have been completed for the wetting, percolation, and drying periods. These analyses provide basic information on water yield relations of these watersheds with native brush-chaparral cover unburned since 1919. Two prediction equations have been developed for each hydrologic period for each watershed. One equation is based on meteorological controls alone, and one on a combination of meteorological controls and measured streamflow from check watershed IX. An office report on this study is being prepared. Similar analyses of data from San Dimas watersheds I, II, and III have been started. These analyses will have a twofold objective: (1) To calibrate the watersheds under undisturbed conditions of vegetation cover in order to evaluate effects of future changes in watershed conditions upon streamflow, and (2) to determine effects of the 1938 wildfire in watershed II, and the 1953 wildfire in watershed I upon streamflow from these watersheds. A study of rainfall-elevation relations in the San Gabriel Mountains of southern California is in progress.

(h) "Uses of Soil-Vegetation Survey Information in Watershed Management", by P. B. Rowe and E. A. Colman. Accepted for publication in Soil Science Society of America Proceedings 21(2).

(2415) WATERSHED MANAGEMENT RESEARCH, NORTHERN CALIFORNIA.

(b) Laboratory project.

(c) Dr. George M. Jemison, Director, California Forest and Range Experiment Station, P. O. Box 245, Berkeley 1, California.

(d) Experimental; field investigations; basic and applied research.

(e) The aim is to develop a hydrologic base for land management decisions. The hydrologic effects of wildfires, of attempts at conversion of brushlands to grass, and of logging are to be evaluated. Present studies emphasize (1) study of watershed damages incident to logging operations, and (2) development of methods of management of high elevation snowpacks for maximum control and yield of water. Major work center is in Berkeley with studies being conducted throughout northern California as well as at two field laboratories: Teakettle Creek Snow Laboratory in the Kings River Basin, east of Fresno, and the Central Sierra Snow Laboratory, near Donner Summit. At Teakettle Snow Laboratory, five small watersheds are under calibration for evaluation of streamflow and sedimentation. At the Central Sierra Snow Laboratory streamflow measurements of Castle Creek will be resumed this year. Daily meteorological measurements are being taken at three stations and snow physics at the headquarters station. Seven small watersheds are being preliminarily tested for suitability as experimental watersheds by means of staff gages and maximum stage indicators.

(g) Snowpack accumulation and melt at measurement points within snow courses at the Central Sierra Snow Laboratory were related to two forest-cover variables. Water equivalent of the snowpack on April 1 of each year and melt rate after April 1 per unit of degree-days above 35°F were studied. Cover variables were the amount of shade from trees to the south of a snow measurement point and the amount of shielding from trees to the north of the point. The amount of shade was expressed as the duration of shading between April 1 and June 15, multiplied by the amount of direct solar energy which would have struck the snow surface in the absence of shading. Shielding was expressed by the ratio of average tree height to distance of the trees from the measurement point. Data from five points

in each of five snow courses for three years of record were analyzed by the method of covariance. The analyses showed a high degree of association between the snowpack and forest-cover variables. The results are interpreted in terms of the timber-cutting pattern that would result in maximum accumulation of snow, minimum melt rate, and maximum prolonged release of snow water in the spring. Observations of erosion associated with logging in the redwood-Douglas fir region following the heavy storm of December 1955 showed extensive gullying of logging roads and skid trails. Earth slides into roads and creeks also caused trouble, and in many places the creeks were choked with tangles of slash and broken logs. The streams showed excessive mudbars, cut banks, sand and gravel filled pools, and tangles of old slash firmly bedded in the stream bottoms.

(h) "Conquering Kennett's Gullies", C. J. Kraebel. American Forests 61(12):36-39 and 42 and 44. Dec. 1955.
"Forest-Cover Effects on Snowpack Accumulation and Melt, Central Sierra Snow Laboratory", H. W. Anderson. Trans. Amer. Geophys. Union 37(3):307-12, 1956.
"From Ocean to Sky to Land to Ocean", W. C. Ackerman, E. A. Colman, and H. O. Ogrosky. Reprint from pages 41-51 of 1955 Yearbook of Agriculture.
"Soil Surveys on Forest and Range Lands", J. L. Retzer and E. A. Colman. Reprint from pages 242-246, 1955 Yearbook of Agriculture.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Central States Forest Experiment Station.

(2655) SOIL RELATIONS (WATERSHED MANAGEMENT).

(b) Laboratory project.
(c) Director, Central States Forest Experiment Station, 111 Old Federal Building, Columbus 15, Ohio.
(d) Field investigations; applied research.
(e) Water available for streamflow on forest, brush and broomsedge grass lands in Southeastern Ohio. Work underway at Vinton Furnace Experimental Forest Ohio.

(2656) WATER RELATIONS (WATERSHED MANAGEMENT).

(b) Laboratory project cooperative with School of Forestry, U. of Missouri, Columbia, Mo.
(c) Director, Central States Forest Experiment Station, 111 Old Federal Building, Columbus 15, Ohio.
(d) Field investigations; applied research.
(e) To determine the influence of forest land management practices on soil properties, and the volume, and quality of water from small watersheds.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Intermountain Forest and Range Experiment Station.

Inquiries concerning Projects Nos. 652 to 655, inclusive, should be addressed to the Director, Intermountain Forest and Range Experiment Station, Ogden, Utah.

(652) SOIL RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

(d) Experimental and field investigation; basic and applied research.
(e) Tests on plots and small watersheds of the effects of forest, brush, and herbaceous plant cover in natural, depleted, and restored condition on the infiltration, storage, fertility, biology, and stability of forest and range land soils; to determine land use practices for stabilizing eroding watershed soils and for maintaining soil stability under the impact of grazing, logging, and other wild land uses. Studies are under way on forest and range lands having coarse, granitic soils of southwestern Idaho; various soils on steep slopes of the Wasatch Mountains in northern Utah; and on heavy limestone soils in central Utah.

(g) Continued records of sediment production from 20 small watersheds in the Boise Basin Experimental Forest near Idaho City, Idaho; also from 2 watersheds having subalpine-herbaceous vegetation on Wasatch Plateau at Great Basin Research Center near Ephraim, Utah. Completed report on effects of plowing and seeding on the forage production and hydrologic characteristics of subalpine range in Central Utah.

(h) "Some Properties of 144 Soils from Three Intermountain States", by Robert E. Taylor, Intermountain Forest and Range Experiment Station Misc. Pub. No. 7, June 1956.
"Nitrogen Losses from Granitic Soils on Cheatgrass Browse Range", by H. F. Haupt, Forest Science, Dec. 1956.
"Infiltration Rates of Two Water-Spreading Projects, Davis County, Utah", by R. B. Marston, Intermountain Forest and Range Experiment Station Research Note No. 20. 1955.

(653) WATER RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

(d) Experimental and field investigation; basic and applied research.

(e) Tests on watersheds of the effects of forest, brush, and herbaceous plant cover, and of mechanical soil stabilization structures, on runoff characteristics of mountain watersheds; to determine land use treatments required for flood control and for maximum yields of usable streamflow.

(g) Completed analysis of watershed research problems on headwater of Missouri River in Montana, and on headwaters of Columbia River in western Montana, northern Idaho, and eastern Washington. Completed initial phase of a 3-year study to evaluate the hydrologic effects of upstream flood control measures in Pleasant Creek watershed of Central Utah. Continued streamflow records from experimental watersheds at Wasatch, Great Basin, and Inland Empire Research Centers.

(h) "Runoff Characteristics of a Small Forested Watershed in Northern Idaho", by A. R. Stage, Northwest Science, Dec. 1956.

(654) PLANT RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

(d) Experimental and field investigation; basic and applied research.

(e) Tests on plots and watersheds of the effects of forest, brush, and herbaceous cover on interception and evapo-transpiration losses; to determine the kind of plant cover required for producing maximum yields of useful runoff from watersheds.

(g) Continue calibration records on 16 plots at Davis County Experimental Watershed to determine effect of seasonal use of range forage on evapo-transpiration losses and water available for streamflow. Initiated study of the seasonal research of soil moisture on aspen forest sites within the Davis County Experimental Watershed.

(655) CLIMATIC RELATIONS (IN WATERSHED MANAGEMENT AND PROTECTION).

(d) Experimental field investigation; basic and applied research.

(e) Measurements and studies of climatic factors including precipitation, temperature, etc., that have a bearing on the hydrologic behavior of forest and range watershed areas at the Boise Field Research Center, Boise, Idaho; Wasatch Field Research Center, Farmington, Utah; Great Basin Field Research Center, Ephraim, Utah; and the Inland Empire Field Research Center, Spokane, Washington.

(g) Continuing climatic records at Wasatch, Great Basin, Boise, and Inland Empire Research Centers.

(h) "Air Movement Under an Aspen Forest and on an Adjacent Opening", by R. B. Marston, Journal of Forestry, Vol. 54, No. 7, July 1956.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Northeastern Forest Experiment Station.

Inquiries concerning Projects Nos. 656, 966, 1187, 1188, and 2419, should be addressed to Dr. Ralph W. Marquis, Director, Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pennsylvania.

(656) WATERSHED MANAGEMENT RESEARCH, DELAWARE-LEHIGH-EXPERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project; in cooperation with the Pennsylvania Department of Forests and Waters and U. S. Geological Survey.
(d) Field investigation; basic and applied research.
(e) A study was started in 1948 on the Delaware-Lehigh Experimental Forest, Monroe County, Pa., to determine the water economy for a watershed covered with scrub oak. Afterwards, the cover will be converted by planting and fire protection to a commercially valuable type, and the effect on water relations will be measured. Installations have been established to evaluate all components of a water balance equation for the watershed.
(g) A 5-year planting program was started in 1956.
(h) Forest and water research project. Delaware-Lehigh Experimental Forest. Irvin C. Reigner, W. E. McQuilkin, E. F. McNamara, and Howard W. Lull. Pa. Dept of Forest and Waters, Report No. 3, 44 pp., illus.

(966) WATERSHED MANAGEMENT RESEARCH, POCONO EXPERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) Studies have been started on the Pocono Experimental Forest, Wayne County, Pa., to determine effects of forest management practices and logging operations upon the quantity and quality of water yielded by a small watershed. Installations have been established to measure precipitation, streamflow and rainfall interception.

(1187) FROST STUDIES IN THE NORTHEASTERN UNITED STATES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To determine the effect of land use and condition upon type and depth of frost formation. Periodic observations of frost type and depth, snow depth, and water content were made on 186 plots throughout the Northeast during the winters 1950-51 and 1951-52.
(g) A report of results has been prepared for publication.

(1188) WATERSHED MANAGEMENT RESEARCH, FERNOW EXPERIMENTAL FOREST, WEST VIRGINIA.

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) Studies were started in 1951 on the Fernow Experimental Forest, Tucker County, W. Va., to determine the effect of different levels of cutting practices and different logging methods upon water quantity and quality. Five watersheds were equipped with streamgaging stations and raingages. No logging will be done on these watersheds during a calibration period. Measurements are being made on areas adjacent to the gaged watersheds to determine erosion rates on logging roads as influenced by length and steepness of grade and various erosion control measures.
(h) "Chaff Seeding - One Answer to Soil Washing on Logging Roads", George R. Trimble, Jr. and Sidney Weitzman. West Va. Conserv.

(2419) WATERSHED MANAGEMENT RESEARCH, HUBBARD BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE.

(b) Laboratory project.
(d) Field investigation; basic and applied research.
(e) The objective is to determine the effect of forest type, condition, and treatment on quantity and quality of streamflow. Studies are conducted in plots and experimental watersheds on the 7500-acre experimental forest in the White Mountains at West Thornton, New Hampshire.
(h) "Snow Storage and Melt in a Northern Hardwood Forest", Richard S. Sartz and George R. Trimble, Jr. Jour. Forestry 54:499-502.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Pacific Northwest Forest and Range Experiment Station.

(969) EFFECT OF LOGGING, CLEARCUTTING AND OTHER FOREST OPERATIONS ON STREAMFLOW.

(b) Laboratory project.
(c) Mr. R. W. Cowlin, Director, Pacific Northwest Forest and Range Experiment Station, Post Office Box 4059, Portland 8, Oregon.
(d) Field investigation; applied research.
(e) H. J. Andrews Experimental Forest in the McKenzie River drainage of west central Oregon. Streamflow from three small experimental watersheds in virgin Douglas-fir has been measured for four years by means of trapezoidal flume stream gages. These observations provide a pretreatment calibration which will be carried on for three years or more. Planned treatments will test effect of two systems of timber cutting on water yield and erosion. In 1956, activities were extended to a second area in cooperation with the City of Portland, Oregon. Pretreatment calibration measurements now being taken on three small watersheds within the Bull Run Reserve, which is the source of Portland's water supply. Cover is virgin Douglas-fir. Streamflow will be measured by means of trapezoidal flumes, one of which is now installed. Results of this study will determine the future management policy to be followed on the watershed.

(2187) EFFECT OF CATTLE GRAZING ON EROSION.

(b) Laboratory project.
(c) Mr. R. W. Cowlin, Director, Pacific Northwest Forest and Range Experiment Station, Post Office Box 4059, Portland 8, Oregon.
(d) Field investigation; applied research.
(e) To test the effect of heavy, moderate and light grazing on erosion, sediment production and runoff, Starkey Experimental Forest and Range. Sediment catchment basins have been constructed in small drainages, one in each of six pastures in which are tested three rates of grazing and two systems of management: deferred-rotation and season-long use. Major effect on erosion will be determined by volume of sediment accumulated in the basins. Study now in its third year.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Rocky Mountain Forest and Range Experiment Station.

Inquiries concerning Projects Nos. 376, 377, 657, 1967, 1968, 1969, 1971, 2188, 2420, 2657 and 2658, should be addressed to Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.

(376) WATERSHED MANAGEMENT RESEARCH, MANITOU EXPERIMENT FOREST.

(b) Laboratory project.
(d) Field investigations; applied research.
(e) Studies of the influence of grazing, timber cutting, and revegetation of depleted watershed lands upon water supplies, erosion and sedimentation, to solve problems in management of watershed lands of the Rocky Mountain Front Range such as: (1) Effect of grazing intensity on the water absorption of granitic soils; (2) runoff and erosion from natural storms on bunchgrass plots; (3) runoff and erosion from natural storms on young pine plots; (4) effect of type conversion on runoff and erosion from small watersheds; and (5) characteristics of runoff from couldburst storms on a large watershed.
(g) The recording of rainfall, runoff, and erosion from plots and watersheds representing different complexes of soil, vegetation, and treatment has been continued in conformance with the long-term nature of the study.
(h) Annual report, 1955, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
"Infiltration as Affected by Vegetation, Soil, and Cattle Grazing in Colorado Ponderosa Pine Ranges", E. J. Dortignac and L. D. Love; manuscript in preparation 1956.

(377) WATERSHED MANAGEMENT RESEARCH, FRASER HYDROLOGIC LABORATORY.

(b) Laboratory project.
(d) Field investigations; applied research.
(e) (1) To determine influence of lodgepole pine and spruce-fir forests and of the management of these forests on the yield of water; (2) to evaluate the alpine snowfields of the Colorado Rockies with respect to their contribution to summer streamflow; (3) to test amount of drifted snow held by several snow fence patterns under high alpine conditions. Purpose is to determine most desirable pattern for snow fence installations to increase amount of snow deposited in alpine snowdrifts.
(g) The cutting and removal of half of the timber from one 714-acre watershed was completed in 1956. Streamflow comparisons between this and an adjacent untreated watershed will be continued to determine the effects of logging on total water yield and its distribution in time. Remeasurement in 1956 of the winter snow accumulation on plots logged in 1940 showed that the abundant young trees now present have no appreciable effect on the snow accumulation. On plots heavily cut in 1940, the 1956 water equivalent of the winter snow accumulation was 40 percent greater than that under virgin forest. This is practically the same difference measured in years 1941-43. The following data were taken for the second summer on several alpine snowfields in the Front Range of Colorado: Water equivalent, rate of depletion, snow quality, and relation between depletion rates and weather factors. Aerial photographs of the alpine area of part of the Front Range were flown in June and again in September 1956 to determine the extent of alpine snowfields.
(h) Annual report, 1955, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
"The Snow Research Program at the Fraser Experimental Forest, Colorado", B. C. Goodell, Proceedings of Western Snow Conference, 1956.
"Some Hydrologic Aspects of Alpine Snowfields under Summer Conditions", Mario Martinelli, Jr., Ph. D. Thesis, State University of New York, College of Forestry at Syracuse, New York, 160 pp. 1956.

(657) WATERSHED MANAGEMENT RESEARCH, TEMPE, ARIZONA.

(b) Laboratory project.
(d) Experimental; basic and applied research.
(e) The purpose is: (1) To study the disposition of rainfall as influenced by watershed vegetation; (2) to determine the influence of various types of natural vegetation as well as vegetation modified by cultural treatment such as grazing and timber harvest, on streamflow, water use, water loss, and erosion and sediment yield; and (3) to determine for phreatophytic vegetation (water-loving plants) the amount of water used. Methods for reducing water use by phreatophytes or for replacing them with more useful plants.
At Sierra Ancha Experimental Watersheds in central Arizona, rainfall, runoff, and erosion are measured on three watersheds in the pine-fir vegetation type at high elevation, on two watersheds in the ponderosa-chaparral type, and from watersheds in the grassland-chaparral type at intermediate elevation, and on nine small watersheds in the semidesert-chaparral type at low elevations. Water use by different types of plants in various soils is studied on eleven large lysimeters. Three watersheds have also been established in the pure ponderosa pine type to test the effects of logging practices upon water yield and sedimentation. Gaging stations for four watersheds in the pure chaparral type were completed this year to evaluate watershed-game interrelations. Phreatophytes investigated on a laboratory scale by a transpiration machine which measures the amount of water vapor given off by seedlings.
(g) The first cut in a pine-fir forest on a calibrated watershed was completed. Fifty percent of the merchantable volume was removed. Basal area removal amounted to 37 percent as a result of logging and improvement cuts that removed hardwoods and mistletoe-infested pines. Two of four watersheds in the chaparral-grassland type were converted to a grassland type by poisoning the shrubs. Since these watersheds have been previously calibrated, the effect of conversion can be measured in terms of water yield and sedimentation. Measurements of water loss of seedlings in the laboratory indicate some significant differences in transpiration rates among species.

(1967) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Laboratory project.
(d) Applied research.
(e) Evaluation of reseeded rangelands for infiltration, soil stabilization, and soil productivity in woodland-sagebrush zone of north central New Mexico.
Rocky Mountain infiltrometer was used to measure infiltration and erosion rates from reseeded and adjacent native rangelands under grazing and nonuse. Measurement of selected vegetation and soil factors included in this study.
(f) Field study completed. Conducted during summers of 1952, 1953, 1954, 1955, and 1956.
(g) Compilation and analyses completed on major effects.
(h) Publications planned: Article summarizing major findings to be released in a scientific journal.

(1968) WATERSHED MANAGEMENT RESEARCH, NORTH CENTRAL, NEW MEXICO.

(b) Laboratory project.
(d) Applied research.
(e) Range and watershed condition, trend, and potential in north central New Mexico. Rocky Mountains infiltrometer was used in 1953 and 1954 to measure infiltration and erosion rates from about 20 fenced-in enclosures installed in 1939 and 1940 on native pinyon-juniper-sagebrush rangelands and from adjacent open range. Detailed soil and vegetation measurements were taken at each infiltrometer plot location. In addition, reexamination was made and quantitative measurement of vegetation taken, both inside and outside the enclosure, for comparison with measured vegetation conditions in 1939-40.
(f) Infiltrometer studies completed in 1953 and 1954.
(h) Station Paper, Rocky Mountain Forest and Range Experiment Station, summarizing findings, planned for release in 1957.

(1969) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Cooperative study with Bureau of Land Management and Geological Survey.
(d) Applied research.
(e) Evaluation of range-watershed conditions on small watersheds in the San Luis drainage of the Rio Puerco. Three contiguous watersheds, ranging from 430 to 680 acres located about 8 miles north of the San Luis community and west of the Rio Puerco main channel provide the study area. Water and sediment inflow are measured in small reservoirs formed by earthen dams. Precipitation amounts and vegetation changes are periodically measured over the watersheds. The preliminary survey and investigation phase is completed; exterior boundary fences installed; and interior fences are under construction. Uniform grazing during a 6-month over-winter period (October 1 to April 1) at medium intensity of use will be practiced on all three watersheds for a 5-year period, commencing October 1955. Thereafter, treatments will be applied to each of three watersheds as follows: Medium grazing use - no change; medium grazing use plus mechanical land treatments including gully control; and heavy grazing use.
(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(1971) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project, in cooperation with Bureau of Land Management, Bureau of Reclamation, and Geological Survey.
(d) Experimental; applied research.
(e) To determine the effect of exclusion of livestock grazing on erosion and runoff from semidesert lands in western Colorado, eastern Utah, and southern Wyoming.
(g) Pretreatment measurements of infiltration and erosion as determined with the Rocky Mountain infiltrometer are summarized by soil types.

(2188) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Laboratory project.
(d) Applied research.

(e) Soil moisture studies. Colman soil electrical units are installed at 3-inch depth intervals from the 1-1/2 inch soil depth to bedrock or to a depth beyond any anticipated moisture penetration. Recording and standard gages are used to measure precipitation. Moist pinyon-juniper zone (17-inch annual precipitation). -- A record of precipitation and soil moisture is maintained under three ground-cover conditions: Under pinyon trees and in a woodland opening; in grassland; and in a bared area kept free of vegetation by chemical spraying. Dry pinyon-juniper-sagebrush zone (13-inch annual precipitation) -- A record of precipitation and soil moisture is maintained under four conditions: Native sagebrush under protection from livestock grazing, and in crested wheatgrass under 25 percent utilization, under 75 percent utilization, and under full protection from cattle grazing.
(h) "Soil Moisture as Affected by Microclimate at a Pinyon-Juniper Site in New Mexico" -- E. J. Dortignac, presented at the 147th National meeting of the American Meteorological Society, Albuquerque, N. Mex., September 5-7, 1956.
Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(2420) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Purpose of the study is to compare the amount of soil moisture withdrawal at different depths under the following cover types: aspen, spruce, oak brush, oak brush herbaceous, Thurber fescue, and Idaho fescue. Four plots were located in each of the following types: Aspen, spruce, Thurber fescue, and Idaho fescue. Three plots were located in the oak brush and oak brush herbaceous types. Four locations on each plot were sampled gravimetrically at the beginning and end of the 1955 growing season. One-foot samples were taken to depths between 6 to 8 feet on each location.
(g) Preliminary figures in relative water use for the 1955 growing season were as follows: Aspen 21.14 inches; spruce 12.25 inches; Idaho fescue 12.86 inches; Thurber fescue 13.17 inches; Gambel oak 12.12 inches; oak herbaceous 12.27 inches. These figures include precipitation during the growing season. Surface runoff from rainstorms was negligible. Although the plots were not sampled in 1956, it is expected that further measurements will be taken in 1957.

(2657) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Purpose is to determine the effect of range conditions and related factors on sediment production and runoff on three mountain grassland watersheds in western Colorado. Ninety degree V-notch weirs are used to gage the watersheds which vary in size from 100 to 300 acres.

(2658) WATERSHED MANAGEMENT RESEARCH, RAPID CITY, SOUTH DAKOTA.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Soil core samples collected from heavily grazed and recently protected bluegrass range in the Black Hills. Samples were collected by 2-inch depth intervals from the surface down to 12 inches. Bulk density and pore space drained by 60 cm. water tension were determined for each sample. Comparison of results is expected to show whether recent protection has altered physical characteristics of the soil sufficiently to have possibly improved infiltration characteristics.

U. S. DEPT. OF AGRICULTURE, FOREST SERVICE, Southeastern Forest Experiment Station.

(380) WATER RESOURCE AND WATERSHED MANAGEMENT RESEARCH.

(b) Laboratory project. For general public use and information.
(c) Mr. J. F. Pechanec, Director, Southeastern Forest Experiment Station, U. S. Forest Service, P. O. Box 2570, Asheville, N. C.

(d) General and complete investigation of forest influences in southeastern United States. Includes fundamental hydrologic research and applied research in water resources and watershed management.

(e) To determine the effect of vegetation on the phases of the hydrologic cycle. To find out the effect of land use and land management practices on water yield and water quality. To develop standards and methods of watershed management so as to derive the greatest benefit from the land and water resources in the southeastern United States.
Most of the actual research experiments and hydrologic data collection is carried out on the 5600-acre Coweeta Hydrologic Laboratory which is located in the zone of maximum precipitation in the Eastern United States (Nantahala Range of the Southern Appalachian Mountains). Within this experimental area are about 33 individual watersheds whose streamflow is being continuously gaged and which are either being treated experimentally or being used as control checks. In addition to the streamflow gaging, there are 16 recording and 69 non-recording (standard) rain gages, 8 recording and 29 non-recording groundwater wells, 8 recording hygrothermographs, 2 recording anemometers, and 2 evaporation pans. Water samples for quality analysis are collected on a daily and storm period basis from selected watershed units.
On the Calhoun Experimental Forest, near Union, S. C., basic research is going forward on the problems and factors involved in rehabilitating Piedmont soils. Studies include measurement of the soil moisture regime under different cover types, hydrologic properties of forest soils, and index values of runoff and sediment production from several small watersheds.
Research projects include determination of effects of: (1) Permanent removal of all major vegetation and cutting all natural regrowth 1941 to 1955 and conversion of same watershed to white pine in 1956; (2) temporary removal of all major vegetation followed by natural regrowth; (3) removal of cove-site forest vegetation 1954 to 1956 and conversion to white pine in 1957; (4) removal of laurel and rhododendron shrub vegetation; (5) permanent removal of all major vegetation on 50 percent of watershed area in alternate strips one-half chain wide; (6) rehabilitating a depleted steep-land agricultural watershed; (7) rehabilitating a grazed woodland watershed; (8) removing wood products and retaining high quality water values on mountain watersheds through improved logging techniques; and (9) removing deficient age classes in a forest stand to increase water yields.

(g) Land use studies of woodland grazing and mountain farming have shown that changes in soil due to trampling and tillage influence infiltration, permeability, total porosity, storm peaks, surface drainage characteristics, changes in time of watershed concentration during storm periods, and stream turbidities. The data also shed light on the time required to alter watershed conditions when undisturbed forested lands are farmed and grazed.
Results from continuing fundamental studies covering the storage and depletion of ground water, annual water balance, and control of storm water are contributing to an understanding of the hydrologic processes on small tributary watersheds having a forest cover. Thus, cutting an ericaceous understory was found to increase stream discharge by several inches the first year with the increase declining to less than an inch by the sixth year. Piedmont studies are showing that the organic layers of forest soils are a valuable diagnostic tool for timber and watershed management. Also through studies of the soil moisture regime under different types of watershed cover, information is being obtained regarding consumptive use of water, percolation rates, and seasonal storage potentials of forest soils.

(h) "Effect on Streamflow of Cutting a Forest Understory", by Edward A. Johnson and Jacob L. Kovner. Forest Science, 2(2): 82-91, June 1956.
"Outline for Compiling Precipitation, Runoff, and Ground Water Data from Small Watersheds", by E. A. Johnson and Robert E. Dils. Southeastern Forest Experiment Station, Station Paper No. 68, 40 pp., August 1956. (Revision of Appalachian Forest Experiment Station. Tech. Note No. 34, by C. R. Hursh, 1938).
Annual Report of the Southeastern Forest Experiment Station.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Beach Erosion Board.

Inquiries concerning Projects Nos. 181, 660, 661, 975, 977, 2190, 2191, 2193, 2194, 2195, 2421, 2422, and 2659 to 2661, inclusive, should be addressed to the President, Beach Erosion Board, 5201 Little Falls Road, Wash. 16, D. C.

(181) EQUILIBRIUM PROFILE OF BEACHES AND STUDY OF SCALE EFFECT.

(b) Laboratory project.
(d) Experimental.
(e) Equilibrium beach profiles will be determined experimentally for waves up to 6 feet in height in a prototype tank; the waves will be modelled at a 1 to 10 scale in small laboratory tanks for various sand sizes to determine scale effect.
(g) Profile determined for 4-foot 11-second wave. Prototype wave resulted in an eroding beach while model wave resulted in accreting beach (for same sand size).

(660) OBSERVED WAVE CHARACTERISTICS.

(b) Laboratory project; additional research by New York University.
(d) Field investigation; basic research.
(e) To secure a more thorough knowledge of the characteristics of ocean waves. A number of electrical recording wave gages have been installed in coastal waters and these records are analyzed for significant height and period. A tape recorder, and electronic analyzer to determine the true wave spectrum are being modified for field and laboratory use.
(h) "The Step Resistance Wave Gage", Joseph M. Caldwell, 1st Conference on Coastal Engineering, Council on Wave Research, Engineering Foundation, 1956.

(661) REPORTS ON BEACH PROCESSES BASED ON EXISTING MISSION, ANAHEIM, AND SANTA MONICA BAY FIELD DATA.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) A study of the relation between movement of beach material and natural forces such as wave, tides, and littoral currents. Fourteen million cubic yards of sand have been placed on Hyperion Beach, Santa Monica Bay, and one million cubic yards have been placed on Sunset Beach, Anaheim Bay, California. Rate of movement of this material from the placement areas is being studied and correlated to wave and tide activity.
(f) Field work completed.
(h) "Wave Action and Sand Movement Near Anaheim Bay, California", Joseph M. Caldwell, Beach Erosion Board Technical Memorandum No. 68, February 1956.

(975) METHODS OF BY-PASSING SAND PAST INLETS.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To study methods and requirements for pumping sand past inlets and to determine the applicability of the methods in stabilization of beaches adjacent to inlets. In connection with this project a study is being made of the sand by-passing operation carried out by the Corps of Engineers at Port Hueneme, California, in 1953 and 1954. Data, including hydrographic surveys and aerial photographs before, during, and at intervals after the dredging, and records of wave height and period are being studied to obtain any pertinent information on sand by-passing which may be applicable in future operation of this type.

(977) DEVELOPMENT OF WAVE HEIGHT AND WAVE DIRECTION GAGES.

(b) Laboratory project.
(d) Experimental; development.
(e) To develop wave height and wave direction gages for use in securing accurate records of wave characteristics.

(g) Additional development of recording parallel wire resistance and capacitance gages for laboratory use has been made to obtain constant linear calibration characteristics. An electronic type laboratory wave gage was developed to measure small waves (less than 1 inch) where capillarity and run-up effects on ordinary gages are an appreciable part of the measurement and hence give erroneous readings (as for tsunami or surge studies).
(h) "An Electronic Gage for Measurement of Small Waves and Ripples", Francis W. Kellum, The Bulletin of the Beach Erosion Board, Office of the Chief of Engineers, Volume 10, No. 1, pp. 32-40, July 1956.

(2190) STUDY OF EFFECT OF A GROIN SYSTEM ON THE RATE OF LITTORAL MOVEMENT.

(b) Laboratory project.
(d) Experimental; basic research.
(e) To study the effect of groins on the rate of littoral drift passing a groin system. Installation of test set-up in the Shore Processes Test Basin has been completed. Initial tests consist of waves generated at a 30-degree angle to the sand beach. Measurements of material movement is being made at the down-beach end.

(2191) SAND MOVEMENT AT MORICHES INLET, LONG ISLAND, NEW YORK.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To investigate the pattern of movement and deposition of the littoral materials in the vicinity of a newly opened inlet. Movement of the littoral material is being traced by means of hydrographic surveys of both the ocean and bay sides of the inlet, and through variation in size characteristics and heavy mineral composition of the littoral material. An attempt is being made to correlate movement of the littoral material with the natural forces involved.

(2193) SHORE PROTECTION PLANNING AND DESIGN.

(b) Laboratory project.
(d) Design.
(e) To assemble in a single volume, insofar as practicable, a manual of practice for shore protection. Attempt to include a detailed summary of applicable methods, techniques and useful data pertinent to the solution of shore protection problems.
(f) Active, to the extent that addenda sheets will be added to Technical Report No. 4, "Shore Protection Planning and Design."

(2194) FACTORS AFFECTING THE ECONOMIC LIFE OF TIMBER IN COASTAL STRUCTURES.

(d) Design.
(e) The purpose is to report on the various factors that affect the economic life of timber in coastal structures. This report includes a discussion of the causes of deterioration of timber in coastal structures and protection methods to increase the economic life.
(f) Completed.
(h) "Factors Affecting the Economic Life of Timber in Coastal Structures", R. A. Jachowski, Beach Erosion Board Technical Memorandum No. 77, December 1955.

(2195) RE-EXAMINATION OF ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) The purpose of this study is to evaluate the effectiveness and economic life of beach fills through artificial nourishment. A selected number of locations where beach fills have been made are being re-examined.
(g) Results of a study of movement of beach material made in connection with a beach fill operation at Ocean City, New Jersey indicates, that the median grain diameter of the fill material used may have precluded reasonable agreement between the estimated and actual quantities of material movement in the problem area.

(h) "Behavior of Beach Fill at Ocean City, New Jersey", G. M. Watts, Beach Erosion Board Technical Memorandum No. 77, 33 pages, February 1956.

(2421) DEVELOPMENT OF A SUSPENDED SEDIMENT SAMPLER FOR LABORATORY USE UNDER WAVE ACTION.

(b) Laboratory project.
(d) Experimental; basic research.
(e) To investigate the working procedures and the degree of error and reproducibility to be expected in the extraction of suspended sediment under wave action.
(f) Completed.
(g) (1) The report discusses the effect on suspended sediment concentration caused by the constantly changing configuration of the bottom resulting from the forces accompanying the wave action. (2) The test results indicate that the water temperature is a significant factor in the study of suspended sediment caused by wave action.
(h) "Development of a Suspended Sediment Sampler for Laboratory Use Under Wave Action", John C. Fairchild, The Bulletin of the Beach Erosion Board, Office of the Chief of Engineers, Volume 10, No. 1. pp. 41-60, July 1956.

(2422) WAVE FORECASTING IN INLAND WATERS.

(b) Office of the Chief of Engineers.
(d) Theoretical and field investigation.
(e) To evaluate methods of wave forecasting in reservoirs.
(h) "Laboratory Study of the Generation of Wind Waves in Shallow Water", Osvald Sibul, Beach Erosion Board Technical Memorandum No. 72, 35 pages, March 1955.
"Laboratory Study of Wind Tides in Shallow Water", Osvald Sibul, Beach Erosion Board Technical Memorandum No. 61, 50 pages, August 1955.

(2659) WAVE FORCES ON PILES.

(b) Laboratory project.
(d) Experimental; applied research, design.
(e) The purpose of the study is to determine the nature and magnitude of forces on piles caused by breaking and non-breaking waves.
(g) Forces as high as 300 pounds per foot have been observed on a pile 12-3/4 inches in diameter with breaking waves about 6 feet high. Non-breaking waves about 4 feet high caused forces on the pile as high as 30 pounds per foot.
(h) "Re-Analysis of Existing Wave Force Data on Model Piles", R. Curtis Crooke, Beach Erosion Board Technical Memorandum No. 71, 19 pages, April 1955.
"Wave Forces on Piles: A Diffraction Theory", R. C. MacCamy and R. A. Fuchs, Beach Erosion Board Technical Memorandum No. 69, 17 pages, December 1954.

(2660) WAVE TANK STUDY OF QUANTITY OF SAND IN SUSPENSION IN THE SURF ZONE (INCLUDING TEMPERATURE EFFECTS).

(b) Laboratory project.
(d) Experimental; basic research.
(e) A vacuum pump type suspended sediment sampler will be used to collect suspended sand samples under various conditions of waves, water temperature and sand. A large field sampler will be used to obtain suspended samples in the prototype wave tank. The purpose of the study is to determine the relationships between wave, water, and sand characteristics and the amount of material maintained in suspension, and hence available for longshore transport by currents.
(g) One series of suspended sand samples at water temperatures of 50°F and 80°F respectively have been collected. Surf zone suspended sampling is currently in progress in the prototype wave tank for waves up to 6 feet in height. Preliminary analysis of the suspended samples collected indicate a generally greater quantity of sand in suspension in the colder water (50°F as contrasted to 80°F).

(2661) WAVE RUN-UP ON SHORE STRUCTURE.

(b) Laboratory project.
(d) Experimental; design.
(e) Wave run-up is determined experimentally by various waves for different types of shore structures. Effect of both structure roughness and permeability is being investigated.
(f) Run-up for smooth slopes has been related to deep water wave steepness and depth of toe of structure.
(g) "Wave Run-up on Shore Structures", Thorndike Saville, Jr., American Society of Civil Engineers, Proceedings Separate 925, April 1956.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Bonneville Hydraulic Laboratory.

Inquiries concerning Projects Nos. 1462, 1464, 1466, 2196, should be addressed to the District Engineer, Portland District, Corps of Engineers, 628 Pittock Block, Portland 5, Oregon.

(405) GENERAL MODEL STUDY OF ICE HARBOR DAM, SNAKE RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Washington.
(c) District Engineer, Walla Walla District, Corps of Engineers, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) A 1:100-scale, undistorted, fixed-bed model reproduces 2.7 miles of the Snake River at the dam site. The proposed structures include a 6-unit powerhouse, 10-bay spillway, and an 86- x 675-foot single-lift navigation lock. Studies will be made to determine flow conditions during various construction stages and with the project completed.
(g) Tests of first-step cofferdam were completed. Results indicated that realignment of upstream corner of cofferdam would reduce backwater effect and lower water-surface elevations along face of cofferdam. Movable bed studies were made to assist in estimating amount and location of erosion in prototype. Effect of rock groins along river bank opposite cofferdam were investigated as an aid to fish migration during first-stage construction. Tests with structures installed were begun.
(h) Five memorandum reports have been issued.

(406) MODEL STUDY OF ICE HARBOR SPILLWAY, SNAKE RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Washington.
(c) District Engineer, Walla Walla District, Corps of Engineers, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) The model consists of a 3-bay section of the 10-bay spillway constructed to 1:40-scale. Tests will be made to verify crest profile which includes a sloping upstream face and to check design of energy dissipating facilities.
(g) Tests were initiated.

(1462) GENERAL MODEL STUDY OF THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oregon.
(d) Experimental; for design.
(e) A 1:80-scale, undistorted, fixed-bed model reproduces 2.7 miles of the Columbia River at the dam site. The original layout consisted of a circular-arc, 30-bay spillway, a 22-unit powerhouse, an 86- by 675-foot navigation lock, a rock-fill non-overflow section, and facilities for passing fish over the dam. Maximum head is 90 feet. Revised layout has a straight 23-bay spillway. Purposes are to study the structures alignment and flow conditions affecting navigation, power generation, cofferdam placement, rock-fill dam construction, and fish passage.

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(f) Tests completed.
(g) Four major layout plans were tested and the most economical plan that effected satisfactory hydraulic conditions was selected. Tests indicated ability to reduce length of spillway and to reduce forebay excavation by 30 feet. Data relative to water-surface elevations and velocities in the tailrace, and the effects of excess fill placed in the forebay have been obtained. Flow conditions during various stages of construction and with the project completed have been observed with special attention given to navigation and fish migration problems.
(h) Twenty-nine memorandum reports have been issued to date. Final report in preparation.

(1464) MODEL STUDY OF ROCK FILL, THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oregon.
(d) Experimental; for design.
(e) The 1:40-scale model of the 600-foot-wide closure section of the rock-fill nonoverflow section of the Dalles Dam includes portions of the river channel upstream and downstream therefrom and the eight partially-completed units at the upstream end of the powerhouse through which the river flow was diverted as the closure fill was constructed. A study of the rock sizes and placement procedure required to construct the fill at a river flow of 200,000 cfs and for stability at 300,000 cfs was made.
(g) The fill has been constructed by placing quarry-run rock (1000 lb and less) in 10-foot lifts or by end-dumping from the Oregon shore at river discharges of 200,000 cfs and less. Owing to the faster placing program possible with the end-dump procedure, studies have been concentrated on this method of closure. The 1000 lb and smaller material was placed without loss in bottom velocities of 17 fps and surface velocities of 24 fps. The higher velocities caused some movement of material but owing to the 250-foot width of fill the material did not move beyond the confines of the fill. Flow data were obtained during the prototype closure for correlation with model data. A model check of one stage of prototype closure showed very good agreement of flow conditions.
(h) Eleven memorandum reports have been issued. One summary report was issued to supply information to prospective bidders.

(1466) MODEL STUDY OF THE DALLES DAM NAVIGATION LOCK, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oregon.
(d) Experimental; for design.
(e) A 1:25-scale model of the 86- by 675-foot lock chamber including its culvert systems and portions of the upstream and downstream approach channels is reproduced. Maximum lift is 90 feet. Studies are being made of various types of filling and emptying systems to determine the most advantageous from the standpoints of rate of operations, degree of turbulence, and economy. The several proposed plans include lateral culverts within the lock chamber combined with several locations of intake ports, longitudinal culverts, and outlet ports.
(f) Inactive.
(g) Designs have been selected for all features of the lock. A change in valve-opening schedule resulted in a filling time of 12.5 minutes and a maximum hawser force of 8 tons without supplemental use of the upstream lock tainter gate. The lock emptied in 16 minutes. Studies have shown that staggered valve operation will reduce maximum hawser stresses.
(h) Six memorandum reports have been issued.

(2196) MODEL STUDY OF FISH LADDER SURGE FOR THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Portland District, Portland, Oregon.
(d) Experimental; for design.
(e) A 1:10-scale model reproduced the 30-foot-wide, 1 on 16 slope, East fish ladder from weir 96 to weir 155. Included are 14 weirs of the downstream tangent, the 180-degree bend, the 47 weirs of the upstream tangent, the 116-degree 45-minute bend, and three weirs upstream therefrom. Provision was made for varying the slope of the fish ladder. The occurrence and best means of controlling the surge were investigated.

(f) Tests completed.
(g) Results have indicated that a bi-nodal surge occurs with or without the orifices in the weirs open. Reduction in surging has been accomplished by: (a) Various designs and arrangements of baffles placed at the quarter points, normal to the downstream sides of the weirs; (b) varying the width of the ladder by changing wall widths in groups of pools; and (c) changing the curved-top weirs (design) to square-top weirs. Subsequent tests indicated that changes in flow over the curved-top, fish ladder weirs, caused by variation in pressure conditions under the nappe, became synchronous over several weirs and caused the surge. Weir crests with sharp-edged control at upstream edge eliminated the surge. Weir crests designed for the prototype with tops 1-1/2 in. wide at the upstream edge followed by an approximately 1 on 1 slope were found to control the surge within the operating range of the fish ladder.
(h) Six memorandum reports were issued. Final report in preparation.

(2662) GENERAL MODEL STUDY OF JOHN DAY LOCK AND DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Wash.
(c) District Engineer, Walla Walla District, Corps of Engineers, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) A fixed-bed model constructed to an undistorted 1:80-scale will reproduce the Columbia River from Mile 213.7 to 216.8. The structures will be at approximately Mile 215.5. Investigation of flow conditions will be conducted for construction stages and for completed project in the interests of design, navigation, fish migration, and power.
(g) Under construction.

(2663) TAINTER GATE CABLE TESTS, THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) Department of the Army, Corps of Engineers, Ohio River Division, Cincinnati, Ohio.
(c) District Engineer, Seattle District, Corps of Engineers, 4735 East Marginal Way, Seattle 4, Washington.
(d) Experimental; for design.
(e) Strain-gage-equipped, calibrated proving rings were mounted on each 7/8-in. cable of the two groups of six cables (12 per gate) that operate the tainter gates on the Dalles Dam spillway. The variation in elongation of the cables during the raising and lowering of a tainter gate "in the dry" were obtained from oscillograph traces.
(f) Tests completed.
(g) Considerable variation was observed in elongation of individual cables although the relative elongation between cables showed no appreciable change during opening and closing a spillway gate.
(h) Report has been issued.

(2664) MODEL STUDY OF EAGLE GORGE TUNNEL, GREEN RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Seattle District, Seattle, Washington.
(c) District Engineer, Seattle District, Corps of Engineers, 4735 East Marginal Way, Seattle 4, Washington.
(d) Experimental; for design.
(e) A 1:25-scale model of regulating tunnel reproduces the tunnel intake, control valves, approximately 700 ft of 500-ft-radius, 22- by 22-ft horseshoe tunnel, stilling basin, and outlet channel.
(f) Tests completed.
(g) Tests showed that center pier of intake section could be decreased in length without adversely affecting flow conditions. Original baffled stilling basin with stepped end sill was changed to nonbaffled type, floor elevation lowered 6 ft and 45-degree end sill used to allow rocks to pass unimpeded through structure. Pressure, water-surface, and velocity data were obtained in addition to valve ratings.
(h) Three memorandum reports have been issued. Final report in preparation.

(2665) MODEL STUDY OF ICE HARBOR POWERHOUSE INTAKE GATES, SNAKE RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Washington.
(c) District Engineer, Walla Walla District, Corps of Engineers, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) The 1:25-scale model contains a test unit consisting of intake and scroll case with emergency closure gates and gate slots. The middle closure gate will be reproduced in plastic with a synchronous-motor-operated lifting mechanism to simulate prototype operating speed. Provision will be made to measure pressures on lip of gate with several lip designs. Tests will be made to determine the gate design producing the least downpull force during emergency closure.
(g) Tests are being made on a 1:25-scale model of one unit of Chief Joseph powerhouse to correlate model downpull forces on intake gate with tests made at Chief Joseph powerhouse during 1955. Correlation is being made to obtain a basis for evaluating tests of Ice Harbor powerhouse intake gates.

(2666) MODEL STUDY OF ICE HARBOR DAM FISH LADDER, SNAKE RIVER, WASHINGTON.

(b) Department of the Army, Corps of Engineers, Walla Walla District, Walla Walla, Washington.
(c) District Engineer, Walla Walla District, Corps of Engineers, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) A 1:10-scale model reproduces a 41-pool tangent of the 1 on 16 slope, 24-ft-wide, south fish ladder in addition to the 6-pool orifice control section of the south fish ladder. Investigations are concerned with fish ladder surge and its elimination and the size and locations of orifices in the control section (no overflow) to function with a 5-ft change in pool elevation without creating undesirable flow conditions.
(g) Results indicated that surge would occur within operating range of fish ladder unless a weir crest approximating a sharp edge was used. Surge was reduced with a contracted weir. Uniformity of heads in control section was obtained by varying the spacing of orifices in alternate baffles.
(h) One memorandum report has been issued.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Los Angeles District.

Inquiries concerning Projects Nos. 1732, 2198, 2667, and 2668, should be addressed to the District Engineer, Los Angeles District, Corps of Engineers, P. O. Box 17277, Foy Station, Los Angeles 17, California.

(1732) MODEL STUDY OF SAN ANTONIO OUTLET WORKS CHANNEL.

(b) Laboratory project.
(d) Experimental for design.
(e) The outlet channel which will carry discharges from the 14.5-foot diameter tunnel of San Antonio Dam will be 14.5 feet wide, curved in alinement, and will carry the design discharge of 8,000 cfs at a depth and velocity of 9 ft. and 61 fps, respectively. A diversion structure to turn out flood flows from the high velocity channel for conservation use is required. The intake for the proposed diversion consists of a slotted opening across the bottom of the outlet channel. Flow passing through the slot will enter a chamber under the channel. Discharge from the chamber will be regulated by slide gates, 4 feet wide by 4 feet high. There will be four gates on the left side to pass 600 cfs, and two gates on the right side to pass 300 cfs. Tests of the design are being conducted in a 1:20-scale model.
(g) Results to date indicate satisfactory flow conditions in all portions of the structure.

(2198) MODEL STUDY OF SUPERELEVATED FLOW IN CURVED TRAPEZOIDAL CHANNELS.

(b) Laboratory project.
(d) Experimental for design.
(e) Tests are being conducted in curved trapezoidal channels to determine the characteristics of flow, and the effectiveness of spiral easement curves in maintaining equilibrium of flow in the curve and in the downstream tangent. A 1:25-scale model having a base width of 62.5 feet, side slopes of 1 on 2.25, a curve with centerline radius of 885 feet, and spiral easement curves 325 feet long at the beginning and end of the circular curve, is being used for the tests. Tests were conducted with discharges of 35,000 cfs and 45,000 cfs in which the velocity of flow was 35 fps and 43 fps, respectively.
(g) Results indicate the necessity for spiral easement curves in establishing equilibrium in trapezoidal channels.

(2667) MODEL STUDY OF SANTA ANA RIVER LEVEES AT RIVERSIDE, CALIFORNIA.

(b) Laboratory project.
(d) Experimental for design.
(e) The Santa Ana River is an alluvial stream which carried considerable bedload during floods. Rock revetted levees having a 1 on 2 side slope are proposed to confine the design flood of 195,000 cfs. Two bridges are located 1,300 feet apart. The left levee is continuous upstream and downstream from the bridges, and the right levee extends downstream from the abutment of the upstream bridge to form a trapezoidal channel having a base width of 930 feet. Flow will be subcritical upstream from the bridges, and supercritical downstream from the bridges. Tests are being conducted in a movable bed model having a horizontal scale ratio of 1:120 and a vertical scale ratio of 1:40 to determine relative scour due to alinement of levees and bridge piers.
(g) Under construction.

(2668) EATON WASH CHANNEL AND DIVERSION STRUCTURE.

(b) Laboratory project.
(d) Experimental for design.
(e) The existing Eaton Dam has a side channel spillway and an outlet channel that merge into a single rectangular channel, 120 feet wide. The proposed 25-foot wide Eaton Wash Channel downstream from the dam will be connected to the spillway and outlet channel by means of a transition. A small low flow channel depressed below the invert of the transition will lead to gated openings through the left wall to divert water for conservation purposes. Tests have been conducted in a 1:20-scale model to determine the proper design of the transition and diversion features of the project.
(f) Test completed.
(g) A satisfactory design was obtained for the transition by inserting low training walls within the transition to produce the desired convergence characteristics. Additional freeboard in the downstream channel was required to confine surface waves produced by the slot diversion channel.

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, St. Paul District.

In cooperation with St. Anthony Falls Hydraulic Laboratory.

Inquiries concerning Projects Nos. 194, 412, 985, 1206, 1977, 2199, 2424, 2425, and 2669 to 2672, incl. should be addressed to the District Engineer, Corps of Engineers, St. Paul District, 1217 U. S. Post Office and Custom House, St. Paul 1, Minn.

(194) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

(b) Subcommittee on Sedimentation, Inter-Agency Committee on Water Resources.
(d) Experimental; applied research and development.

(e) Plans and specifications to facilitate the manufacture of suspended sediment and stream bed material samplers, particle size analyzers and associated laboratory apparatus have been prepared. Approved designs available include a light weight hand operated sediment sampler (4 lb.), a medium weight sediment sampler (62 lb.), heavy sediment samplers (100 and 300 lb.), a sediment sample splitter, a bottom withdrawal tube, a hand operated bed material sampler, a heavy bed material sampler (100 lb.), visual accumulation sedimentation tubes and particle size analyzer to record the sedimentation size distribution (fall or settling velocities) of sand particles. Work is continuing on the development of automatic suspended sediment sampling apparatus and techniques.
(g) Instruments and apparatus required for sampling and analyzing fluvial sediments are being manufactured in quantity to satisfy current needs of Federal agencies. Report No. 11, "The Development and Calibration of the Visual Accumulation Tube", is awaiting printing and the preparation of Report No. 12, "Some Fundamentals of Particle Size Analysis", is essentially complete.
(h) "Visual Accumulation Tube for Size Analysis of Sands", by B. C. Colby and R. P. Christensen, Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Volume 82, No. HY3, paper No. 1004, 17 pages, June 1956.

(412) ST. ANTHONY FALLS LOCKS.

(b) St. Paul District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) The lower lock has a single-culvert system and chamber laterals; the upper lock has culverts in each side wall and chamber laterals alternating from the two culverts. The two locks will have lifts of 25 and 49 feet, respectively. A revised hydraulic system is being installed in the 1:22.4 scale model of the upper lock.
(f) Project reactivated.

(985) FILLING AND EMPTYING SYSTEMS FOR HIGH LIFT LOCKS.

(b) Office of the Chief of Engineers, U. S. Army, Washington, D. C.
(d) Experimental; applied research.
(e) To develop adequate criteria for the design of filling and emptying systems for high-lift locks. Tests will be conducted in prototype locks, in model locks for definite projects, and in a general lock model simulating a maximum lift of 150 feet.
(f) General lock model facilities were utilized in tests on definite project studies.

(1206) CONDUIT GATE STRUCTURES AND TRANSITIONS.

(b) Office of the Chief of Engineers, U. S. Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general model study was conducted to establish gate operating procedures for multiple gate conduits and design criteria for conduit transitions downstream from single and multiple control gates. The model simulated a complete conduit outlet structure with an upper pool reservoir, multiple control gates at inlet transition, and a stilling basin.
(f) Completed.
(g) Tests were made to determine the effects on flow conditions in circular conduits of variation in conduit length, training vanes mounted within the conduit, and modification of the upstream transition between the control structure and conduit.
(h) "Laboratory Tests on Hydraulic Models of Conduit Gate Structures and Transition", Hydraulic Laboratory Report No. 61, November 1955.

(1977) MODEL STUDY FOR GREENUP AND MARKLAND LOCKS, OHIO RIVER.

(b) Huntington, W. Va., and Louisville, Ky., Districts, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) The hydraulic systems of the two locks which are similar in design were tested in a 3 to 100 scale model. The design contemplates locks 110 feet in width and 1,280 feet in length with lifts of 32 and 35 feet, respectively. The filling and emptying systems are combined in two culverts, one in each wall, with lateral culvert diffusers in the lock floor and flared outlets discharging into the river below the dam.
(h) Final report is being prepared.

(2199) MODEL STUDY OF FILLING AND EMPTYING SYSTEMS FOR EISENHOWER AND GRASS RIVER LOCKS, ST. LAWRENCE SEAWAY.

(b) Buffalo District, Corps of Engineers, U. S. Army.
(e) The hydraulic systems of the two locks, similar in design, were tested in a 1 to 24.24 scale model. The filling and emptying systems are combined in two culverts, one in each wall, with intake in the upper gate sill, ports in the chamber walls, and diffusers in the lower approach channel. A single wall port discharging into a segment of the lock chamber was tested in a 1 to 36.2 scale model.
(f) Testing completed.
(h) Final report in preparation.

(2424) EMERGENCY VERTICAL LIFT GATE, EISENHOWER LOCK, ST. LAWRENCE SEAWAY.

(b) Buffalo District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) A vertical lift gate located in the sill block upstream of the lock intake manifold can be raised about 45 feet above the sill to prevent the flow of water through the lock in the event of damage to the miter gates. A model simulating a 50-foot section of the 80-foot wide emergency lift gate was built to a scale of 1 to 33.33 and tested to determine vertical and horizontal water loads and power required to lift the gate through flowing water.
(h) Final report combined with project reference number (2199) is in preparation.

(2425) MISSISSIPPI RIVER NEAR AITKIN, MINN., INLET CONTROL STRUCTURE, DIVERSION CHANNEL.

(b) St. Paul District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) The inlet to the diversion channel bypassing Aitkin consists of a trapezoidal drop structure with weir crest 7.2 feet above the channel bed. During spring floods considerable scour has occurred in the diversion channel immediately downstream from the inlet. A 1 to 36 scale model of the inlet structure and a reach of the diversion channel was tested to determine what measures would afford adequate protection against further scour.
(h) "Laboratory Tests on Hydraulic Model of Inlet Control Structure, Diversion Channel, Mississippi River near Aitkin, Minnesota", Hydraulic Laboratory Report No. 62, August 1956. The report has been completed and will be published next year.

(2669) MODEL STUDY OF FLOOD CONTROL STRUCTURE, GENESEE RIVER AT WELLSVILLE, NEW YORK.

(b) Buffalo District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) A control structure will be used at a channel expansion in the Genesee River at Wellsville. A 1 to 36 scale model was tested to determine whether the proposed control structure would perform satisfactorily.
(f) Tests completed.
(g) Tests demonstrated that a proposed upstream contraction concentrated the flow in the middle third of the downstream discharge channel, resulting in excessive scour in the channel bed. A more uniformly distributed discharge was obtained by eliminating the contracting transition upstream and by using a gradual expansion in the transition downstream from the control structure.

(2670) MODEL STUDY OF FILLING AND EMPTYING SYSTEMS FOR JACKSON LOCK, TOMBIGBEE RIVER, ALABAMA.

(b) Mobile District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) The model is being built to a scale of 3 to 100--simulating a lock 110 feet wide by 670 feet long with a lift of about 34 feet. The performance of the proposed design of the hydraulic system will be tested and modifications for improvement developed if necessary.
(f) The model is in the construction stage.

(2671) MODEL STUDY OF INTAKES FOR JIM WOODRUFF LOCK, APALACHICOLA RIVER, FLORIDA.

(b) Mobile District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) The model simulating the proposed Jim Woodruff Lock structure and a short reach of the upstream approach was built at a scale of 3 to 100 to evaluate adverse currents in the lock approach bay and the vortices developed. Tests were continued to develop necessary improvements.
(f) Testing completed.
(g) The intake manifold and channel walls were modified to eliminate vortices in the upper approach.
(h) Final report is in preparation.

(2672) MODEL STUDY OF INTAKES FOR DEMOPOLIS AND WARRIER LOCKS, TOMBIGBEE RIVER.

(b) Mobile District, Corps of Engineers, U. S. Army.
(d) Experimental; for design.
(e) Models simulating the Demopolis Lock and the contemplated Warrior Lock were built at a scale of 3 to 100 with intakes in the gate sill and the approach walls. Tests were conducted to develop modifications for the Demopolis Lock which would eliminate the vortical disturbance over the intakes and to develop a satisfactory intake design for Warrior Lock.
(f) Testing completed.
(g) The intake manifold design and channel walls were modified to reduce vortical activity in the approach to Demopolis Lock. Warrior Lock approach functioned satisfactorily.
(h) Final report in preparation.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Waterways Experiment Station.

Inquiries concerning Projects Nos. 211, 218, 230, 236, 425, 673, 674, 678, 682, 993, 994, 998, 999, 1000, 1002, 1004, 1207, 1211, 1212, 1467, 1472, 1474, 1475, 1735, 1736, 1738. 1739, 1979, 1980, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 2200, 2201, 2203, 2204, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2434, and 2673 to 2686, incl., should be addressed to The Director, Waterways Experiment Station, Corps of Engineers, P. O. Box 631, Vicksburg, Miss.

(211) MODEL STUDIES OF OUTLET WORKS, SPILLWAY AND STILLING BASIN, GARRISON DAM, MISSOURI RIVER, NORTH DAKOTA.

(b) The District Engineer, Garrison District, Corps of Engineers, Riverdale, North Dakota.
(d) Experimental; for design.
(e) Three models were used for complete investigation of the spillway and outlet works. A 1:100 model of the converging-chute spillway was used to study the hydraulic performance of the approach channel, crest, chute, stilling basin, and pilot channel, and to correct unsafe conditions. A 1:50 model of the downstream portion of the five power and three flood-control conduits was used to examine the performance of the conduits, stilling basin, and powerhouse substructure under diversion and reservoir operation conditions. A 1:25 model of the 22- and 26-foot-diameter flood-control conduits was used to investigate flow through the gated section and the conduit proper. Of special interest was the use of a radial gate to control conduit flow. Incidental models were tested in a vacuum tank to determine the cavitation characteristics of the caterpillar emergency-gate slots in the flood-control conduits and the articulated tunnel joints. Tests were conducted on a 2-foot section of the penstock gate seals to determine their operating characteristics under varying heads.
(f) Testing completed.

(g) Model tests indicated the radial-type gate to be very stable for openings at which the conduit flowed only partially full, but at full flow a violent eddy formed in the gate well causing vibration of the gate and an increased load on the gate hoist. The effect of the eddy was minimized ny use of cover plates over the structural members of the gate. Also, the conduit roof at the downstream end of the gate well required special streamlining to prevent undesirable pressure conditions. Modifications to the bottom of the caterpillar vertical-lift emergency gate for the conduits and to the clearances into the gate well resulted in more favorable hydraulic conditions. Cavitation tests provided a basis for selection of shapes for the tunnel emergency-gate slots, articulated joints, and drain inlets. Performance of the stilling basin for the flood-control tunnels was satisfactory but economies were effected by increasing the slope, thereby reducing the length of the approach apron and of the dividing piers. Also tests revealed the desirability of an additional 9 feet of excavation in the exit channel. Study of diversion flows revealed that the capacity of the power tunnels could be increased by installation of the surge tank substructures prior to diversion. Also, these substructures improved velocity distribution in the tailrace area. Realignment of the right bank of the spillway approach channel was required to correct unequal distribution of flow which caused overtopping of the chute walls and poor energy dissipation. Performance of the spillway weir and chute was adequate. The spillway stilling basin performed in an entirely satisfactory manner but economies were effected by eliminating one row of baffle piers and reducing the length of the apron by 50 ft. The penstock gate seal operated satisfactorily as long as the pressure applied to the backside of the seal was at least 5 psi greater than the pressure in the penstock downstream from the gate.

(h) "Outlet Works and Spillway for Garrison Dam, Missouri River, North Dakota; Hydraulic Model Investigation", Waterways Experiment Station Technical Memorandum No. 2-431, March 1956. (Available on loan.)

(218) CONDUIT INTAKE MODEL TESTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Scale models are being used for a general study of the hydraulic characteristics of entrance curves for (1) rectangular conduits in which the entrance is flared in four directions, (2) a gated tunnel having a rectangular entrance with floor at same elevation as approach channel (entrance flared in three directions), and (3) a rectangular conduit in which parallel side walls are extended upstream from the entrance and only the roof flared (entrance floor at same elevation as approach channel). Tests involve determination of pressures and discharge coefficients.

(g) Most favorable pressure conditions on an entrance flared in four directions were obtained with the upstream portion of the entrance shaped to the ellipse

$$\frac{X^2}{D^2} + \frac{Y^2}{(0.32\ D)^2} = 1$$

and the downstream portion of the entrance shaped to the ellipse

$$\frac{X^2}{D^2} + \frac{Y^2}{(0.16\ D)^2} = 1$$

In the above equations, D is the distance across the conduit in the direction concerned. A slightly smaller entrance can be obtained by the use of a single curve with a semiminor axis of D/3 or D/4 to provide a gradual reduction in the pressure gradient. Tests also indicated that a conduit with an entrance curve shaped to D/3 may be varied as much as 10 degrees from normal to the face of the dam without an appreciable effect upon pressures. The skewing of the axis to parallel the face of the dam, as advocated by some designers, did not accomplish the desired results. Variation of the depth of approach channel had little effect on the magnitude of pressures through the entrance. The placing of bulkhead guides near the point of curvature of the entrance had little effect on pressures in the intake.

(h) "Entrances to Conduits of Rectangular Cross Section: Report No. 1, Investigation of Entrance Flared in Four Directions; CWI Item No. 802, Conduit Intake Model Tests", Waterways Experiment Station Technical Memorandum No. 2-428, March 1956. (Available on loan.)

(230) MODEL STUDY OF FLOOD CONTROL, CUMBERLAND, MARYLAND.

(b) The District Engineer, Washington District, Corps of Engineers, Washington, D. C.
(d) Experimental; for design.
(e) A fixed-bed, 1:60 model of the critical portions of Wills Creek and the North Branch of the Potomac River was used to study and develop proposed plans for protection of Cumberland from floods. The principal design problems centered around the determination of satisfactory side-wall alignments, satisfactory bridge pier and abutment designs, a satisfactory junction design, adequate stilling basin below industrial dam, and amount of dredging that can be eliminated below the industrial dam.
(f) Testing completed.
(h) Final report in preparation.

(236) MISSISSIPPI BASIN MODEL.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; for design.
(e) The project provides for construction and operation of a model of the Mississippi River Basin including the Mississippi, Ohio, Missouri, White, Arkansas, and Red Rivers, and their principal tributaries. All existing and proposed flood-control reservoirs, dikes, floodwalls, and other pertinent works will be reproduced. The model area comprises 200 acres, and measures 4,500 feet east and west, and 3,900 feet north and south. Completed construction consists of the Upper Mississippi River from Hannibal, Missouri, to Tiptonville, Tennessee; the Missouri River from Sioux City, Iowa, to the mouth; the Arkansas River from Blackburn Dam Site, Oklahoma, to Pine Bluff, Arkansas; the Ohio River from Golconda, Illinois, to the mouth; the Cumberland River from Old Hickory Dam, Tennessee, to the mouth; and the Tennessee River from Pickwick Dam to the mouth. The topography of the streams and flood plains are being reproduced to a horizontal scale of 1:2,000 and vertical scale of 1:100. Water-surface elevations are measured by electrically operated stage devices with the recorders located in central control buildings. Stream flow is introduced and controlled by automatic instruments called inflow controllers. The model was designed to aid in the development of coordinated basin-wide plans for flood control and operation of flood-control structures.
(g) The extent of operation of the model is determined each year by the testing programs requested by the Districts and Divisions that have operable sections on the model. Tests were conducted during the current year for the Missouri River Division, Ohio River Division, Lower Mississippi Valley Division, and the Southwestern Division. The tests consisted of studies of flood-routing methods to aid in flood forecasting and reservoir operations on the Missouri River, verification tests of the Kentucky reservoir and Tennessee River, reservoir operation tests on the Cumberland River, hypothetical and project floods to aid in planning flood protection on the Mississippi River, and the development of stage and discharge data for ungaged tributary inflow points on the Arkansas River.

(425) COMPREHENSIVE MODEL STUDY, DELAWARE RIVER, PENNSYLVANIA.

(b) The District Engineer, Philadelphia District, Corps of Engineers, Philadelphia, Pa.
(d) Experimental; for design.
(e) To develop and test plans for reduction of shoaling in several ranges of the navigation channel, the entire Delaware River estuary from the Atlantic Ocean to Trenton is reproduced in the model which is of the fixed-bed, silt-injection type, with scale ratios of 1:1000 horizontally and 1:100 vertically. Tides and tidal currents are reproduced by automatic tide-control machines. Observed prototype salinities are reproduced in the Delaware Bay portion of the model, and provisions made for the injection of silt, and for measuring silt deposits.
(g) Hydraulic and shoaling studies of several reaches of the 40-foot channel from Philadelphia to Trenton were accomplished. Test results indicate that the exact alignment of the channel in these reaches is not critical from the viewpoint of channel shoaling and hydraulic conditions; therefore, the channel alignment may be established on the basis of cost of construction and ease of navigation.
(h) "Delaware River Model Study: Report No. 1, Hydraulic and Salinity Verification", Waterways Experiment Station Technical Memorandum No. 2-337, May 1956. (Available on loan.)

(673) GENERAL SPILLWAY MODEL TESTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A 1:40 model is being used to study hydraulic characteristics of the standard spillway shape with heads up to 1-1/3 times the design head of the crest, including the effect of crest piers and gates, elevation of downstream floor of spillway, and downstream slope of spillway. Tests will also be made to establish general rules for design of roller-type energy dissipators. The drop from spillway crest to bucket is varied to study the effect of nappe thickness. Tests to study pressures on a flat apron-type energy dissipator, to determine the effect of tainter gate location on spillway pressures and discharge characteristics, and to study the effect on discharge coefficients of the location of the toe curve on a low ogee spillway have been completed.
(g) Reports on the effects of crest piers and varied heights of spillway on discharge coefficients and the results of varying the spillway slope and exit area elevation below the spillway are being prepared. Depending upon the height of spillway, the discharge coefficient at the design head varied from 3.87 to 4.10. The value of the pier contraction coefficient for the semicircular-shaped pier nose commonly used was about 0.015 at design head. This value decreased to zero as the head was increased to 1.2 times the design head. Tests to study effect of nappe thickness indicated that thickening of the spillway nappe permitted established roller action in a stilling basin to continue at a lower tailwater elevation than when the jet was thinner. Pressures on a flat apron-type energy dissipator approximated the water-surface elevation on the apron. Tests to study the effect on discharge coefficients of the location of the toe curve on a low ogee spillway indicated that the toe curve location has little effect on discharge coefficients after it falls a 0.566 H_d distance below the spillway crest.
(h) Combined report in preparation.

(674) MODEL STUDIES OF FORT RANDALL DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) The District Engineer, Omaha District, Corps of Engineers, Omaha, Nebraska.
(d) Experimental; for design.
(e) A 1:100 comprehensive model was used to determine effects on velocities of depth and curvature of the approach channel; to investigate flow over the chute-type, tainter-gate-controlled spillway, and develop a good stilling basin design; and to study flow conditions in the exit area. A 1:50 outlet stilling basin model was used to: Develop a satisfactory stilling basin below the eight 28-foot-diameter conduits which were being used for diversion during construction and which will eventually be incorporated in the powerhouse substructure; to verify the design of the stilling basin for the four 22-foot-diameter flood-control conduits to insure satisfactory operation under present and future tailwater conditions; and to determine the limit of required tailrace paving and the necessity for bank protective works by study of currents and wave action. A 1:25 intake and flood-control conduit model was used to determine the character of flow for various reservoir levels; measure loss coefficients of the intake structure; investigate pressures in the transition section; and determine the effects of partial gate operation upon downpull and oscillation of the gates and upon air requirements.
(f) Testing completed.
(h) Final report in preparation.

(678) CHARLESTON HARBOR MODEL STUDY.

(b) The District Engineer, Charleston District, Corps of Engineers, Charleston, South Carolina.
(d) Experimental; for design.
(e) Tests were made to determine whether channel realignment, the provision of channel control works, or other remedial measures will be effective in reducing the present heavy rate of shoaling in certain reaches of the harbor navigation channels. The fixed-bed model had scales of 1:800 horizontally and 1:80 vertically.
(f) Testing completed.
(h) Final report in preparation.

(682) HYDRAULIC CAPACITY OF MEANDERING CHANNELS IN STRAIGHT FLOODWAYS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general investigation of the hydraulic capacity of meandering channels in straight floodways. Typical channel and floodway conditions were reproduced in a 100- by 30-foot flume. Two floodway widths, three depths of overbank flow, and three degrees of roughness were used in testing channels of various degrees of sinuosity and meander-belt widths. Studies were made of effects of radius of curvature of bends; sinuosity of channel; depth of overbank flow; overbank roughness; water-surface slope; valley slope; and ratio of overbank area to channel area.
(f) Testing completed.
(g) Investigations indicated that: where the floodway channel is relatively narrow (and small) compared to the floodway widths, the effect of sinuosity of channel on floodway capacity is small; in the case of the 2-foot-wide (model) channel and a 16-foot-wide floodway the effects of increasing the channel sinuosity on floodway capacity becomes a critical factor; when the floodway width exceeds the meander-belt width by about 300 percent, the effect of channel sinuosity on floodway capacity becomes relatively small; and channel discharge is reduced about 8-10 percent by increasing the channel sinuosity from 1.20 to 1.40 and from 1.40 to 1.57.
(h) "Hydraulic Capacity of Meandering Channels in Straight Floodways, Hydraulic Model Investigation; CWI Item No. 807, Hydraulic Capacity of Meandering Channels", Waterways Experiment Station Technical Memorandum No. 2-429, March 1956. (Available on loan.)

(993) CAVITATION RESEARCH.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) The purpose of the investigation is to study the cavitation characteristics of such structures as baffle piers, steps in stilling basins and offset joints. The models are tested in a vacuum tank or a variable-pressure, closed-jet water tunnel. An investigation is being conducted to determine flow characteristics in gate slots with upstream and downstream seal gates. Flow from the lower lip of the upstream seal gate "expanded" into the slot and created severe turbulence and vortex action, indicating possible cavitation for prototype conditions. A review of literature is under way to evaluate the many variables that affect cavitation results.
(g) Results of tests indicated that the point of incipient cavitation varies with the scale of the model when cavitation results from vortex- or eddy-type flow. When cavitation exists at a zone of separation, the variation in the point of incipient cavitation as a function of model scale is reduced. Results of baffle pier tests indicated a chamfer on the edges of the baffle pier was as effective as a curved surface in lowering the point of incipient cavitation.
(h) "Cavitation at Baffle Piers; CWI Item No. 806, Cavitation Investigations (hydraulics)", Waterways Experiment Station Miscellaneous Paper No. 2-154, March 1956. (Available on loan.)

(994) EFFECTS OF MODEL DISTORTION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study is being made to determine the effects of model scale distortion on velocity distribution and other hydraulic conditions. A series of tests has been completed in a triangular flume having an adjustable central angle and adjustable slope. Studies are being conducted in a rectangular flume having a 90-degree bend with provisions for changing the vertical scale to provide a distortion of 0 to 10.
(h) A report of the initial phase of the study is in preparation.

(998) STUDY OF WAVE FORCE ON BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.

(e) A general investigation of wave phenomena and resulting forces is to be conducted in a wave tank to develop formulas, supported by experimental data, from which wave pressures on impervious surfaces, vertical and inclined, can be determined.
(f) Suspended.

(999) STABILITY OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Rubble-mound structures are studied in a wave tank to determine size of cap rock and slope of mound necessary to withstand action of waves and to develop formulas, supported by experimental data, from which the action of waves on rubble structures can be determined. Test data will be presented in dimensionless form, therefore no model scale, as such, is being utilized.
(g) Test results on breakwaters constructed of shaped and sized cap rock (quarry armor stone) and protective layers of concrete tetrapods indicate that the relationship between the more important variables is

$$W_r = \frac{\nu_r H^3}{K_d (S_r - 1)^3 \cot \alpha}$$

where W_r is weight of individual cap rock or tetrapods, H is height of selected design wave, S_r is the ratio of specific weight of rock (ν_r) to specific weight of fluid in which the structure is located, α the design angle between the seaside face of the structure and the horizontal, and K_d is a dimensionless coefficient. For breakwaters constructed of armor stone K_d varies from 3.1 for the no-damage criterion to 15.9 when as much as 30-60 percent of the armor stone is removed from the design section by wave action. From test results on breakwaters constructed with a protective cover of two, three, and four layers of tetrapods on the seaside slope it was found that K_d was approximately 11 for the no-damage criterion. Tests results on breakwaters constructed of armor rock and tetrapods have shown that wave run-up decreases as the angle between the face of the breakwater and the horizontal decreases. Also, wave run-up decreases as wave steepness increases. The wave run-up factor (ratio between height of wave run-up and wave height) for rubble breakwaters varies from a maximum of about 1.1 for a 1-on-1-1/4 slope to a minimum of about 0.2 for a 1-on-5 slope. On tetrapod slopes the maximum and minimum run-up factor varies from about 0.95 for a 1-on-1-1/4 slope to about 0.65 for a 1-on-3 slope.
(h) A report on the quarry stone phase of the subject study is being prepared.

(1000) ROUGHNESS STANDARDS FOR HYDRAULIC MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study is being conducted to evaluate resistance of definite types of roughness in terms of Manning's "n" and other parameters, so that much of the trial-and-error process of adjusting the surface roughness of river models can be eliminated. Tests have been performed in three rectangular flumes and a triangular flume.

(1002) SCALE EFFECTS IN HARBOR MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Several representative tests of rubble-mound breakwaters which have been conducted in the large wave flume (120 feet long, 4 feet deep, and 5 feet wide) will be repeated in the small wave flume (94 feet long, 1-1/2 feet deep, and 1 foot wide), using a linear scale one-half that of the larger-flume tests, to determine the effects of different scale ratios on the results of breakwater stability tests. It also is planned to perform similar tests, using a much larger model, in the large wave tank at the Beach Erosion Board Laboratory in Washington, D. C.

(g) Results of stability tests on breakwaters with side slopes of 1 on 1-1/4, 1 on 1-1/2, 1 on 2, 1 on 2-1/2, 1 on 3, and 1 on 4 constructed in the small wave flume have shown that reduction of the flume width from 5 feet to 1 foot and use of a linear scale in the small flume one-half the scale used in the larger-flume tests increases the value of the coefficient K_d in the Waterways Experiment Station formula from 3.1 to 5.6 for the no-damage criterion.

(1004) INSTRUMENTATION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; development.
(e) Various types of instruments for use in hydraulic models are being developed to make such measurements as those of wave heights, dynamic fluid pressures, and gate vibration and downpull. Development of an improved tidal reproducing apparatus is in progress. Investigation is under way of ultrasonic flow meter techniques for prototype dam applications.

(1207) MODEL STUDY OF PENSTOCK INTAKE AND SLUICE COASTER GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study of relative merits of various penstock intake and sluice coaster gate lip shapes, seals, and recesses is being conducted. The investigation includes determination of downpull effects of changes in gate-lip shape, length and shape of seals, size and shape of the recess in the face of the dam, and need for an air vent in the entrance. The 1:20 model of the sluice coaster gate is being tested in combination with a typical sluice which includes a slide gate, standard entrance curves conforming to the elliptical equation $(x^2/D^2) + (y^2/(D/3)^2) = 1$.
(g) Tests of the sluice coaster gate with various depths of the recess in back of the gate revealed downpull forces increase when the recess depth is reduced to 6 inches or less.

(1211) MODEL STUDIES OF HOOSIC RIVER, ADAMS AND NORTH ADAMS, MASSACHUSETTS.

(b) The District Engineer, New York District, Corps of Engineers, New York, New York.
(d) Experimental; for design.
(e) Two models were used to verify the hydraulic design for improvement of certain sections of the North and South Branches of Hoosic River in North Adams, Massachusetts, and of the main channel in Adams, Massachusetts, and to determine whether changes should be made for safety, increased efficiency, or economy. The flow in the major portion of these channels will be below critical depth. In Phase 1 of the North Adams study a 1:30 model reproduced the lower sections of the North and South Branches and about 1,300 feet of the main stream below the confluence of the North and South Branches. In Phase 2 North Branch was extended to include the control weir at the upstream limit of the improvement works for North Adams. In Phase 3 South Branch was extended upstream to include the debris basin sta 181+75. A 1:20 model reproduced a section of the main channel beginning in Adams approximately 8 miles above that reproduced in the 1:30 model. About 1,200 feet of Tophet Brook, which joins the Hoosic River, also was reproduced.
(f) Tests of Phases 1 and 2 of the 1:20 model of the main channel in Adams, Massachusetts, and of Phase 1 and Phase 2 on the 1:30 model of the North and South Branches of Hoosic River in North Adams, Massachusetts, have been completed. Tests in the final Phase 3 of the 1:30 model of the North and South Branches of the Hoosic River in North Adams, Massachusetts, will be completed during early 1957.
(g) Phase 2 (Adams 1:20 model) tests of original design indicated flow conditions to be generally satisfactory and checked computations closely except at a few points. Satisfactory designs were developed to eliminate unsatisfactory flow conditions below a control weir at a diversion structure and at the junction of Fiske Brooke. Rating curves were developed for two drop-structure plans at the Cook St. bridge within the Phase 1 reach.
(h) Final report of Phase 2 tests on 1:20 model of the main channel in Adams, Massachusetts, in preparation.

(1212) MODEL STUDIES OF OUTLET WORKS, OAHE DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) The District Engineer, Omaha District, Corps of Engineers, Omaha, Nebraska.
(d) Experimental; for design.
(e) Three models were constructed for complete investigation of the outlet works proposed for Oahe Dam. A 1:60 model, reproducing the downstream portion of six 18.25-foot-diameter outlet tunnels, the stilling basin, and 2,300 feet of the discharge and pilot channels, was used to investigate the performance of the outlet works and to effect revisions demonstrated to be desirable. A 1:25 model of the upstream portion of one of the flood-control tunnels, the control structure, and a short length of tunnel downstream was used to: (1) Check piezometric pressures in the intake structure and transition, particularly pressure variations in the bulkhead slot area; (2) determine the effect of curvature on flow conditions in the upstream tunnel and critical areas downstream therefrom; (3) check piezometric pressures at various points in the gate chamber of the control shaft and the upstream and downstream transitions, with particular attention to pressures near the gate slots; and (4) test surge conditions in the emergency gate well. A 1:25 model of one of the regulatory tunnels consisting of a short length of upstream tunnel, the control structure, and all of the downstream tunnel is being used to: (1) Check piezometric pressures in the gate slots, gate lip, transitions, and gate passage; (2) study the effects of forces acting on the service and emergency gates; (3) determine partial gate discharge ratings for the regulatory gate; (4) measure air demand characteristics; (5) determine flow characteristics in downstream transition and downstream tunnel for any condition of partial gate operation; (6) check piezometric pressures in the downstream tunnel; and (7) determine most suitable length of fillets required at outlet portal.
(g) The 1:25 regulatory tunnel model performed satisfactorily. However, model tests demonstrated that flow conditions at the upstream seal regulatory gate were very turbulent and that vortices formed in the slots beneath the gate, indicating possible cavitation for prototype conditions. Decision was made to use the more conventional downstream seal regulatory gate with 45-degree bottom.

(1467) ANALYSIS OF HYDRAULIC EXPERIMENTAL DATA (MODEL AND PROTOTYPE) AND DEVELOPMENT OF DESIGN CRITERIA.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Analytical (model and prototype) and field investigations; for design.
(e) A general study to develop, analyze, and disseminate to Corps of Engineers establishments, hydraulic design criteria to insure adequate capacity, economy of construction, and safe and satisfactory operation. Criteria are developed from model and prototype tests relating to the design of spillways, outlet works, gates and valves, channels, and navigation structures. Program also includes prototype tests in cooperation with other Corps of Engineers establishments.
(g) "Hydraulic design criteria" charts have been prepared on friction losses for corrugated metal pipe and discharge coefficients for tainter gates on spillway crests. Design aid charts have been prepared on backwater computations for open channel flow and for rectangular and circular channel sections. Vibration of a tainter gate in the Mud Mountain Dam flood-control conduit and spillway crest pressures at Pine Flat and Chief Joseph Dams were measured in the prototype. Operating forces on prototype mitertype lock gates were measured at Cheatham Lock.
(h) "Hydraulic Design Criteria" Issue No. 6. (Available for purchase in limited quantities.)
"Vibration and Pressure-Cell Tests, Flood-Control Intake, Fort Randall Dam, Missouri River, South Dakota", Waterways Experiment Station Technical Report No. 2-435, June 1956, (available on loan).
"The Effect of Artificial Stimulation of the Turbulent Boundary Layer in Rectangular Conduits", Miscellaneous Paper No. 2-160, March 1956, (available on loan).

(1472) INDIANA HARBOR, INDIANA (LAKE MICHIGAN), MODEL STUDY OF WAVE ACTION.

(b) Youngstown Sheet and Tube Co. and Inland Steel Co., East Chicago, Indiana.
(d) Experimental; for design.

(e) Investigation of a proposed bulkhead is being conducted in a fixed-bed-type model which reproduces all of Indiana Harbor to an undistorted linear scale ratio of 1:150 (model to prototype). Sufficient area of adjacent shore line and hydrography lakeward of the harbor were reproduced to insure proper approach of waves from critical storm directions. Model waves are generated by a plunger-type wave machine 60 feet in length. Companion tests are being performed in a small wave flume to determine the optimum design of a rubble wave absorber. These tests are being performed using an undistorted scale of 1:50 (model to prototype).

(1474) OPERATING FORCES OF MITTER-TYPE LOCK GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study to collect basic data on operating forces of miter-type lock gates and to determine the effect of various elements upon these forces is being conducted in a 1:20 model. A lock chamber 110 feet wide is reproduced with provisions for varying the length up to 600 feet on each side of the gate. Forces required for operation of miter gates will be measured for variations of the following elements: gate leaves, speeds and accelerations of operation, submerged depths, recess shapes, bottom clearances, chamber lengths, and nonsynchronous operation of gate leaves. Variations in the type linkage driving the gate also will be investigated.
(h) A combined report of test results of the Ohio River, modified Ohio River, and Panama type linkage is in preparation.

(1475) SIPHON ACTION AT PUMPING PLANTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) This study is being conducted to aid in developing design criteria for pumping plants which depend upon development of siphonic action on the discharge side of the pumps in order to yield the required discharge. The investigation determined the minimum initial priming velocity and length of time required to expel air from (prime) the siphon. Variables investigated during the tests were: rates of flow, water levels on the discharge side of the pumps, slope and length of the riverward leg, and venting conditions at the crown. A full size model of a 6-inch plastic discharge line with a lift of 30 feet was assembled for the investigation.
(g) Analysis of the test data by techniques of dimensional analysis and obtaining a solution to the general equation by the method of least squares to obtain the best correlation of the test data gave the following equation for the minimum velocity required to start siphonic action:

$$V_{min} = \frac{0.428\ (gD)^{0.522}\ (L/D)^{0.132}}{S^{0.0704}}$$

where V = average velocity in full pipe (feet per second),
D = diameter in feet,
L = length of sloping riverward leg in feet,
S = sine of angle with horizontal, and
g = acceleration due to gravity.

The generalized priming equation was derived from model data and checked against 73 prototype tests on approximately 50 different discharge lines of various lengths, slopes, and diameters ranging from 12 to 72 inches. The observed velocities and priming times agreed very satisfactorily with the values computed by the generalized priming equation and the priming time curve obtained in the model tests. The following formula will give conservative size air vents of the summit (to reduce the positive phase of the priming cycle):

$$d = 0.025\ D \left(\frac{2}{h}\right)^{0.25}$$

where d = diameter of air vent in feet,
D = pipe diameter in feet, and
h = depth of submergence over the outlet in feet.

(1735) MODEL STUDY OF WAVE RUN-UP ON SHORE STRUCTURES.

(b) The Resident Member, Beach Erosion Board, Corps of Engineers, Washington, D. C.
(d) Experimental; for design.
(e) Tests are being conducted in a wave flume, using a scale of 1:17, to investigate the relationship between water level, wave height, wave period, and beach slope and wave run-up on selected types of shore structures used to prevent erosion caused by wave action.
(g) Tests have shown that the volume of overtopping water and height of wave run-up vary with wave steepness, depth of water at toe of structure, and shape and roughness of the face of the structure. Wave run-up and overtopping decrease as wave steepness increases. Decreasing the angle between the structure face and the horizontal, and increasing the roughness of the structure face decreases wave run-up and overtopping. A complete analysis of the results of these tests has not been completed. The Beach Erosion Board is preparing a report which will present an analysis of the test data and design criteria for various types of shore structures.

(1736) MODEL STUDY OF EFFECTS OF INLETS ON ADJACENT BEACHES.

(b) The Resident Member, Beach Erosion Board, Corps of Engineers, Washington, D. C.
(d) Experimental; applied research.
(e) To determine the effects of natural or artificial inlets on adjacent beaches for various conditions of waves, tides, rate of littoral drift, and other factors, tests are being made in a basin simulating an ocean and a lagoon separated by a barrier beach of sand that can be breached to reproduce the desired inlet.
(g) Test facilities for the study had to be moved from one site to another. This work was accomplished, and a repeat of the last test made on the old test site was undertaken on the new site for confirmation purposes.

(1738) MODEL STUDIES OF GREENUP LOCKS AND DAM, OHIO RIVER.

(b) The District Engineer, Huntington District, Corps of Engineers, Huntington, West Virginia.
(d) Experimental; for design.
(e) A 1:120 model of the nonnavigable-type dam and twin parallel locks was used to determine the best arrangements of locks and appurtenant walls, to study approach conditions under various flows and methods of operation of control gates, and to demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint. Additional tests were conducted to determine the feasibility of replacing portions of the upper and lower guard walls with pontons and cells.
A 1:25 model reproduced the proposed emergency gate and a portion of the upper approach to the lock. The purpose of the model investigation was to determine the vertical forces acting on the 110-foot-wide by 11-foot-thick emergency gate as its crest is raised from elevation 497 to above the upper pool, elevation 515, under all possible conditions of tailwater.
(f) Testing completed.
(g) Tests to determine hydraulic forces on the 1:25-scale emergency gate revealed a maximum downpull of about 220 kips and a maximum uplift in the range of 25 to 50 kips, depending on tailwater conditions below the gate. Vibration data on the gate indicated a maximum displacement of the gate of 0.185 inch at random frequencies ranging from 1.0 to 2.5 cycles per second.
(h) Final report in preparation.

(1739) MODEL STUDIES OF MARKLAND LOCKS AND DAM, OHIO RIVER.

(b) The District Engineers, Huntington and Louisville Districts, Corps of Engineers, Huntington, West Virginia, and Louisville, Kentucky.
(d) Experimental; for design.
(e) A comprehensive 1:120 model of the nonnavigable-type dam and twin parallel locks, a 1:36 section model of the spillway and stilling basin, a 1:4 section model of the gate sill and gate lip and two 1:25 models of a vertical-lift-type spillway gate and a submergible-type spillway tainter gate were constructed to: (1) Determine best arrangements of locks and appurtenant walls; (2) study approach conditions under various flows and methods of

operation of control gates and powerhouse; (3) demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint; (4) investigate the design of the spillway and stilling basin elements; and (5) determine the hydraulic characteristics of a vertical-lift-type spillway gate and a submergible-type spillway tainter gate.

(f) Testing completed on the 1:120 model; the section models are active.

(g) Satisfactory arrangement of lock walls, method of gate operation, and location for Stevens Creek diversion channel outlet were determined on the 1:120 model. Tests results on the 1:36 model indicated that a basin 74 feet long with 2 rows of 6-foot-high baffle piers and a 4-foot-high end sill performed the most satisfactorily. Tests of hydraulic forces on the vertical-lift spillway gate revealed downpull forces equal to about 10 percent of the weight of the gate. Tests on the 1:4 model revealed pressures in the area between the gate sill and lip about 1 foot lower than the tailwater immediately below the gate. Tests of hydraulic forces on the submergible-type spillway tainter gate indicated a maximum downpull force of about 300 kips at a 5-foot submergence of the gate.

(h) Final report in preparation on the 1:120 model.

(1979) MODEL STUDY OF STILLING BASIN, BULL SHOALS DAM, WHITE RIVER, ARKANSAS.

(o) The District Engineer, Little Rock District, Corps of Engineers, Little Rock, Arkansas.

(d) Experimental; for design.

(e) The spillway was constructed with a stepped-type stilling basin designed to spread the jets issuing from the conduits. After a period of operation the steps were damaged by cavitation. A 1:12 model was used to develop a satisfactory method of repairing the basin for conduit discharges; a 1:50 section model was used to check the performance of the modified basin with spillway discharges.

(f) Testing completed.

(h) Final report in preparation.

(1980) MODEL STUDIES OF TABLE ROCK DAM, WHITE RIVER, MISSOURI.

(b) The District Engineer, Little Rock District, Corps of Engineers, Little Rock, Arkansas.

(d) Experimental; for design.

(e) A 1:50 section model of the stilling basin was used to determine the adequacy of the basin for spillway flow, and a 1:12 model of the stilling basin was used for tests of the basin under conduit flow. Current patterns and velocities around the training walls and in the powerhouse area were studied in a 1:100 general model.

(f) Testing completed.

(g) The action of the stilling basin was improved by installing higher and wider baffles. The spacing between baffles was increased and the first row of baffles was moved 11 feet downstream without decreasing the efficiency of the basin. The spreading action of the conduit outlets was improved by installing deflector and splitter blocks in the exit portals. Flow conditions around the left training wall of the stilling basin were found to be satisfactory.

(h) Final report in preparation.

(1982) MODEL STUDIES OF OLD RIVER LOW-SILL CONTROL STRUCTURE, OLD RIVER, LOUISIANA.

(b) The President, Mississippi River Commission, Corps of Engineers, Vicksburg, Mississippi.

(d) Experimental; for design.

(e) The Old River low-sill control structure will control flow into Old River, which links the Mississippi and Atchafalaya Rivers, so that Mississippi River flows will be divided between the lower reaches of the Mississippi and Atchafalaya. Tests were made on 1:36 models to investigate the over-all performance of the proposed structure with special attention to discharge coefficients, flow conditions at the abutments, effectiveness of the stilling basin, magnitude of downpull forces on the vertical-lift gates, and relative effectiveness of various riprap placement plans.

(f) Testing completed.

(g) Tests indicated that improved flow conditions could be obtained by realignment of the upstream and downstream training walls. It was demonstrated that the horizontal stilling basin could be raised from elevation -12.0 msl to elevation -5.0 msl, and that certain revisions to basin components produced improved stilling action. Calibration of the model resulted in satisfactory verification of the computed discharges. Downpull tests of the vertical-lift gates showed that the two lower gate leaves should be operated together in order to eliminate destructive bouncing which occurred when the bottom leaf was operated by itself. The model riprap failed at a discharge slightly less than the maximum design flood and at a tailwater 5 feet deeper than the minimum predicted. Model tests failed to produce a riprap placement plan which was significantly better than the proposed design.
(h) Final reports in preparation.

(1983) MODEL STUDY OF SEDIMENT DIVERSION THROUGH PROPOSED OLD RIVER, LOUISIANA, CONTROL STRUCTURES.

(b) The President, Mississippi River Commission, Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) A 10-mile reach of the Mississippi River upstream of the mouth of Old River was reproduced in fixed-bed and movable-bed models to scale ratios of 1:400 horizontally and 1:100 vertically. Tests were conducted on the fixed-bed model to determine a suitable location and design for control structures (consisting of an overbank and a low-sill structure) that will permit the same percentage of sediment to enter the Atchafalaya River as now enters that stream through Old River, should Old River be closed with a lock and dam. Additional tests have been undertaken on the movable-bed model to determine effects of changes in design and location of structures, changes in shape and alignment of approach channel, and effect of diversion on Mississippi River channel.
(f) Testing completed.
(g) Tests were made of currents and sediment movement with the structures in operation without and with permeable dikes, and with recession of the bankline in the bend upstream. Test results indicated the general location selected for the structures to be satisfactory insofar as sediment diversion is concerned, provided that the relative positions of the overbank and low-sill structures are reversed so as to place the overbank structure upstream of the low-sill structure. The model study also indicated that velocities on the structures side of the Mississippi River channel will increase and velocities on the opposite side will decrease, which will result in some adjustment in the Mississippi River channel in the vicinity. The extent of changes in the Mississippi River channel resulting from installation of the structures and the effects of such changes on the water-sediment ratio of the diverted flow could not be determined from the fixed-bed model. The movable-bed studies indicate that: Operation of the structures will alter the distribution of sediment within the Mississippi River channel and tend to increase the water-sediment ratio of the diverted flow; with the approach channel normal to the Mississippi River channel, the amount of bed load diverted through the structures will tend to be high and minor changes in alignment of the approach channel will have little effect on the bed material diverted; the amount of material diverted through the structure can be reduced by a change in the direction of the entrance to the approach channel by means of a training dike; the south bank of the approach channel will be subjected to a strong current attack and will have to be heavily protected; the attack on the south bank of the approach channel can be reduced by changing the alignment of that bank.
(h) Final report in preparation.

(1984) MODEL STUDY OF CONTROL GATE FOR TUNNEL NO. 4, FORT PECK DAM, MISSOURI RIVER, MONTANA.

(b) The District Engineer, Garrison District, Corps of Engineers, Riverdale, North Dakota.
(d) Experimental; for design.
(e) Tests to study methods of eliminating cavitation on the port liner and vibration of the cylinder gate in the main control shaft of tunnel No. 4 were conducted on a 1:25 model. Discharge capacities, pressures, air demand, and gate vibration were determined for the existing cylinder gate installation.
(f) Testing completed.

(g) Approximately ten alterations to the existing control structure were investigated. These alterations involved the use of partition walls in the outer water passage of the structure, guide vanes in the transition below the structure and in the discharge ports, venting below the piers of the inner tower, baffles and roof cap in the outer water passage of the structure, and offsets below the ports of the inner tower. The most satisfactory alternate design consisted of a 1.0-foot offset below the discharge ports of the inner tower and six 1.0-foot-diameter vents below this offset. This design eliminated negative pressures in the port areas and greatly improved pressure conditions in the area below the offset. Pressure surges at the cylinder gate also were reduced.
(h) Final report in preparation.

(1985) DEVELOPMENT OF TURBULENCE METER.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; development.
(e) The investigation is being conducted to develop instruments that will: (a) Indicate the speed and direction of fluid currents at great depths and moderate velocities; (b) indicate the speed and direction of currents at shallow depths and high velocities; (c) receive signals from (a) or (b) and separate them into (1) instantaneous velocity and direction, (2) mean velocity and direction, and (3) the root-mean-square deviations from the mean.
(f) Negotiations have been initiated to contract with the Iowa Institute for Hydraulic Research for the delivery of a prototype instrument.

(1986) SALT WATER INTRUSION AND RELATED PHENOMENA.

(b) Committee on Tidal Hydraulics, Corps of Engineers (correspondence should be addressed to Mr. C. F. Wicker, Chairman, Committee on Tidal Hydraulics, Philadelphia District, Corps of Engineers, Philadelphia, Pennsylvania).
(d) Experimental; applied research.
(e) To determine the effects of salinity and related phenomena on the vertical distribution of currents and shoaling characteristics in estuaries, tests are being made in a lucite flume 327 feet long, 1.5 feet deep, and 0.75 foot wide. One end of the flume is connected to a 25-foot-square tidal basin in which any desired tide may be produced and in which the salinity may be controlled. The opposite end is connected to a fresh-water source.
(g) Tests for various conditions of tidal range, fresh-water discharge, and control salinity were made; the results are being analyzed to determine significant phenomena.

(1987) MODEL REPRODUCTION OF PROTOTYPE EROSION BELOW STILLING BASINS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Initially, the investigation will be conducted on a model of a selected dam with provisions for studying sands of different sizes in the channel below the stilling basin. Later, models with two or more different linear scales will be constructed to verify findings using suitable bed materials.
(f) Preliminary design and layout in preparation.

(1988) WATER TEMPERATURE EFFECTS ON BED FORMS AND ROUGHNESS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Existing laboratory flumes, in which water temperatures can be varied to simulate normally experienced summer and winter temperatures, will be used for investigating the effects of water temperature on bed forms and bed roughness of various types of bed materials.
(f) Preliminary design and layout in preparation.

(2200) MODEL STUDY OF FLOOD CONTROL, ANACOSTIA RIVER, MARYLAND AND DISTRICT OF COLUMBIA.

(b) The District Engineer, Washington District, Corps of Engineers, Washington, D. C.
(d) Experimental; for design.

(e) A fixed-bed model, scale 1:30, reproducing 2,100 feet of the Northwest Branch channel of the Anacostia River was used: (a) To verify conclusions, based upon theoretical computations, that the paved channel as designed will induce the supercritical velocities necessary to lower water-surface elevations to provide clearance under existing and proposed bridges, and that the hydraulic jump will be formed and retained on the paved section for the expected range of tailwater elevations; and (b) to test modifications of the original design.
(f) Testing completed.
(g) Results indicate that with the channel as originally designed, the hydraulic jump would not be retained on the paved channel for the entire range of tailwater elevations. A satisfactory plan was developed which involved: Reduction of the width of the flood plain above the paved channel; superelevation of the channel floor within the curved reach; change in the shape of the transition below a railroad bridge; and raising the floor of another bridge 2 feet.
(h) "Flood-Control Project for Northwest Branch, Anacostia River, District of Columbia and Maryland; Hydraulic Model Investigation", Waterways Experiment Station Technical Report No. 2-434, June 1956. (Available on loan.)

(2201) MODEL STUDY OF LAKE REGULATION, LAKE ERIE.

(b) The District Engineer, Buffalo District, Corps of Engineers, Buffalo, New York.
(d) Experimental; for design.
(e) The existing Niagara River and Falls Model (1470) was used to determine the nature and extent of the excavation required to increase the outlet capacity of the Niagara River to permit regulation of levels of Lake Erie.
(f) Testing completed.
(h) Final report in preparation.

(2203) MODEL STUDY OF WAVE RUN-UP AND OVERTOPPING, LAKE OKEECHOBEE LEVEE SECTIONS, FLORIDA.

(b) The District Engineer, Jacksonville District, Corps of Engineers, Jacksonville, Florida.
(d) Experimental; applied research and design.
(e) Tests were conducted in a wave flume using a model scale of 1:30 to determine the optimum levee section for Lake Okeechobee, Florida, with respect to overtopping due to wave and wind setup. A few tests were conducted on a 1:17-scale model to determine the effects of model scale.
(f) Testing completed.
(g) Test results showed that the height of wave run-up and quantities of overtopping water vary with wave height, wave period, levee slope, shape of levee face, depth of water at toe of levee slope, and depth of water at break in grade of composite levee slopes. The height of wave run-up and quantity of overtopping water decrease as the slope of the levee decreases and increase as the wave height and wave period increase. The construction of berms on the lakeside of the levee face and a decrease in water depth at the toe of the levee slope decrease the height of wave run-up. An increase in the model scale results in a small increase in wave run-up and an increase in overtopping which increases as the quantity of overtopping decreases. Although there is evidence of scale effect, the model data are believed to be sufficiently accurate for selection of an efficient levee section. Test results showed that, excluding levee slopes of 1 on 2 and 1 on 10, which are considered impractical, a levee slope of 1 on 6 would be a very efficient levee section.
(h) Final report in preparation.

(2204) STILLING BASINS FOR OUTLET WORKS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; for design.
(e) Scale models are being used for a general study of the hydraulic characteristics of stilling basins below outlet works and will involve study of such items as radii and flare of side walls as affected by the length of the curved portion of the basin immediately downstream from the conduit; shape of conduit exit portal to improve entrance conditions into stilling basin; and advantages of the use of diverging side walls as compared to parallel

walls. Emphasis will be placed on the development of a satisfactory stilling basin for a simple circular outlet tunnel without any transition inside the tunnel.
(f) Suspended.

(2426) MODEL STUDY OF NAVIGATION LOCK, PORT ALLEN, LOUISIANA.

(b) The President, Mississippi River Commission, Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) A new channel in the Gulf Intracoastal Waterway from Indian Village to Port Allen, Louisiana, includes a navigation lock in the Mississippi River levee at that point. Several designs for the lock ports were tested in a preliminary culvert and single port model constructed to a 1:25-scale ratio. The major investigations were conducted in a 1:25 model reproducing 150 feet of upstream approach, intake manifolds, 1,250 feet of lock chamber, culverts, lateral ports, outlet manifolds, and 1,000 feet of downstream topography. This model includes provisions for changing the arrangement of filling ports.
(f) Suspended.
(g) Satisfactory designs have been developed for the ports and intake and outlet manifolds. Additional tests are to be made for lifts less than 45 feet as soon as the model facilities become available. These tests will involve filling and emptying operations with various tow arrangements, heads, and valve travel.

(2427) MODEL STUDY OF OUTLET WORKS, ABIQUIU DAM, RIO CHAMA, NEW MEXICO.

(b) The District Engineer, Albuquerque District, Corps of Engineers, Albuquerque, New Mexico.
(d) Experimental; for design.
(e) A 1:20 model reproduced the 12-foot-diameter outlet tunnel including the control section consisting of twin gate passages and a flip-bucket energy dissipator. Of particular interest were the transitions between the rectangular gate passages and the circular tunnel.
(f) Testing completed.
(g) A satisfactory gate transition section was developed. Also a flip-bucket design was developed that gives reasonable distribution of flow in the exit area.
(h) Final report in preparation.

(2428) SAVANNAH HARBOR MODEL STUDY.

(b) The District Engineer, Savannah District, Corps of Engineers, Savannah, Georgia.
(d) Experimental; for design.
(e) The investigation is being conducted in a model which reproduces the following: (a) That portion of the Atlantic Ocean, adjacent to the harbor entrance, from Calibogue Sound on the north to Wassaw Sound on the south; (b) the Savannah River and its flood plain to the head of tide at Ebenezer Landing; and (c) that portion of the Intracoastal Waterway which crosses the area included in the model. The model is of fixed-bed construction with scale ratios, model to prototype, of 1:800 horizontally and 1:80 vertically. Automatic tide generators are used to reproduce tides and tidal currents throughout the harbor, and salt water is used in the model ocean to reproduce the effects of density difference on current velocities and distributions. Shoaling studies are made by injecting finely ground gilsonite into the model to reproduce the patterns of shoaling as observed in the prototype, following which the effects of proposed improvement plans on shoaling patterns may be observed and evaluated.
(g) Tests of authorized changes in project channel dimensions indicated no measurable effects on the hydraulic, salinity, or shoaling regimens of the harbor. Tests of various schemes for diverting all or part of the river discharge from the harbor indicate that shoaling can be greatly reduced, and the locations of major shoaling areas can be changed appreciably, by diversion of the river discharge.

(2429) MODEL STUDIES OF THE CORNWALL ISLAND AND BARNHART ISLAND - LAKE ST. FRANCIS REACHES, ST. LAWRENCE RIVER.

(b) The District Engineer, Buffalo District, Corps of Engineers, Buffalo, New York.
(d) Experimental; for design.

(e) Two fixed-bed models are being used to study plans for navigation improvement in the lower portion of the International Rapids section of the St. Lawrence River. A 1:100 model of the Cornwall Island Reach reproduces all features of the river from just below the tailrace of the proposed Barnhart Island powerhouse to about the mid-point of Cornwall Island, and includes portions of both the north and south Cornwall Island channels, Polly's Gut, and the entrance to Grass River locks. A model of the Barnhard Island-Lake St. Francis Reach, built to scales of 1:300 horizontally and 1:100 vertically, reproduces a greater area upstream and downstream of Cornwall Island. Both models are being used to study navigation conditions in the approach to the Grass River locks, and proposed plans for excavations in both Cornwall Island channels to effect navigation improvement in South Channel.
(g) Three plans have been developed for the south Cornwall Island channel that satisfy the navigation design criteria.

(2430) GARY HARBOR, INDIANA (LAKE MICHIGAN), MODEL STUDY OF WAVE ACTION.

(b) U. S. Steel Corporation, Gary Steel Works, Gary, Indiana.
(d) Experimental; for design.
(e) Investigation of a proposed bulkhead was conducted in a fixed-bed-type model which reproduced Gary Harbor to an undistorted linear scale of 1:150 (model to prototype). Sufficient area of adjacent shore line and hydrography lakeward of the harbor was reproduced to insure proper approach of waves from various storm directions. Model waves were generated by a movable plunger-type wave machine 40 feet in length. Tests are now in progress in a small wave flume to determine the optimum design of a wave absorber to reduce wave reflection from the proposed bulkhead. A 1:50 scale is being used in the flume tests.

(2431) MODEL STUDIES OF STILLING BASIN, WARRIOR DAM, WARRIOR RIVER, ALABAMA.

(b) The District Engineer, Mobile District, Corps of Engineers, Mobile, Alabama.
(d) Experimental; for design.
(e) Two section models were used to determine a stable slope for dumped riprap immediately downstream from the stilling basin and to verify the adequacy of the spillway and stilling basin designs for this proposed navigation structure: (a) A 1:20 model reproducing 400 feet of the approach area, a portion of the spillway crest, left embankment, and stilling basin (2 full gate bays and adjacent half bays), and 800 feet of the exit area; and (b) a 1:60 model of the center section of the spillway and stilling basin reproducing one full gate bay and adjacent half bays.
(f) Testing completed.
(g) Satisfactory design of spillway and stilling basin, method of spillway gate operation, and determination of a stable slope for dumped riprap below the stilling basin were accomplished.
(h) Final report in preparation.

(2432) MODEL STUDIES OF FORT GAINES LOCK AND DAM, CHATTAHOOCHEE RIVER, GEORGIA.

(b) The District Engineer, Mobile District, Corps of Engineers, Mobile, Alabama.
(d) Experimental; for design.
(e) Two models will be used to study the hydraulic characteristics of the spillway and stilling basin, orientation of spillway and powerhouse in the river channel, and the alignment and location of the lock for this proposed navigation structure: (a) A 1:80 model reproducing the entire problem area, including 1,500 feet of the approach area, the spillway, and navigation lock, and 3,500 feet of the exit area, and (b) a 1:40 model of the center section of the spillway and stilling basin reproducing one full gate bay and adjacent half bays.
(g) Satisfactory orientation of spillway and powerhouse in the river channel, alignment and location of the lock, and design of the spillway and stilling basin were accomplished.

(2434) VERMILION BAY MODEL STUDY, LOUISIANA.

(b) Department of Public Works, State of Louisiana.
(d) Experimental; for design.

(e) Vermilion Bay, on the Louisiana coast, is connected with the Gulf of Mexico through the deep and narrow channel of Southwest Pass, and is part of a bay system containing, to the east, East Cote Blanche, West Cote Blanche, and Atchafalaya Bays. The Vermilion River and several smaller streams flow into Vermilion Bay, but their combined discharges are too small during the summer to prevent intrusion of saline Gulf waters into the bay through the deep channel of Southwest Pass. On the other hand, because of barrier reefs and the discharge of the Atchafalaya River, the waters of East Cote Blanche, West Cote Blanche, and Atchafalaya Bays are fresh enough for irrigation purposes during most of the year. The plan of improvement contemplates closure of Southwest Pass in an attempt to bring the salinity of Vermilion Bay into agreement with that of the other bays to the east. Should this plan not be effective, the probability exists that the shallow entrances to the other bays might also be closed, provisions being made to pass the discharge of the tributary streams over the closures.
A fixed-bed model, to linear scales of 1:100 vertically and 1:2000 horizontally, reproduces a part of the Gulf of Mexico, Vermilion, East Cote Blanche, West Cote Blanche, and Atchafalaya Bays, and portions of the tributary streams. Should it be necessary to effect a closure of West Cote Blanche Bay, the model will be enlarged to reproduce the adjacent flood plain so as to determine the effects of these closures upon the passage of floods.

(2673) MODEL STUDY OF BARKLEY DAM, CUMBERLAND RIVER, TENNESSEE.

(b) The District Engineer, Nashville District, Corps of Engineers, Nashville, Tennessee.
(d) Experimental; for design.
(e) A 1:120 model, reproducing the Cumberland River from mile 29.4 to 32.2, the lock, dam, and powerhouse, is being used to investigate flow characteristics in the approaches to the lock.
(g) Flow conditions were observed and velocities measured throughtout the model.

(2674) MODEL STUDY OF CALUMET RIVER LOCK, SOUTH CHICAGO, ILLINOIS.

(b) The District Engineer, Chicago District, Corps of Engineers, Chicago, Illinois.
(d) Experimental; for design.
(e) The Calumet River Lock in South Chicago will be part of a project for widening and deepening the Calumet-Sag Channel, an important link in the Great-Lakes-to-the-Gulf Waterway. The lock will be 1,000 feet long, 110 feet wide, and will provide a depth of 12 feet over the sills. Normal lifts will be of the order of 5 feet; however, extreme conditions can produce head differentials as great as 9 feet. Also, normal opeation will require lifts from the navigation pool to lake elevation but reversal in head during periods of low lake level is possible. Filling and emptying of the lock will be accomplished between the leaves of sector gates, supplemented by loop culverts around the lakeside sector gates. Filling and emptying characteristics are being studied on a 1:20-scale model which reproduces the immediate approaches and entire lock. Provisions have been made for mechanical operation of the sector gates and automatic recording of pertinent data.
(g) A satisfactory method of filling has been developed which requires the use of two 10- by 10-foot loop culverts to supplement filling through the sector gates. A schedule of culvert valve and sector gate operation for various lifts has been recommended. Lock emptying and head reversal tests are currently under way.

(2675) MODEL STUDIES OF DARDANELLE DAM, DARDANELLE, ARKANSAS.

(b) The District Engineer, Little Rock District, Corps of Engineers, Little Rock Arkansas.
(d) Experimental; for design.
(e) A 1:120-scale model, reproducing the structures and 4,000 feet of approach channel and 8,000 feet of exit channel, is being used for the investigation. The approach channel is molded in concrete to overburden contours while the exit channel is molded in concrete to bedrock contours but has the overburden topography molded in pea gravel in order to facilitate revision of the channel configuration. It is proposed to measure currents around the lock approaches for all arrangements of structures; measure forces against barge tows in the lock approaches; and introduce some type of lightweight material into the model to reveal sedimentation tendencies.

(g) Current measurements for two proposed layouts of the structures indicate that navigation currents in the downstream lock approach will be satisfactory with the powerhouse located either between the lock and spillway near the left side of the river or adjacent to the right bank. The former plan would provide more aid in maintaining the dredged channel approaching the lock.

(2676) HIGH VELOCITY PITOT TUBE.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; development.
(e) A cantilevered strut will be developed for holding a pitot tube into open channel flows with velocities of 30 to 50 feet per second.
(g) Strut will be manufactured upon completion of design.

(2677) MODEL STUDY OF KALAMAZOO RIVER, BATTLE CREEK, MICHIGAN.

(b) The District Engineer, Detroit District, Corps of Engineers, Detroit, Michigan.
(d) Experimental; for design.
(e) The flood-control project on the Kalamazoo River involves the construction of a paved cutoff channel at Battle Creek, Michigan, and general channel improvements on the Kalamazoo River downstream of its confluence with the cutoff channel. The purposes of the model study are to determine: Water-surface profiles in the cutoff channel under various flows; the need for a stilling basin at the confluence of the cutoff channel and Kalamazoo River; the extent of pier extensions for highway and railroad bridges crossing the cutoff channel; and the need for superelevation at the curves of the cutoff channel. A 1:40 fixed-bed model reproduces 1,000 feet of the cutoff channel, 700 feet of the Battle Creek River channel, and 4,300 feet of the Kalamazoo River channel.
(g) Tests of the original design demonstrated that flow conditions were generally excellent throughout the model; however, some unsatisfactory and unfavorable conditions existed. Realignment of the channel provided improved flow conditions and lowering of stage heights at the confluence of the Battle Creek River and the Kalamazoo River cutoff channel. Flow conditions were improved at the Fountain Street Bridge by bridge pier extensions and channel realignment.

(2678) MODEL STUDY OF LOCKS AND DAM NO. 41, LOUISVILLE, KENTUCKY.

(b) The District Engineer, Louisville District, Corps of Engineers, Louisville, Kentucky.
(d) Experimental; for design.
(e) Locks and Dam No. 41 is located on the Ohio River at Louisville, Ky., approximately 606 miles downstream from Pittsburgh, Pa. A fixed-bed, 1:120 model reproduces the reach of the Ohio River from about mile 602 to about mile 608 including adjacent overbank areas, the locks and dam structures, and all bridges and other structures that might affect flow conditions. Investigations are being made to determine the effects of location, size, and alignment of a new approach channel on navigation and surge conditions; determine the best location for a new navigable span on the Pennsylvania Railroad bridge; determine a method of operating the dam for optimum navigation conditions; study navigation conditions in the lower approach as affected by flow through dam, powerhouse, and lock-emptying system; and provide a means for navigation interests to satisfy themselves as to the acceptability of the proposed plan by observing the model in operation.
(f) Tests of four basic plans and several modifications of these plans have been completed.
(g) Tests indicate that enlarging the existing canal would provide better entrance conditions with all plans tested. Navigation conditions were satisfactory in the lower approach with the flows tested.

(2679) MODEL STUDY OF NEEDLE GATES, OLD RIVER OVERBANK STRUCTURE.

(b) The President, Mississippi River Commission, Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.

(e) The Old River overbank structure will help to control diversion from the Mississippi River to the Atchafalaya River during flood stages. The structure will consist of a low weir with crest elevation of 52.0 msl surmounted by piers and needle gates for controlling discharge. The spillway will contain 73 gate bays with clear widths of 44 feet. Each bay will be fitted with 15 needles measuring 2 feet 10-1/2 inches by 18 feet. The needles will be hinged to the superstructure above the weir and will seal against the weir at the lower ends. The gates will be operated by a crane cable attached to the lower ends of the needles. A 1:8-scale section model of the spillway and stilling basin, reproducing one full bay and about 73 percent of each of the two adjacent bays, was used for the study.
(f) Testing completed.
(g) Hoist cable stresses and hinge reactions observed in the model checked the design computations very well so no revisions were tested. A short series of tests of the stilling basin indicated that the stilling action could be improved by moving the first row of baffles to a position 8 feet downstream from the second row.
(h) Final report in preparation.

(2680) MODEL STUDY OF HURRICANE TIDES IN NARRAGANSETT BAY, RHODE ISLAND.

(b) The Division Engineer, New England Division, Corps of Engineers, Boston, Massachusetts.
(d) Experimental; for design.
(e) A fixed-bed model, 1:1000 horizontally and 1:100 vertically, reproduces all of Narragansett Bay and an adjacent portion of the Atlantic Ocean. An automatic tide generator is used to reproduce normal tides throughout the model, and a separate, manually operated tide generator is used to reproduce hurricane tides of the desired characteristics at the bay entrance. Numerous barrier plans for prevention of hurricane-tide damage have been proposed by state, municipal, civic, and industrial interests, varying in scope from plans to protect the entire bay system to plans of a local nature for protection of the city of Providence alone. The relative and absolute effectiveness of the various plans in reducing hurricane-tide elevations throughout the bay system are being determined, as well as the effects of the best plan or plans on such important factors as tidal circulation, pollution, salinity, and shoaling for normal conditions. Fresh water only is being used in the model during tests to determine the effectiveness of the proposed barriers in reducing hurricane-tide damage, but both salt and fresh water are being used in tests to determine the effects of the best barrier plans on all significant factors for normal conditions. Model appurtenances consist of automatic tide gages to record both hurricane-tide and normal-tide elevations at critical points throughout the bay system, recording salinity meters for salinity studies, recording dye meters for observing pollution and/or flushing characteristics, current meters for observing detailed velocity distribution, and equipment for simulating shoaling of the channels and other navigation facilities.
(g) Tests of about 36 plans for reduction of hurricane-tide heights in the Narragansett Bay area were completed. The test results indicate that the most satisfactory plan for preventing hurricane-tide damage consists of a barrier in the upper bay near Fox Point and barriers in the lower bay near the Jamestown Bridge in West Passage, Bull Point in East Passage, and Tiverton in the Sakonnet River. All of the lower bay barriers would include fixed openings for navigation.

(2681) LARGE SCALE TESTS OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Tests are being conducted by the Beach Erosion Board, under the general supervision of the Waterways Experiment Station, to investigate the effects of model scale on the results of experimentally determined criteria for the design of rubble-mound breakwaters. Stability tests will be conducted on breakwater slopes of 1 on 1-1/2 and 1 on 2-1/2, using wave periods of 3.36, 5.60, and 7.87 seconds. Tests in the Beach Erosion Board wave flume (15 feet by 20 feet by 635 feet) are being conducted using a linear scale of 7.5 to 1 based on the tests conducted in the Waterways Experiment Station 5- by 4- by 119-foot wave flume. Stability tests have been conducted in the Waterways Experiment Station small wave flume (1 foot by 1.5 feet by 94 feet) using a scale of 0.5 to 1 based on tests conducted in the 5- by 4- by 119-foot wave flume. Therefore, data on the stability of rubble-mound breakwaters will be available for three different linear scales, 0.5 to 1, 1 to 1, and 7.5 to 1.
(g) A survey to locate the rock required for the tests is in progress.

(2682) SACRAMENTO BARGE CANAL LOCK MODEL STUDIES, SACRAMENTO RIVER, CALIFORNIA.

(b) The District Engineer, Sacramento District, Corps of Engineers, Sacramento, California.
(d) Experimental; for design.
(e) The Sacramento Barge Canal Lock on the Sacramento River is part of the proposed improvement for the Sacramento River Deep Water Ship Canal. The project plan consists of (a) a deep water channel from Suisan Bay to Washington Lake, 30 feet deep at mean low water, 200 feet wide in tangents and 300 feet wide in curves and through existing channels, (b) a 70-acre, 30-foot-deep harbor at Lake Washington, (c) a connecting barge canal from Washington Lake to Sacramento River, 13 feet deep and 120 feet wide with a navigation lock 86 by 600 feet, and a combination highway and railroad bascule bridge. The maximum anticipated lock lift determined from a study of proposed flow conditions is 21.1 feet. A minimum depth of 13 feet is provided over the upper and lower gate sills. Because of the possibility of a reversal of head, sector gates were selected as the means of filling and emptying the lock. Flow will pass directly into or from the lock between the gate leaves as they are opened. In addition the gate leaves and recesses have been designed so that flow will pass between the face of the leaves and the wall of the recesses, thereby providing three flow passages at each end of the lock. The immediate approaches and entire lock are reproduced in a 1:20-scale model. Provisions have been made for mechanical operation of the sector gates and automatic recording of pertinent data.
(g) Initial tests results indicate that a filling time of about 12 minutes can be obtained for a 12-foot lift with hawser stresses on a normal tow not exceeding 5 tons.

(2683) MODEL STUDY OF SURGES, LONG SAULT CANAL, ST. LAWRENCE RIVER.

(b) The District Engineer, Buffalo District, Corps of Engineers, Buffalo, New York.
(d) Experimental; for design.
(e) Surges in the intermediate pool produced by failure of the upstream lock (Eisenhower Lock) gates, are being studied in a fixed-bed model built to linear scale ratios of 1:200 horizontally and 1:100 vertically. The model reproduces all pertinent features of the portion of Long Sault Canal extending from just upstream of Eisenhower Lock to the downstream end of the Grass River Lock. Included in the model are Eisenhower and Grass River Locks, Dike No. 6, and the 18,000-foot-long intermediate pool.
(g) The maximum heights of the surge waves at Grass River Lock are 4.5 feet (0.5 foot below top of lock walls, elevation 205.0) when closure of the emergency lift gate at Eisenhower Lock is effected within a 29-minute period (10.0 minutes free flow through the lock and 19.0 minutes closing the gate). The observed time of overtopping when the lift gate was not placed in operation was 38.0 minutes.

(2684) SUPERELEVATED FLOW INVESTIGATIONS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) This study will be an extension of the work performed by the Los Angeles District, CE, involving model study of superelevated flow in curved open channels. It will be concerned with the use of superelevated spirals in simple and S-curves of very short radii. A second phase of the study will be concerned with design of curves for equal distribution of energy across the channel at the downstream end of the curve.

(2685) WAVE ACTION, SUPERIOR ENTRY, DULUTH-SUPERIOR HARBOR, LAKE SUPERIOR MODEL STUDY.

(b) The District Engineer, St. Paul District, Corps of Engineers, St. Paul, Minnesota.
(d) Experimental; for design.
(e) A 1:150-scale fixed-bed model is used which reproduces all the navigation approach channel and harbor breakwater structures as well as the inner harbor dock area serving Superior, Wisconsin. The model consists of adjacent lake and shore-line areas to permit reproduction of storm waves from all critical directions. Investigations are being made to determine the reasons for the wave action problems that exist and which cause ship damage in the vicinity of the Superior Entry, and to develop the most effective remedy possible so that navigation and docking hazards now prevailing will be adequately reduced.

(g) A refraction diagram study to determine the direction of approach and magnitude of storm waves to be used for model testing has been completed. Base tests to determine which wave direction causes the worst wave action inside the harbor are now in progress.

(2686) MODEL STUDY OF WOONSOCKET FALLS DAM, BLACKSTONE RIVER, RHODE ISLAND.

(b) The Division Engineer, New England Division, Corps of Engineers, Boston, Massachusetts.
(d) Experimental; for design.
(e) A 1:50 fixed-bed model reproduced the Blackstone River from about 1,600 ft above to about 600 ft below the dam. Provisions for measuring pressures on the downstream side of the dam were included in the model. The flood-control project channel improvement includes the reconstruction of the dam and rock excavation between the toe of the dam and a bridge just downstream to minimize submergence of the dam.
(f) Testing completed.
(g) Results indicate the head loss below the dam to be considerably lower than the computed value and that the amount of rock excavation below the dam can be reduced without affecting the headwater elevation above the dam.
(h) Final report in preparation.

U. S. DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS.

(568) SCOUR AT BRIDGE PIERS AND ABUTMENTS.

Cooperative with Iowa Institute of Hydraulic Research. See page 43.

(1074) HYDRAULICS OF STILLING BASINS.

Cooperative with Colorado A and M College. See page 15.

(1101) MOVEMENT OF SEDIMENT IN HIGHWAY DRAINAGE SYSTEMS.

Cooperative with Iowa Institute of Hydraulic Research. See page 43.

(1597) A STUDY OF THE EFFICIENCY OF SAND TRAPS.

Cooperative with Iowa Institute of Hydraulic Research. See page 44.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETER.

Cooperative with Stanford University. See page 88.

(2066) STUDY OF OPEN CHANNEL CONSTRICTIONS IN A SLOPING FLUME.

Cooperative with Colorado A and M. College. See page 18.

(2134) HEAD LOSSES IN STORM DRAIN JUNCTIONS.

Cooperative with the University of Missouri. See page 67.

(2208) EXTENSION OF FLOOD FREQUENCY RECORDS.

Cooperative with the U. S. Weather Bureau. See page 165.

(2266) HYDROLOGIC INVESTIGATIONS OF SMALL DRAINAGE BASINS IN CALIFORNIA.

Cooperative with the University of California. See page 12.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF HIGHWAY CULVERTS.

Cooperative with Iowa Institute of Hydraulic Research. See page 45.

(2435) HYDRAULICS OF PIPE CULVERTS.

Cooperative with the National Bureau of Standards. See page 162.

(2540) SCOUR AT BRIDGE CROSSINGS.

Cooperative with the Iowa Institute of Hydraulic Research. See page 47.

U. S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS, Fluid Mechanics Section.

Inquiries concerning Projects Nos. 159, 160, 1477 to 1479, incl., 1482, 1742, 1989, 1990, 2205, 2435 and 2436, should be addressed to the Chief, Fluid Mechanics Section, National Bureau of Standards, Washington 25, D. C.

(159) MODEL LAWS FOR DENSITY CURRENTS.

(b) Waterways Experiment Station, Corps of Engineers, Department of the Army.
(d) Theoretical and experimental; basic and applied research.
(e) To determine model laws for models involving the motion of stratified liquids. The two major problems are (1) the motion of a heavy liquid initially confined in a "lock" when released into a long channel containing a stationary lighter liquid, and (2) the motion of a heavy liquid from a "sea" into a long channel with either still or flowing lighter liquid.
(h) "An Experimental Study of the Motion of Saline Water from Locks into Fresh Water Channels", by Garbis H. Keulegan, (in preparation).

(1477) TURBULENT EXPANSION OF JETS IN WATER.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research.
(e) To determine experimentally the nature of turbulent expansion of jets in water with relation to Reynolds number, using jets of hot water, salt water, etc.
(h) Report in preparation.

(1478) WIND WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research.
(e) Includes mathematical and experimental studies of (1) wind tides (setup), (2) growth of wind waves, and (3) surface traction of wind on wavy surfaces.

(1479) ENERGY DISSIPATION IN STANDING WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental and theoretical; basic research.
(e) To determine significance of viscous boundary layer effects in wave phenomena.
(h) "Energy Dissipation in Standing Waves in Rectangular Basins", by G. H. Keulegan (in preparation).

(1482) INITIAL VELOCITY DISTRIBUTIONS IN SALT WATER WEDGE.

(b) Laboratory project.
(d) Experimental; basic research.

(e) To determine velocities and particle trajectories during initial motion when a gate separating two bodies of liquids of different densities is suddenly opened.
(h) Report in preparation.

(1742) MECHANISM OF TURBULENCE.

(b) Office of Scientific Research, Air Research and Development Command.
(d) Experimental.
(e) To study with the aid of dye-tracer techniques the manner in which turbulence originates and sustains itself in shear flow.
(f) Completed.
(h) Report in preparation.

(1989) STABILITY OF THE INTERFACE BETWEEN TWO PARALLEL STREAMS OF IMMISCIBLE FLUID OF DIFFERENT DENSITIES.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical.
(e) To determine the stability criterion of the free laminar boundary layer between two parallel streams of different densities.
(h) "Interfacial Waves in Viscoelastic Media", by C. M. Tchen, Jour. Applied Physics, Vol. 27, pp. 431-434, May 1956.
"Stability of Oscillations of Superposed Fluids", by C. M. Tchen, Jour. Applied Physics, Vol. 27, pp. 760-767, July 1956.
"Approximate Theory on the Stability of Interfacial Waves Between Two Streams", by C. M. Tchen, Jour. Applied Physics, Vol. 27, pp. 1533-1536, Dec. 1956.

(1990) INTERNAL PROGRESSIVE WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental.
(e) To determine laws of propagation and dissipation of internal progressive waves.

(2205) WAVE FORCES ON IMMERSED OBJECTS.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental.
(e) Forces on submerged cylinders subjected to waves of various characteristics will be determined.
(h) "Forces on Cylinders and Plates in an Oscillating Fluid", by G. H. Keulegan and L.H. Carpenter, NBS Report No. 4821, Sept. 1956.

(2435) HYDRAULICS OF PIPE CULVERTS.

(b) Bureau of Public Roads.
(d) Experimental; applied research.
(e) To determine hydraulic characteristics of various types of culvert entrances with regard to slope, length and roughness of culvert barrel.

(2436) FLOW OVER HYDROPHOBIC MATERIALS.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; applied research.
(e) To determine coefficient of Teflon disks and plates oscillated in various fluids.
(h) "Resistance of Flow in Teflon and Brass Tubes", by Marion R. Brockman, NBS Report No. 4673, May 1956.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU.

Inquiries concerning Projects Nos. 1010, 1011, 1012, 1015, 1744, 1745, 1750, 1751, 2206, 2207, 2208, 2437, and 2443, should be addressed to Mr. William E. Hiatt, Chief, Hydrologic Services Division, U. S. Weather Bureau, Washington 25, D. C.

(1010) ELECTRONIC FLOOD ROUTING ANALOGUE.

(b) Laboratory project.
(d) Field investigation; operation and applied research.
(e) A basic circuit for an electronic analogue computer to solve flood wave problems by the Muskingum method has been developed and its application to the solution of local streamflow problems is being studied at the following River Forecast Centers: Cincinnati, Ohio; Knoxville, Tenn.; St. Louis, Mo.; Kansas City, Mo.; Tulsa, Okla.; Portland, Oregon; Harrisburg and Pittsburgh, Pa.; Hartford, Conn.; and Augusta, Ga. A circuit for more complex routing, developed at Stanford University, has been added to the analogue at Washington, D. C.

(1011) SHORT RANGE SNOWMELT FORECASTING.

(b) Laboratory project.
(d) Field investigation; operation and applied research.
(e) To develop relations between streamflow resulting from melting snow and appropriate meteorological parameters using a statistical approach.
(g) A reasonably adequate procedure has been established and is being refined and tested.

(1012) AUTOMATIC RADIO REPORTING RAIN GAGE.

(b) Laboratory project.
(d) Experimental; development.
(e) A simple telemetering device has been constructed for use with a standard recording rain gage. Limited field tests indicate satisfactory performance. Other telemetering units are also being tested.

(1015) MEASUREMENT OF EVAPORATION.

(b) Laboratory project.
(d) Theoretical and field investigation; applied research.
(e) Studies are directed toward the derivations of reliable procedures for estimating evaporation from reservoirs (existing and proposed) and land surfaces, utilizing readily available meteorological data and pan evaporation observations.
(g) Water-loss project at Lake Mead applying methods and techniques developed at Lake Hefner has been completed and final report has been prepared for publication. This project, like the Lake Hefner; study was a cooperative investigation involving Bureau of Reclamation, Navy, Geological Survey and Weather Bureau.
Another such study was made at Felt Lake, on contract with Stanford University, and the observational program has been completed. These data are now being analyzed. Evaporation-pan studies are being made at Silver Hill, Md. The effect of mono-molecular films, such as cetyl alcohol, on pan evaporation is also being tested.
A study of evapo-transpiration has been initiated. The purpose is to develop an accounting method for estimating soil moisture deficiency. It is hoped that the soil moisture deficiency will provide an improved antecedent index which will result in more accurate river forecasts.

(1744) DEVELOPMENT OF RIVER FORECASTING METHODS.

(b) River Forecasting Centers for Ohio River Basin, Cincinnati, Ohio; Susquehanna and Delaware River Basins, Harrisburg, Pa.; Lower Missouri River Basin, Kansas City, Mo.; Tennessee River Basin, Knoxville, Tenn.; Columbia River Basin, Portland, Oregon; Middle and Upper Mississippi River Basins. St. Louis, Mo.; Arkansas River Basin, Tulsa, Okla.; New England and Hudson River Basins, Hartford, Conn.; and South Atlantic and East Gulf Basins, Augusta, Ga.

(d) Theoretical and field investigation; operation and applied research.
(e) The purpose of these investigations is to develop modern river forecast procedures for all ranges of flow for various streams of each basin. Procedures include (a) rainfall-runoff relations involving consideration of the physics of soil moisture, vegetative reception, transpiration, evaporation and geological features of the basins; (b) snowmelt forecasting relation involving consideration of the physics of snow and heat transfer; (c) unit hydrographs; (d) streamflow routing procedures; based upon adaptations of basic hydraulic principles.
(g) Forecasting procedures have been developed for key points; refinement of these procedures and development for other basins are underway.
(h) "River and Water-Supply Forecasting", by Max A. Kohler, Trans. N. Y. Academy of Sciences, Ser. II, Vol. 18, No. 8, June 1956.

(1745) WATER SUPPLY FORECASTS FOR WESTERN UNITED STATES.

(b) Work being conducted in following field offices: River Forecast Center, Portland, Oreg.; Water Supply Forecast Unit, Salt Lake City, Utah; River Forecast Center, Kansas City, Mo.; Weather Bureau Office, Sacramento, Calif.
(d) Theoretical and field investigation; operation and applied research.
(e) The purpose of these investigations is the development of precipitation-runoff relations for water supply forecasting utilizing statistical methods to correlate precipitation during the winter with runoff during the melting season.
(g) Water Supply Forecasts are prepared for over 300 points in the Western United States. These forecasts of water year and residual flow are released in Monthly Water Supply Forecast Bulletins January through May. This research program is of a continuing nature designed to improve and extend the present forecasting service.
(h) "River and Water-Supply Forecasting", by Max A. Kohler, Trans. N. Y. Academy of Sciences, Ser. II, Vol. 18, No. 8, June 1956.

(1750) CRITICAL METEOROLOGICAL ANALYSIS OF MAJOR STORMS.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical; basic research.
(e) Detailed hour-by-hour analysis of all meteorological data available during selected major winter rainstorms.

(1751) MAXIMUM STATION PRECIPITATION.

(b) Corps of Engineers, Department of the Army.
(d) Analysis of data.
(e) Tabulations of maximum recorded 1-, 2-, 3-, 6-, 12-, and 24-hour precipitation, for automatic recording rain gage stations, by states.
(h) Weather Bureau Technical Paper No. 15, Part XVI: Pennsylvania, Part XVII: Mississippi, Part XVIII; West Virginia, Part XIX: Tennessee, Part XX: Indiana.

(1994) SHORT PERIOD FLUCTUATIONS IN GREAT LAKE WATER LEVELS.

(b) Laboratory project.
(c) Mr. D. Lee Harris, Scientific Services Division, U. S. Weather Bureau, Washington 25, D.C.
(d) Theoretical and field investigation; basic and applied research.
(e) The continuous records of lake level gages belonging to the U. S. Lake Survey and several other organizations for the year 1950 and selected periods of other years are being examined to learn the properties of the seiche-like phenomena observed on the Great Lakes. A theoretical model which appears to explain the observations has been derived. This work is undertaken to investigate the possibility of forecasting the floods which are due to the oscillations of the lakes.
(g) Evidence has been found which indicates that moving atmospheric disturbances may generate water level disturbances much larger than those which can be accounted for by any type of equilibrium theory.

(h) "The Effect of a Moving Pressure Disturbance on the Water Level in a Lake", by D. Lee Harris has been accepted for publication in the Meteorological Monograph Series of the American Meteorological Society.

(2206) HYDROMETEOROLOGICAL ASPECTS OF MISSISSIPPI LEVEE DESIGN.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical; design.
(e) An investigation of the meteorological storm potential associated with past floods and the likelihood of various meteorological combinations of possible future flood-producing storms.
(f) Completed.
(h) "Meteorology of Flood-Producing Storms in the Mississippi River Basin", Hydrometeorological Report No. 34, Government Printing Office, 1956.

(2207) SEASONAL VARIATION OF THE PROBABLE MAXIMUM STORM.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical; design.
(e) An attempt to break down the probable maximum precipitation developed in Hydrometeorological Report No. 23 to seasonal values.
(f) Completed.
(h) "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours", Hydrometeorological Report No. 33, Government Printing Office, 1956.

(2208) EXTENSION OF FLOOD FREQUENCY RECORDS.

(b) Bureau of Public Roads, Department of Commerce.
(d) Theoretical and field investigation; applied research and design.
(e) Extension of the record of peak annual discharge values through use of precipitation data and river forecasting procedures, in order to increase the reliability of frequency analyses of relatively short discharge records.
(f) Suspended.
(g) Pilot project showed differences between frequency curves based on observed and estimated flood peaks to be small and far less than between frequency curves developed from segments of observed records. Application was later made to over 30 basins in Appalachian-Piedmont area for establishment of regional relations.
(h) Final report made to Bureau of Public Roads.

(2437) UNITED STATES STORM CHARACTERISTICS PROJECT.

(b) Soil Conservation Service, Department of Agriculture.
(d) Theoretical and field investigation; applied research and design.
(e) Studies to provide rainfall data for design criteria in estimating required capacities of hydraulic structures. Work includes (1) construction of rainfall intensity-duration-frequency curves for 200 first-order Weather Bureau stations for durations of 5 minutes to 24 hours and return periods of 2 to 100 years; (2) extension of Weather Bureau Technical Paper No. 24 (1749 in 1955 edition) to 24 hours and to return periods of 100 years; (3) development of a generalized relationship between depth, area, duration and frequency for areas up to 400 square miles, durations of 20 minutes to 24 hours, and return periods of 2 to 100 years.
(f) Item (1) completed and item (2) in press.
(h) "Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico", U. S. Weather Bureau Tech. Paper No. 25, Wash., D. C., Dec. 1955.
"Rainfall Intensities for Local Drainage Design in the Western United States", U. S. Weather Bureau Tech. Paper No. 28.

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(2438) STORM TIDE PREDICTIONS.

(b) Laboratory projects.
(c) Mr. D. Lee Harris, Scientific Services Division, U. S. Weather Bureau, Washington 25, D.C.
(d) Theoretical and field investigation; basic and applied research.
(e) Departure from predicted tides as shown by the records of the Coast and Geodetic Survey and other organizations are being studied to learn the extent of the meteorological effect on the tides. The goal of this work is the prediction of the coastal inundations produced by hurricanes and other storms. Empirical methods of forecasting these inundations, derived within the past few months, are currently being employed by many Weather Bureau stations. Continued improvement in these forecasts is expected to result from this research.
(h) "Some Problems Involved in the Study of Storm Surges", D. Lee Harris, being published as National Hurricane Research Project Report No. 4, Weather Bureau, Washington 25, D.C.

(2443) RADAR-RAINFALL PROJECT.

(b) Laboratory project in cooperation with University of Miami, Coral Gables, Fla., and Texas A and M College, College Station, Texas.
(d) Experimental; operation.
(e) Integration of the instantaneous PPI scope image over time by photographic process, to provide a pattern of accumulated rainfall over area that can be calibrated by key rainfall observations for the period of integration. To be used in flood forecasting with other radar intelligence.
(h) "Investigation of Rainfall Measurement by Radar", by H. W. Hiser and L. F. Conover, Marine Laboratory and Radar Research Laboratory, University of Miami.
"Radar in Flood Hydrology", by William E. Hiatt, Symposia Darcy, Vol. III, International Association for Scientific Hydrology, 1956.

U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY.

(194) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

Cooperative with Corps of Engineers, St. Paul District, St. Paul, Minnesota. See Project 194, page 137.

(690) DISCHARGE THROUGH MULTIPLE OPENINGS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.
(d) Experimental; applied research.
(e) Laboratory studies to define the distribution of flow through multiple bridge openings with any given natural distribution and varied number, size, and location of openings.
(f) Laboratory tests and analyses are continuing.

(1221) STEADY STATE ELECTRIC FLOW NET MODELS.

(b) Laboratory project.
(c) Mr. R. R. Bennett, U. S. Geological Survey, Washington 25, D. C.
(d) Applied research.
(e) Preparation of electric flow net models using graphite paper, conductive paints, etc. Includes design and construction of a variable resistor grid analogous plotter. Objective is to catalog flow nets for various boundary conditions identical or similar to those occurring in nature.

(1755) CHARACTERISTICS OF SAND CHANNEL STREAMS.

(b) Laboratory project.
(c) Mr. Tate Dalrymple, U. S. Geological Survey, Washington 25, D. C.

(d) Field investigation; applied research.
(e) The research is conducted at a 1,900 foot reach. The following factors are being investigated; variation of value of "n" with stage; extent of scour and fill; reliability with which scoured depths can be determined by subsequent prodding; and quantity of suspended sediment in transport.

(1759) INFILTRATION STUDIES.

(b) Laboratory project.
(c) Mr. Irwin Remson, Seabrook, N. J.
(d) Field investigation; applied research.
(e) Study of the movement of percolating waters between the land surface and the water table, and water-budget studies in connection with the waste disposal project at Seabrook Farms.
(h) Provisional reports on file.

(1764) COMBINED PHYSIOGRAPHIC AND HYDRAULIC STUDIES.

(b) Laboratory project.
(c) Mr. Luna B. Leopold, U. S. Geological Survey, Washington 25, D. C.
(d) Field and office research.
(e) Hydraulic and physiographic factors controlling slope and pattern of natural river channels.
(h) "River Channel Patterns; Braided, Meandering and Straight", L. B. Leopold, and M. G. Wolman, Geological Survey Professional Paper 282-B, in press.
"River Floodplains; Some Observations on Their Formation", M. G. Wolman and L. B. Leopold, Geological Survey Professional Paper 282-C, in press.

(1765) SONAR INVESTIGATIONS (EQUIPMENT DEVELOPMENT).

(b) Laboratory project.
(c) Dr. A. N. Sayre, U. S. Geological Survey, Washington 25, D. C.
(d) Development; theoretical laboratory.
(e) To adopt the sonar principle of the fathometer as method of delineating under-water sediments of moderate thickness (several hundred feet) and depth to underlying bedrock. Development work is presently in progress to modify and simplify the procedures of interpretation and use of the sonar technique for geophysical investigations on land.

(1995) COMPARATIVE STUDY OF SOIL MOISTURE EQUIPMENT.

(b) Laboratory project.
(c) Mr. Irwin Remson, U. S. Geological Survey, Trenton, N. J.
(d) Field investigation; applied research.
(e) A comparative study of all commercially available instruments for measuring soil moisture, possible design of new instruments.

(1998) DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES FOR SUBSURFACE EXPLORATION OF GROUND WATER.

(b) Cooperative with the State of Arizona.
(c) Mr. H. E. Skibitzke, U. S. Geological Survey, Tucson, Arizona.
(d) Applied research.
(e) To adapt instruments and techniques for solving problems of the occurrence of water in alluvial fill; including electrical resistivity methods, electric logging, and deep well current meters.

(2000) GHYBEN-HERZBERG LENS.

(b) Laboratory project.
(c) Mr. Dan A. Davis, U. S. Geological Survey, Honolulu, T. H.
(d) Field investigation.
(e) Study of ground-water body in marine islands, to determine the relationship of fresh water storage to the geology of the island, rainfall, head, tidal fluctuations, leakage, and draft.

(2210) THERMAL STRUCTURE OF COOLING POND.

(b) Cooperative with Texas Board of Water Engineers.
(c) Mr. Trigg Twichell, U. S. Geological Survey, Austin, Texas.
(d) Field investigation at Lake Colorado City, Texas.
(e) Observations of effect of advected heat upon thermal structure, evaporation, and radiation from cooling pond at power plant.
(f) Field work complete.
(h) Report in preparation.

(2444) REDESIGN OF PRICE CURRENT METER (INSTRUMENT DEVELOPMENT).

(b) Laboratory project.
(c) Mr. A. H. Frazier, Equipment Development Laboratory, U. S. Geological Survey, 1509 Hess Street, Columbus 12, Ohio.
(d) Development.
(e) To design a rotor for Price current meter that can be mass-produced with identical rating calibration and be affected little or not at all by vertical components of the velocity.
(g) Models being tested.

(2445) COLLECTION AND ANALYSIS OF WATER SAMPLES FOR RADIOACTIVE SUBSTANCES.

(b) Field and laboratory project.
(c) Quality of Water Branch, Water Resources Division, U. S. Geological Survey, Wash. 25, D.C.
(d) Research and field investigations.
(e) Study of methods of collection, treatment and testing of water samples for investigations of occurrence and movement of radioactive substances in surface and ground waters.
(h) "Determination of Low Levels of Uranium in Natural Waters", by L. L. Thatcher and F. B. Barker.
"The Detection and Estimation of Radium in Waters", by F. B. Barker and L. L. Thatcher. Presented before American Chemical Society meeting at Atlantic City, N. J., Sept. 1956.

(2446) METHODS OF DETERMINATION OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER.

(b) Laboratory project.
(c) Quality of Water Branch, Water Resources Division, U. S. Geological Survey, Wash. 25, D.C.
(d) Research.
(e) Continuing study and development of methods for analysis of water.
(h) "Rapid Spectrophotometric Determination of Low Fluoride Concentrations in Water", by L. L. Thatcher. Presented before American Chemical Society meeting at Atlantic City, N.J. Sept. 1956.

(2447) RECORDING CONDUCTIVITY OF WATER.

(b) Laboratory project.
(c) Mr. J. D. Hem, U. S. Geological Survey, Denver, Colorado.
(d) Laboratory and field study; applied research.
(e) Study of performance and utilization of a meter for determining and recording conductivity of water in a stream under field conditions.

(2448) RELATIONSHIPS OF SEDIMENT DISCHARGE TO STREAMFLOW.

(b) Laboratory project.
(c) Mr. R. B. Vice, U. S. Geological Survey, Washington 25, D. C.
(d) Analytical; applied research.
(e) To identify and describe factors that cause areal and time variations in sediment discharge and to improve procedures for computing sediment loads from measured rates of sediment discharge.
(f) Project inactive.

(g) The study demonstrates that curves relating water discharge and sediment discharge can be used for some stations, when shifted to periodic measured sediment discharges, to compute sediment discharges for annual and monthly periods with an accuracy suitable for many uses and that considerable correlation is present in the relationship of unmeasured sediment discharge and mean velocity.
(h) "Relationship of Sediment Discharge to Streamflow", B. R. Colby, Geological Survey Water-Supply Paper in process of publication.
"Relationship of Unmeasured Sediment Discharge (Difference Between Total and Measured Sediment Discharge) to Mean Velocity", by B. R. Colby, submitted for publication in Transactions, American Geophysical Union.

(2687) AQUIFER ANALYTICAL METHODS.

(c) Mr. R. H. Brown, U. S. Geological Survey, Washington, D. C.
(d) Analytical; applied research.
(e) To develop more versatile and comprehensive methods of determining and evaluating aquifer and ground-water reservoir hydrologic characteristics.

(2688) MECHANICS OF AQUIFERS.

(c) Mr. J. F. Poland, U. S. Geological Survey, Sacramento, California.
(d) Field investigation; basic and applied research.
(e) To determine the principles and factors involved in the strain, deformation, and compaction of water-bearing rocks resulting chiefly from changes in hydrologic environment.

(2689) DIFFUSIONAL PROCESSES AND HYDRODYNAMICS OF SALT-FRESH WATER INTERFACE IN AQUIFERS.

(c) Mr. H. H. Cooper, U. S. Geological Survey, Tallahassee, Florida.
(d) Field and laboratory investigation; basic and applied research.
(e) To determine the factors affecting the distribution of saltwater in coastal aquifers subject to saltwater encroachment.

(2690) MICROSCOPIC FLOW THROUGH POROUS MEDIA.

(c) Mr. E. S. Simpson, U. S. Geological Survey, Mineola, L. I., N. Y.
(d) Laboratory investigation; basic research.
(e) To determine the factors affecting the pattern of microscopic flow of water and other liquids through porous media.

(2691) ARTIFICIAL RECHARGE THROUGH WELLS.

(b) Cooperative with Arkansas Agricultural Experiment Station and Corps of Engineers, U. S. Army.
(c) Mr. P. E. Dennis, U. S. Geological Survey, Little Rock, Arkansas.
(d) Field investigation; applied research.
(e) Study of the physical and chemical factors affecting the introduction of water in aquifers through recharge wells.

(2692) ANALOGUE COMPUTER FOR ANALYSIS OF GROUND-WATER FLOW SYSTEMS.

(c) Mr. H. E. Skibitzke, U. S. Gelogical Survey, Tucson, Arizona.
(d) Theoretical study and instrument development.
(e) Development of the physical and mathematical theory of ground-water flow systems and construction of an analogue computer for analyzing ground-water flow systems under transient conditions.

(2693) FLOW THROUGH CULVERTS.

(b) Laboratory project.
(c) Mr. R. W. Carter, U. S. Geological Survey, Washington, D. C.
(d) Applied research.

(e) Laboratory study to define methods and coefficients for computing peak discharge through culverts on basis of highwater marks and culvert geometry.
(f) Completed.
(g) "Computation of Peak Discharge at Culverts", by R. W. Carter, U. S. Geological Survey Circular 376.

(2694) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, Georgia Institute of Technology, Atlanta, Georgia.
(d) Library search, re-analysis and correlation of published data, plus some original research.
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Objectives include the publication, in generalized form, of available experimental data.
(h) "Discharge Characteristics of Broad-Crested Weirs", by H. J. Tracy, U. S. Geological Survey Circular.

(2695) CONTINUOUS DISCHARGE RECORDS IN TIDAL STREAMS.

(b) Laboratory project.
(c) Prof. H. R. Henry, Michigan State University, Lansing, Mich.
(d) Theoretical and applied research.
(e) The objective of this study is to develop methods of obtaining continuous discharge records in tidal streams. Equations developed from theoretical considerations will be checked by field observations.

(2696) VELOCITY DISTRIBUTION IN NATURAL STREAM CHANNELS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.
(d) Analytical.
(e) Velocity distributions in natural stream channels that represent a wide range in boundary geometry are being studied.

(2697) PRESSURE-ACTUATED RIVER GAGE.

(b) Laboratory project.
(c) Mr. E. G. Barron, U. S. Geological Survey, Columbus, Ohio.
(d) Instrumentation development.
(e) To develop a more economical system of recording river levels.
(g) A gas-purging system that works in combination with a mercury manometer follower has been developed. The instrument has extreme sensitivity through a great range of river levels and activates the recording mechanism of commercially available water-stage recorders. Twenty-seven instruments are currently being installed for field testing.

(2698) EVALUATION OF EFFECT OF CHANNEL STORAGE ON PEAK DISCHARGE.

(b) Laboratory project.
(c) Mr. W. D. Mitchell, U. S. Geological Survey, Champaign, Ill.
(d) Analytical and experimental.
(e) The objective of the project is to develop parameters that describe channel storage effectively in an areal correlation of peak flow.

(2699) UNIFORM FLOW IN OPEN CHANNELS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.
(d) Theoretical and experimental; basic research.
(e) A comprehensive laboratory study of uniform flow in open channels.

(2700) PARAMETERS CONTROLLING THE SHAPE AND PATTERN OF NATURAL STREAM CHANNELS.

(b) Laboratory project.
(c) Mr. M. G. Wolman, U. S. Geological Survey, Washington 25, D. C.
(d) Basic research.
(e) The effect of discharge, load, grain size, and slope will be studied in a small channel free to adjust both bed and side walls.

(2701) SEDIMENT TRANSPORT INVESTIGATIONS.

(b) Field project (cooperative with Bureau of Reclamation).
(c) Mr. P. C. Benedict, Geological Survey, Lincoln, Nebraska.
(d) Field observations and theoretical analysis.
(e) Field and theoretical investigations of the methods, equipment, and computations used for determining sediment movement and the theory of sediment transport. Specifically included are studies on sampling techniques; the effect of water temperature on sediment transport; the relationship of roughness to sediment discharge, slope, and width-to-depth ratio; the effect of Kolk action on the vertical distribution of velocity and sediment; the revaluation of Von Karmen's Universal Constant of momentum exchange for sediment-laden flow; the influence of suspended sediment on vertical distribution of velocity; the influence of ice cover on sediment transport; the influence of cobble-bed streams on total sediment transport; and other related sediment transport problems.
(g) Evaluation of the equal-transit-rate (ETR) method of measuring suspended-sediment discharge indicates the method is satisfactory when properly used. Tests of a new (petrolatum-type) surface bed-material sampler give results that compare favorably with the core-type of sampler. The modified Einstein procedure is adequate for computing total load when water temperature is near freezing. In general low values of roughness are associated with low temperatures and high sediment loads on Middle Loup River at Dunning, Nebraska.
(h) Report in preparation.

(2702) ROUGHNESS AND WATER-SEDIMENT MOVEMENT IN ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Dr. D. B. Simons, Geological Survey, Colorado A and M College, Fort Collins, Colo.
(d) Basic and applied research.
(e) Attention is currently directed to the determination and correlation of factors which influence water-sediment movement and roughness in alluvial channels under selected laboratory conditions. Subsequent studies will be conducted for the purpose of defining (1) variation in roughness properties with the range in standard deviation and skewness exhibited by bed material in natural streams; (2) influence of fine suspended sediments on roughness and sediment transport; (3) relation of these findings to channel geometry; and (4) adaptation of findings to conditions in natural streams.

(2703) EVAPORATION SUPRESSION.

(b) Work coordinated with, and executed in conjunction with, that of the Southwest Research Institute and the U. S. Public Health Service.
(c) Mr. G. E. Harbeck, U. S. Geological Survey, Denver, Colorado.
(d) Basic and applied research.
(e) Evaporation from test reservoirs, both with and without monomolecular surface films, is being measured. Laboratory tests will be made to determine the effects of monomolecular films on emissivity and reflectivity and on the vertical humidity profile.

U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION.

Inquiries concerning Projects Nos. 1495, 1498, 1499, 1502, 1775, 1777, 2003, 2005, 2010, 2015, 2213, 2214, 2217, 2224, 2225, 2449 to 2452, incl., 2454 to 2461, incl., and 2704 to 2726, incl., should be addressed to the Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colo.

(1495) YELLOWTAIL DAM SPILLWAY AND OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Yellowtail Dam Spillway and Outlet Works", Report Hyd-414, by G. L. Beichley, is in preparation but temporarily suspended.

(1498) WEIR STANDS--IRRIGATION WATER DISTRIBUTION SYSTEM.

(f) Completed.
(h) Report in preparation.

(1499) CANAL TURNOUT--METER LOCATION.

(f) Completed.
(h) Report in preparation.

(1502) STABLE CHANNEL STUDIES--TRACTIVE FORCES REQUIRED TO MOVE NONCOHESIVE MATERIALS.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests are conducted in a trapezoidal channel to determine tractive forces required to scour observed sizes of materials in a pit-run gravel mixture. Information obtained will be used in design of canals in noncohesive materials and in choosing gravel for protective canal cover.
(h) Progress report for straight section in preparation.

(1775) HIGH HEAD TURNOUT WITH REGULATING VALVE AND IMPELLER-TYPE METER.

(f) Completed.
(h) Report prepared for internal use only.

(1777) SIPHON SPILLWAY STUDIES.

(b) Laboratory project.
(d) Combined field investigation and applied research; for design.
(e) Purpose is to determine the operating characteristics of siphon spillways, as currently designed, with a view to lessening the priming time and lowering the head necessary to prime. Also, attempts will be made to design a partialization device to regulate the degree of prime through the automatic control of air intake, thereby enabling the siphon to operate more or less continually at reduced flow rather than intermittently at full capacity.
(f) Model of new design completed but not tested; work suspended.
(g) The shortcomings of present design practice have been defined, and the changes indicated have been incorporated in a new model.
(h) Report to be prepared.

(2003) RESEARCH STUDY ON STILLING BASINS, ENERGY DISSIPATORS, AND ASSOCIATED APPURTENANCES.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Extensive tests were made to generalize the design of slotted and solid submerged buckets for high, medium, and low dam spillways. Data were obtained from buckets of 6-, 9-, 12- and 18-inch radius and discharges up to 6 cfs per foot of width. Bucket capacities and tail water ranges were determined.
(f) Completed.
(g) From the data analysis general design rules are developed and hydraulic design procedures are presented for the design of submerged buckets for spillways of almost any size. Charts and drawings are used to simplify the necessary calculations.
(h) "Progress Report III, Section 7, Slotted and Solid Buckets for High, Medium, and Low Dam Spillways", Report Hyd-415, by G. L. Beichley and A. J. Peterka. This is an extension of the studies previously reported in Progress Report II, having the same general title as Project No. 2003.

(2005) CAVITATION EROSION ON ROUGHNENED SURFACES.

(f) Continuing study.
(h) "Caviation Erosion of Roughened Concrete Surfaces", PAP-88, by D. Colgate.

(2010) BOULDER CREEK SUPPLY CANAL.

(f) Completed.
(h) "Hydraulic Model Studies of Boulder Creek Supply Canal Drainage Inlets and Overflow Weir Sections--Colorado-Big Thompson Project, Colorado", Report Hyd-407, by Glenn L. Beichley.

(2015) DEVELOPMENT OF A LOW VELOCITY CURRENT METER.

(f) Completed.
(h) Report to be prepared.

(2213) SEEPAGE LOSS STUDIES--GENERAL.

(f) Completed.
(h) Report to be issued by Colorado A and M College (Project 820).

(2214) LOWER-COST CANAL LINING STUDIES--USING BENTONITIC CLAYS TO CONTROL SEEPAGE.

(f) Completed.
(h) "The Use of Dispersed Bentonite to Reduce Seepage", Report Hyd-417, by T. J. Rhone.

(2217) PALO VERDE DIVERSION DAM.

(f) Completed.
(h) "Hydraulic Model Studies of Palo Verde Diversion Dam", Report Hyd-408, by G. L. Beichley.

(2224) SHERBURNE LAKES OUTLET WORKS.

(f) Suspended.
(h) Report to be prepared.

(2225) ALAMOGORDO DAM--SPILLWAY.

(f) Completed.
(h) "Hydraulic Model Studies--Service Spillway--Alamogordo Dam Enlargement", Report Hyd-416, by D. Colgate.

(2449) TIBER DAM RIVER OUTLET WORKS.

(f) Completed.
(h) "River Outlet Works Stilling Basin--Tiber Dam--Missouri River Basin Project", Report Hyd-402, by D. Colgate.

(2450) CASITAS DAM SPILLWAY AND OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of the Spillway and Outlet Works for Casitas Dam--Ventura River Project, California--December 13, 1955", Report Hyd-404, by W. P. Simmons, Jr.

(2451) WU SHEH DAM TUNNEL SPILLWAY.

(f) Completed.
(h) Report in preparation.

(2452) GLENDO DAM OUTLET WORKS.

(f) Completed.

(h) "Hydraulic Model Studies of the Glendo Dam Outlet Works--Glendo Unit--Missouri River Basin Project, Wyoming--June 20, 1956", Report Hyd-413, by W. E. Wagner.

(2454) GATE SLOT STUDIES.

(b) Laboratory project.
(d) Experimental; applied research.
(f) Completed.
(g) The effect of upstream deflectors, downstream offsets, and guide tracks within the slot, at slot width-to-depth ratios of 0.5 to 2.0 have been investigated using an air model.
(h) Results will be included in a general report on gate slots.

(2455) CASA COLORADA CHANNEL ALIGNMENT--MIDDLE RIO GRANDE.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests are continuing on a 1:140 horizontal and 1:22 vertical scale model to aid in channelization and levee protection by steel jetties. A 1:16 sectional model is being used to study small areas of the jetty field. Plastics with a specific gravity of 1.06 are being used as suspended sediment in the distorted model.
(g) The energy loss in typical jetty layouts has been investigated for a limited number of depths and velocities.
(h) "Use of Steel Jetties for Bank Protection and Channelization in Rivers", by Enos J. Carlson and Phillip F. Enger, presented Hydraulics Division Meeting, ASCE, Madison, Wis., Aug. 1956. Progress report in preparation.

(2456) USE OF FLOCCULATING AGENTS TO INCREASE SETTLING RATE OF SEDIMENTS.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests are being performed to determine the effectiveness of a small quantity of a flocculating agent to flocculate sediment in settling basins and thus permit more efficient removal of the sediment from the water.
(g) Tests performed on a small scale indicate that a flocculant is very effective in increasing both the rate and quantity of sediment removal.
(h) "Progress Report I--Preliminary Investigations in Hydraulic Laboratory of Flocculating Agent No. 1--December 1, 1955", Report Hyd-405, by T. J. Rhone.
"Progress Report No. 2--Preliminary Investigations of Flocculating Agents in Hydraulic Laboratory", Report Hyd-420, by T. J. Rhone.

(2457) EROSION AND TRACTIVE FORCE STUDY OF UNLINED AND EARTH-LINED CANALS.

(b) Laboratory and field project.
(d) Experimental; for design.
(e) Soil samples and hydraulic measurements to determine tractive force distribution are being taken on stable canals and on canals where deposition and scouring are occurring. Different soil types are being investigated and main stress will be on cohesive soils. Correlation of hydraulic and soils data will improve data for design.
(f) Hydraulic measurements were taken on 17 field sites during the Summer of 1956. Additional sites are being selected and soils samples taken.
(h) Progress report in preparation.

(2458) HEATED PRECIPITATION STORAGE GAGE.

(f) Completed.
(h) Report to be prepared.

(2459) FISH COLLECTING FACILITIES--INTAKE TO TRACY PUMPING PLANT.

(f) Completed.
(h) "Hydraulic Studies of Fish Collecting Facilities--Delta-Mendota Intake Canal--Central Valley Project, California", Report Hyd-410, by W. B. McBirney.

(2460) FISH COLLECTING FACILITIES--VELOCITY CONTROL DEVICE--INTAKE TO TRACY PUMPING PLANT.

(f) Completed.
(h) Results included in report on Project No. 2459.

(2461) TULE RIVER PARSHALL FLUME.

(f) Completed.
(h) "Hydraulic Model Studies of Tule River Parshall Flume--Friant-Kern Canal--Central Valley Project", Report Hyd-406, by W. E. Wagner.

(2704) DETERMINATION OF RIPRAP SIZES.

(b) Laboratory project.
(d) Applied research.
(e) Existing data, experiences, literature, and reports of field performance of laboratory tested structures are analyzed to determine the necessary rock size for a stable rock blanket downstream from stilling basins or other outlets.
(f) Completed.
(g) A curve, bottom velocity versus rock size, is presented which gives the minimum size of individual rock necessary to withstand movement. Field experiences are given to justify use of the curve. It is suggested, however, that additional data are needed and that the curve may need some adjustment.
(h) "Stilling Basin Performance Studies--An Aid in Determining Riprap Sizes", Report Hyd-409, by A. J. Peterka.

(2705) TRINITY DAM MORNING-GLORY SPILLWAY.

(b) Laboratory project.
(d) Experimental; for design.
(e) Trinity Dam utilizes a morning-glory entrance in conjunction with a 45° sloping tunnel. Testing of a 1:30 scale model is concerned with developing crest piers and a combination deflector and air vent to ventilate the tunnel, particularly the upper bend. A 1:60 scale model is being used to study flows entering the river channel from the spillway flip bucket and from the outlet works and powerplant.
(g) No significant results obtained as yet.
(h) Report will be prepared following completion of testing.

(2706) EROSION OF EARTH MATERIAL--FOSS DAM.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests were made on earth samples to determine the erosion characteristics of the firm, lean, layered clay through which the proposed unlined emergency spillway would pass.
(f) Completed.
(g) The material will erode by air slaking, and will erode upon exposure to flowing water by expanding and breaking up into loose flakes, chips, and slabs. Dissolution was slight.
(h) "Erosion Studies on the Earth Material from the Site of the Proposed Unlined Emergency Spillway at Foss Dam--Washita Project, Oklahoma", Report Hyd-426, by W. P. Simmons, Jr.

(2707) HYDRAULIC DOWNPULL STUDIES--PALISADES-TYPE SLIDE GATES AND GLENDO FIXED-WHEEL GATES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Studies were made using air models to determine the hydraulic downpull forces acting on the gate leaves so that appropriate hoists could be designed. The data was to be in general form and applicable to similar structures.
(f) Testing completed.
(g) The maximum downpull on the Palisades-type slide gate with the 45° sloping bottom was 59 percent of the force that would be exerted with atmospheric pressure beneath the leaf and full bonnet pressure on top of the leaf. The maximum downpull of the Glendo gate occurred at an opening between 3 and 4 inches and was 39,600 pounds.
(h) Report in preparation.

(2708) EROSION TESTS ON SANDSTONE--GLEN CANYON DAM.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests were made to determine the resistance of the sandstone material at Glen Canyon Dam site to erosion by flowing water. The information was needed in evaluating whether or not lining would be required in the diversion tunnels that pass through the sandstone abutments.
(f) Completed.
(g) Very little erosion occurred with sediment-free water, even at impact velocities up to 110 feet per second. Considerable erosion occurred with sediment-laden water at an impact angle of 15° with velocities of 20, 30, and 40 feet per second. Various size sediments were used.
(h) "Erosion Studies on Sandstone Through Which the Glen Canyon Diversion Tunnels Will Pass--Glen Canyon Dam--Colorado River Storage Project", Report Hyd-423, by W. P. Simmons, Jr.

(2709) FLOW CHARACTERISTICS IN PIPE WITH SQUARE-CORNERED ENTRANCE.

(b) Laboratory project.
(d) Experimental; for design.
(e) Basic data was obtained on the flow conditions and pressure distribution in a pipeline downstream from a square edged entrance at various submergences, approach wall designs, and Reynolds' number. The information was intended for reference material in calibrating meter gates.
(f) Testing completed.
(g) Submergence had considerable effect on coefficient of discharge for submergences less than 2d, and little effect above 2d. Similarly, the approach shapes affected C_d at submergences below 2d, and had little effect above 2d. Reynolds' number had a minor effect.
(h) Report in preparation.

(2710) TUMUT AND EUCUMBENE TUNNEL CONTROL STRUCTURES.

(b) Snowy Mountains Hydro-Electric Authority, Australia.
(d) Experimental; for design.
(e) Studies were made to determine the suitability of the 7-ft 6-in by 9-ft 0-in Palisades-type slide gate for use in controlling flow releases at differential heads up to 375 feet at free discharge and submerged conditions, and to determine the best conduit shapes downstream of the gate structures.
(f) Testing completed.
(g) The Palisades slide gate design performed satisfactorily in the control structures at all gate openings with free discharge and deeply submerged conditions. However, at gate openings from 0 to 5 percent with small submergences, severe negative pressures occurred on the walls just downstream of the gate slots. Operation at 0 to 5 percent openings with small submergence will be rare, and can be avoided by opening the gate beyond 5 percent. The best conduit shape for the Tumut structure, where discharges take place either freely or submerged, consists of a gradual transition from the rectangular gate to the 11-ft 3-in-diameter tunnel. The best shape for the Eucumbene structure, where discharges always occur submerged, consists of an abrupt expansion from the gate into the 13-ft 0-in-diameter tunnel.
(h) Report in preparation.

(2711) GATE SLOT MODIFICATIONS TO IMPROVE SUBMERGED PERFORMANCE OF SLIDE GATES--TOOMA-TUMUT AND VAQUERO CONTROL STRUCTURES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests were made to determine the effect on flow and pressure conditions caused by moving the Palisades-type gate slots farther upstream on the leaf. The gate slots are narrower than the thickness of the leaf. Other tests were made to determine the effect of tapering the gate slots near the floor.
(f) Testing completed.

(g) Excellent flow and pressure conditions were obtained with the gate slots moved upstream of the point of control on the leaf. Exploitation of this hydraulic improvement is pending during studies of seal problems involved. No improvement in pressure distribution resulted from tapering the slots to small dimensions near the floor.
(h) Report to be prepared.

(2712) VAQUERO DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:24 scale model was used to determine the proper dimensions of the outlet works stilling basin to contain flows up to 14,700 cfs. A 1:24 scale model using water, and a sectional air model were used to design the gate chamber.
(f) Completed.
(h) Report in preparation.

(2713) HIGH HEAD MODEL TESTS ON FLATIRON AND POLE HILL TURBINES, AND ON TWO TURBINE BY-PASS ENERGY ABSORBERS.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests were conducted at a 550-foot head on a 1:4.21 scale model of the Francis-type turbines that will operate at prototype heads of 1,045 and 825 feet. The specific speed of the model was made numerically equal to the prototype, and the tests were made to determine if the turbine would meet the specification efficiencies under the unusually high heads. Tests were also made at the 550-foot head on 1:4.5 scale models of a standard and a proposed design for the by-pass energy absorbers to determine their performance characteristics.
(f) Tests completed.
(h) "High Head Model Tests for the Flatiron and Pole Hill Francis-type Turbines and Two Turbine By-Pass Energy Absorbers", Report Hyd-348, by W. P. Simmons, Jr. and L. V. Wilson.

(2714) ANCHOR DAM SPILLWAY AND OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:15.8 scale model of the tunnel spillway and a portion of the outlet works structure which joins the spillway tunnel in the vertical bend built for the purpose of developing the design of the spillway and outlet works including the 25° horizontal bend and the combination stilling basin and flip bucket at the downstream tunnel portal.
(g) Tests thus far show that topography at the spillway entrance must be revised to provide smooth flow. The junction of the outlet works with the spillway tunnel in the vertical bend performed satisfactorily under all operating conditions. The edges along joint lines in the junction should be rounded to minimize light subatmospheric pressures, however. A guide vane was installed in the crown of the tunnel along the downstream two-thirds of the horizontal bend to prevent the higher discharges from swirling over the top of the tunnel and hampering tunnel ventilation. The combination stilling basin and flip bucket performed well.
(h) A report will be prepared.

(2715) ROBLES DIVERSION DAM.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:12 scale sectional model of the proposed rock crest was constructed and tested to determine whether a crest section constructed of rocks and having a very rough profile would be less efficient in discharging the design flow than a smooth concrete profile.
(f) Completed.
(g) The rough rock profile was found to be practically as efficient as a smooth concrete profile.
(h) "Hydraulic Model Studies of Robles Diversion Dam Spillway", Report Hyd-427, by G. L. Beichley is in preparation.

(2716) FLATIRON AFTER BAY FLUME.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:10.3 scale model was constructed to develop a wave suppressor and a gaging station to improve the accuracy of the measuring flume.
(f) Completed.
(g) An underpass type wave suppressor and a double V-notch submerged weir for gaging the flow was developed in the model and installed in the prototype.
(h) A motion picture entitled "Flatiron After Bay Flume and Gaging Station" shows satisfactory performance of the prototype structures. Both the film and a Memorandum Report are available on loan.

(2717) FLAMING GORGE DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:26 scale model will be built to develop the stilling basin design.

(2718) TRINITY DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:28 scale model is being built to develop the stilling basin design.

(2719) GLEN CANYON DAM SPILLWAY.

(b) Laboratory project.
(d) Experimental; design.
(e) The model is being built to a scale of 1:63.5 and will include the tunnel spillways on both sides of the river, the curved arch dam, the outlet works, the powerhouse and a section of the Colorado River upstream and downstream from the dam. The tunnel spillways are to be modeled in transparent plastic so that flow conditions can be thoroughly investigated. Other features to be studied will be the approach channels to the spillway, the discharge capacity of the spillways, the pressures on the face of the crests, the flip buckets at the downstream portal of the tunnels and the effect in the river when all structures are discharging.

(2720) POTHOLES EAST CANAL--CHECK INTAKE STRUCTURE.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:16 model of the intake structure was used to determine the adequacy of the stilling basin downstream from three radial gates and the effectiveness of a baffled chute which lowers the flow approximately 25 feet from the stilling basin to an intake channel.
(f) Completed.
(g) Satisfactory stilling basin was developed using baffle piers. Baffled chute adequately impeded the flow to prevent excessive scour in the intake channel.
(h) "Hydraulic Model Studies of the Check Intake Structure--Potholes East Canal--Columbia River Project, Washington", Report Hyd-411, by W. E. Wagner.

(2721) VEGA DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) The outlet works was reproduced to a scale of 1:11.25 to develop a stilling basin which would permit the flow to enter a canal with a minimum of waves and surges.
(f) Completed.
(g) Satisfactory stilling basin developed using chute blocks and baffle piers. No wave suppressor deemed necessary.
(h) "Hydraulic Model Studies of Vega Dam Outlet Works--Collbran Project, Colorado", Report Hyd-418, by W. E. Wagner.

(2722) YANHEE DAM SPILLWAY.

(b) Royal Irrigation Department, Kingdom of Thailand (through FOA).
(d) Experimental; for design.
(e) Using a 1:77.37 model, development studies were made of the spillway approach, the flow characteristics in the tunnels, and the effect of the spillway flow on the downstream river channel.
(f) Completed.
(g) The left pier was reshaped to improve the entrance conditions; the tunnel transition was redesigned to reduce flow disturbances in the inclined tunnel; and the lip of the flip bucket was elevated to reduce the drawdown and to provide better flow distribution in the river channel.
(h) Report in preparation.

(2723) HOWARD PRAIRIE DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:11.25 model was used to study the spread of the jet leaving a high pressure slide gate and to develop a satisfactory stilling basin for the outlet works.
(f) Completed.
(g) No adverse pressures were observed downstream from the gate and an adequate basin was developed using chute blocks and baffle piers.
(h) Report in preparation.

(2724) FRICTION FACTOR TESTS IN LARGE PRESSURE CONDUITS.

(b) Laboratory project.
(d) Field investigation; design.
(e) Purpose of the project was to determine friction factors by prototype tests of large concrete pressure conduits up to 20 feet in diameter. This information is needed to correlate friction factor data with smooth interior finishes of concrete conduits that can be consistently produced with present day construction methods. Tests have been completed on an inverted siphon with a diameter of 14.666 feet where the friction-head measuring section was 372 diameters in length. Friction-head values were determined by use of four-tap piezometer installations that isolated siphon entrance and outlet losses from the measuring section. Average velocities of flow were determined by salt-velocity discharge measurements.
(g) The test described above covered a Reynold's number range from 4.7×10^6 to 8.1×10^6 and the friction factor as computed by use of the Darcy-Weisbach formula was 0.011 compared to 0.015 used for design.
(h) Report to be prepared.

(2725) ANGOSTURA DIVERSION WORKS.

(b) Laboratory project.
(d) Experimental; for design and rehabilitation.
(e) A 1:10 scale model of the diversion dam, canal turnout structure, and river sluiceway was constructed to determine a method of reducing the quantity of bedload sediment moving into the canal turnout.
(f) Completed.
(g) Recommended modifications evolved from the model studies included: curved parallel walls were placed to form a 30-foot-wide approach channel from the river to the turnout; an overhanging sill or corbel was installed in front of all 4 bays of the turnout structure; and the right approach wall was extended downstream to bisect the existing river sluiceway and to provide for independent operation of either half of the sluiceway. An optional recommendation was to place a vortex tube in the overhanging sill of the last bay of the turnout structure. The recommended modifications reduced the ratio of the sediment concentration in the turnout to the sediment concentration in the sluiceway from 8:1 to 0.02:1 when the vortex tube was operating and from 8:1 to 0.18:1 without the vortex tube.

(h) "Hydraulic Model Studies on the Sediment Problem--Angostura Diversion Works--Middle Rio Grande Project, New Mexico", Report Hyd-419, by T. J. Rhone.

(2726) VANE SHEAR TESTER FOR FIELD AND LABORATORY USE.

(b) Laboratory project.
(d) Experimental; for instrumentation development.
(e) Development of a portable vane shear tester for use in erosion-tractive force studies.
(f) Completed.
(g) A portable tester was developed which determines the in-place shear strength of surface silts and soft clays. It may be easily used on the bottom and sides of earth-lined canals.
(h) Report in preparation.

U. S. DEPARTMENT OF THE NAVY, DAVID TAYLOR MODEL BASIN.

Inquiries concerning Projects Nos. 467, 470, 709, 710, 711, 1268, 1503, 1505, 1506, 1511, 1512, 1514, 1516, 1517, 1521, 1522, 1778 to 1786, incl., 1788, 1789, 1790, 2018, 2019, 2229 to 2238, incl., and 2727 to 2730 incl., should be addressed to the Commanding Officer and Director, David Taylor Model Basin, Washington 7, D. C.

(467) DEVELOPMENT OF A HOT-WIRE INSTRUMENT FOR TURBULENCE MEASUREMENTS IN WATER.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Flow instrumentation.
(e) Development of the hot-wire technique for measuring turbulent velocity components in water.
(f) Suspended.
(g) During the course of development of such an instrument, exchange of information was frequently made between TMB and the Iowa Inst. of Hydraulic Research. Most of the inherent difficulties associated with the use of hot-wire in water have been eliminated. However, the accumulation of dirt on the wire still prevents obtaining a stable wire calibration. To this end, Iowa has suggested the use of a hot-film plated on the end of a glass wedge. It was desired then to suspend the work at DTMB pending the outcome of the Iowa University efforts. The hot-film instrument has been demonstrated at TMB recently and shows a stable linear calibration. A report on the theoretical study of the time response of a coated wire is in preparation.
(h) "Time Constants and Frequency Response of Coated Hot-wire Used as Turbulence-Sensing Elements", by A. Borden, TMB Report 952, (to be published).
"Summary Report on the Development of a Hot-wire Turbulence-Sensing Element for Use in Water", by R. G. Stevens, A. Borden and P. E. Strausser, TMB Report 953, (to be published).

(470) ELECTROLYTIC TANK STUDIES.

(b) Bureau of Ordnance; David Taylor Model Basin.
(d) Potential flow research.
(e) Investigations using the method of electrical analogy to obtain pressure measurements on and about various bodies in a fluid.
(g) An electrolytic tank has been developed for obtaining the pressure distribution about cylindrical bodies. A single probe method is used to obtain potential differences on the body and a double probe method is used for obtaining the potential differences in the surrounding field.
Refinement of instrumentation and techniques has made possible the determination of pressure coefficients at a body surface with an accuracy of better than 0.4 percent of the stagnation pressure.
A technique for determining the potential distribution over the surface of a submerged body has been developed. A special probe is being designed for this purpose.

(709) THEORY OF WAVE RESISTANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A mathematical study of the theory of wave resistance for the purpose of establishing methods for extending the theory to the analysis of ship resistance. Studies will include the general theory of waves in liquids and will encompass a review of existing theory and comparisons with existing experimental data.
(g) A synopsis has been written on the application of theory to the calculations of wave resistance.
Calculations were made to obtain general information about wave resistance of submerged bodies of revolution. The forms considered are ellipsoids, Rankine ovoids, and a simple family of streamlined bodies. A report of this work is to be published.

(710) RESEARCH ON MAIN INJECTION SCOOPS AND OVERBOARD DISCHARGES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Investigations to determine the characteristics of a broad series of injection scoops and discharges to provide design data for use in design of future high-speed ships.
(g) A study of the effect of changes in scoop geometry on scoop efficiency has been completed by Newport News Shipbuilding and Drydock Company. Full-scale tests of a destroyer condenser scoop have been completed. Analysis of data is in progress.
(h) "Research and Test of Main Injection Scoops and Overboard Discharge", by J. P. Craven and M. S. Macovsky, reanalysis of data of Newport News Shipbuilding and Drydock Company report. TMB Report No. 1098, November 1956.

(711) CAVITATION RESEARCH.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism and effects of cavitation phenomena including the physics and analytical description of steady-state cavities in real and ideal fluids and investigations of the inception of cavitation, the growth and collapse processes of transient cavities, and the effects of cavitation on the forces on underwater bodies.
(g) A study is being made of a linearized theory for cavity flows about hydrofoil sections at non-zero cavitation number. Research is also in progress on unsteady cavity flows about symmetric bodies.

(1268) STUDIES OF THE INTERACTION OF APPENDAGES AND BODIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamics of submerged bodies.
(e) An investigation of potential flow and boundary layer phenomena associated with appendage-body combinations in order to determine the nature of interference effects. The generation of lift and moments by fins in non-uniform flows is being studied. A theoretical and experimental investigation is being made in order to determine the mutual interference effects of appendages and bodies. In addition an experimental investigation is being carried out in order to determine the effects of non-uniform flows on the lift and moments of a low aspect ratio fin.
(f) Suspended.
(g) A theoretical investigation is being made.

(1503) BOUNDARY LAYER TRANSITION STUDY.

(b) Cooperative with Bureau of Ships.
(d) Basic research.
(e) A study of methods for stimulating predictable turbulent boundary layers to improve the reliability of model tests for resistance prediction. Tests are to be made with flat plates, ship models and bodies of revolution and will include investigations of the effects of size arrangement of stimulators and the effect of pressure gradient.

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(g) Theoretical studies have directed attention toward internal roughness stimulators. Design criteria are being developed by means of qualitative boundary layer measurements on flat plates using pin type stimulators.

(1505) EFFECT OF TRANSVERSE CURVATURE ON FRICTIONAL RESISTANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Studies to determine the effect of transverse curvature on the frictional resistance to motion of a body through a liquid. Shear stress measurements and velocity profiles will be obtained at 10-foot intervals along a 150-foot length of towed cylinder. Results will be extended to determine flat plate resistance without surface and edge effects normally present.
(g) A theoretical analysis of the laminar flow case for slender cylinders has been made to determine significant parameters and the expected magnitude of the curvature effect. Equipment for the experimental phase has been completed.

(1506) STIMULATION OF TURBULENCE ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Development of a turbulence stimulating device which will insure adequate turbulence in the boundary layer over the entire length of any ship model. Empirical and theoretical studies will be conducted to evaluate the relative effectiveness of turbulence rods, trip wires, sand roughness, isolated stubs, noise makers and vibrators. Their relative effectiveness will be calculated by studying the model resistance and the character of the boundary layer flow around ship models as determined by the dye-method, the chemical compound, and the hot wire survey method.
(g) The work of the previous year was devoted to the study of the stimulating effect of studs and the development of the technique of the chemical compound. The effect of various stimulators on the BSRA model has been established and the evaluations work will compare the results for each stimulator with the results obtained by the English tanks. The evaluation of the stimulators used is still continuing.

(1511) SERIES 60 SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Experimental and theoretical investigation of the effect of changes in certain features of hull shape on the seaworthiness characteristics of a series of ship models. Three single screw ship forms of 0.60, 0.70 and 0.80 block coefficient have been adopted for this purpose. Tests to determine the motion and speed reduction characteristics of the 0.60 block model were completed.
(g) The phase between pitching and heaving motion affects the seaworthiness characteristics such as wetness, slamming, and speed reduction. Consequently this phase relationship was further studied both experimentally and theoretically.
(h) "Behavior of the Series 60, 0.60" Block Coefficient Model in Waves", by V. G. Szebehely and S. E. Lee, DTMB Report 1035, May 1956.
"Scale Effects in Seaworthiness", by V. G. Szebehely, M.D. Bledsoe and G. P. Stefun, DTMB Report 1070, July 1956.

(1512) EFFECTIVENESS OF BILGE KEELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of the amplitudes of roll versus rolling moment and frequency at or near resonance for a ship model with and without bilge keels; the increase in resistance of a model due to rolling and roll-induced yawing; and the lift, drag, and torque developed by fins. Data will be used in arriving at criteria for the design of fin stabilizers.
(f) Completed.

(g) Roll tests have been made in the basin on a ship model with and without bilge keels. Also, wind tunnel measurements have been made to determine the effect of variation in fin stabilizers on lift, drag, and torque characteristics.

(1514) MANEUVERING CHARACTERISTICS OF SINGLE-SCREW VESSELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of side forces on propeller, rudder, and hull of a single-screw ship model during successive phases of starting, stopping, and backing maneuvers.
(f) Inactive.
(g) A test program has been formulated. A side-force dynamometer has been designed and completed. Testing is expected to begin when priority considerations permit.

(1516) STUDIES OF RESISTANCE PREDICTION METHODS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) The theoretical possibility of separating the viscous and wave drag for surface flows by means of wake surveys has been demonstrated. Experiments are to be performed on ship models to verify the practical possibility of using this method to improve resistance predictions.
(g) Instrumentation for the wake survey, including pitot rakes and traversing mechanisms are completed. The use of pressure transducers rather than manometric systems is being investigated.

(1517) MINIATURE MODEL BASIN.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Facility development.
(e) In order to obtain data on the drag, side force, and vortex configurations of vibrating cylinders a special model basin facility was required. This facility consists of a miniature model basin with small towing carriage whereby cylinders may be towed over a range of speeds while oscillating with controllable amplitude and frequency. Measurements of the attendent forces are made by means of strain gage apparatus and vortex configurations may be studied by means of special photographic techniques.
(g) Preliminary tests have been conducted on a 2-inch diameter circular cylinder to determine the magnitude of vortex-induced forces. Results suggested the existence of three-dimensionality of the wake. This was subsequently verified by flow visualization of the wake on the same cylinder. A new cylinder is being constructed which will permit measuring the forces on a small segment over which the flows should be two-dimensional. Concurrent tests are being conducted in a low-turbulence wind tunnel to determine criteria for two-dimensional flow over a cylinder. Hot-wire anemometer techniques are being used to determine span-wire correlation of vortex shedding as a function of Reynolds number. Tests will be conducted on two-dimensional fairings to correlate shedding frequency with shape parameters.

(1521) 36-INCH VARIABLE PRESSURE WATER TUNNEL.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a 36-inch variable pressure water tunnel for investigation of propulsion, cavitation, and noise characteristics of propellers as well as tests on subsurface bodies. Interchangeable test sections of open and closed jet type will be provided. The maximum design speed is 85 f.p.s.
(g) A construction contract was awarded in December 1955 with a completion date in early 1958.
(h) "A 36-Inch Variable Pressure Water Tunnel", by W. F. Brownell, DTMB Report 1052, 56 pages, June 1956.

(1522) WAVEMAKER STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Hydrodynamic research and facility development.
(e) Theoretical and experimental studies of surface wave generators to develop criteria for the design and construction of a large-scale wavemaker installation. A program of research on wave absorbers is also underway. Prerequisite to this latter investigation is the development of practical means for evaluating the effectiveness of a given absorber.
(f) Completed.
(g) A small pilot model of a pneumatic wavemaker has been developed and successfully operated. Improvement has been made in the means of controlling amplitude and frequency of generated waves. A much larger pneumatic wavemaker has been installed in the 140-foot model basin, and has been in regular operation generating waves for ship model tests. A 51-foot wide pneumatic wavemaker has been installed in the deep water basin. A method of making measurements and determining wave absorption characteristics therefrom has been developed analytically. The accuracy with which wave height can be determined has been improved by the development of an electronic wave-height recorder which operates on a change of capacitance principle.
(h) "A 51-Foot Pneumatic Wavemaker and an Absorber", by W. F. Brownell, W. L. Asling and W. Marks, DTMB Report 1054, 41 pages, August 1956.

(1778) HYDRODYNAMIC NOISE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Investigations of the characteristics of underwater noise associated with various hydrodynamic phenomena such as cavitation, bubble oscillation, turbulence and splashing.
(g) Experimental and theoretical studies have been made of noise produced by cavitation, splashing, oscillating air bubbles, and turbulence.
(h) "Hydrodynamic Sources of Sound", by H. M. Fitzpatrick and M. Strasberg, Proceedings of a Symposium on Naval Hydrodynamics, Office of Naval Research and National Academy of Sciences National Research Council, September 1956.

(1779) TURBULENT BOUNDARY LAYERS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) A theoretical and experimental investigation of the velocity profile and wall shearing stresses in turbulent boundary layer. In order to provide a simple and accurate determination of shear stress at the wall, the use of surface tube technique for measuring this characteristic has been investigated in both zero and adverse pressure gradients.

(1780) BUBBLE FLOW STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Studies of bubble drag and virtual mass, and the kinematic behavior of bubbles as a function of size, pressure gradient, density, viscosity and surface tension of the media.
(g) Theoretical solutions are being determined for the effect of container walls on the drag of rigid and fluid spheres.
(h) "Wall Effect for Rigid and Fluid Spheres in Slow Motion", by W. L. Haberman, Proceedings Ninth International Congress of Applied Mechanics, 1956.

(1781) ROTATING-ARM AND MANEUVERING BASIN.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a circular basin of 260-foot diameter with a rotating arm whose radius can be varied from 18 to 120 feet. To be used for towing tests of surface and subsurface models. Also, design and construction of a maneuvering basin 350 feet long and 230 feet wide, equipped with traveling bridge and towing carriages, and wavemakers for the purpose of making maneuvering tests on ship models.
(g) Construction contract awarded in May 1956 with a completion date in early 1959.
(h) "A Rotating Arm and Maneuvering Basin", by W. F. Brownell, TMB Report 1053, 73 pages, July 1956.

(1782) SHIP MOTIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Basic research.
(e) Determination of ship motions in a regular seaway when coupling exists between heave and pitch. The work is to be based on the linear theory and is a continuation of work on uncoupled motion. It is intended to extend the applicability of the linear theory to a larger number of vessels of various type.
(f) Inactive.

(1783) MATHEMATICAL SHIP LINES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical research.
(e) Development of a suitable method for the mathematical determination of ship lines which can be applied to a wide variety of ship forms especially to those of modern design.
(g) A method has been developed for the mathematical fairing of graphical lines. This is a first step toward the development of a flexible system of mathematical ship lines. Successful application of this method has been made to a vessel. Future work is directed toward the development of a system of mathematical lines which will permit the derivation of a hull form for a given set of parameters.

(1784) RESEARCH ON UNSTEADY FLOW PROBLEMS--UNSTEADY EFFECTS ON STABILITY DERIVATIVES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical and experimental.
(e) Studies of the effect of oscillation frequency and amplitude, speed of advance and geometry on the stability derivatives of an oscillating body in a fluid.
(f) Discontinued.
(g) The effect of the various parameters has been studied with a spheroid of 7 to 1 fineness ratio. It was shown that unsteady effects may be of importance especially when combined with non-linearity.

(1785) RESEARCH ON UNSTEADY FLOW PROBLEMS--GENERAL THEORY.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical research.
(e) A general theoretical study of the field of time-dependent hydrodynamic phenomena.
(f) Discontinued.
(g) Flows with d'Alembert type unsteadiness, unsteady jet problems, decay of vorticity, d'Alembert flows, Gerstner's waves, potential waves, have been studied. It was shown that the dimensionless parameter which describes the unsteadiness of general fluid motion reduces to the conventional Strouhal number (or dimensionless frequency ratio) for oscillatory flows under certain conditions.

(1786) STUDIES OF THE SLAMMING OF SHIPS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Computations and measurements of the maximum pressure and impact forces on the bottoms of slamming ships for the purpose of developing design criteria to effect their reduction.
(g) Studies with ship models were made to determine hydrodynamic impact forces on ships. Regular and confused seas were studied to determine conditions favorable for slamming.
(h) "Correlation of Theoretical and Experimental Import Pressures", by F. N. Schwartz and Margaret D. Bledsoe, TMB Report (in preparation).

(1788) WAX DEVELOPMENT.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) Development of a wax composition and manufacturing techniques for the manufacture of ship models up to 30 ft. on water-line length.

(f) Completed.
(g) The blend developed is entirely suited to the climatic conditions existing in Washington, D. C. The strength of this material is such that all types of models, including submarines, may be constructed and handled with no greater care than is given to corresponding wood models. Ninety-one (91) models, varying in length between 19 and 24 ft. and in weight between 1,000 and 4,500 lbs., and four 30 ft. models have been successfully manufactured and tested since the development of this new wax blend. The introduction of wax model construction technique has resulted in a substantial saving in time and cost of ship model manufacturing at TMB.
(h) The following reports are being reviewed prior to publication:
"The Development of a N-Butyl Methacrylate Wax Blend for Manufacturing Wax Models at TMB", by W. Hinterthan.
"Development and Application of a Wax Composition for the Manufacture of Experimental Ship Models", by W. Hinterthan.
Memorandum: "Methods to be followed in the Blending of Wax for TMB Wax Model Production", by W. Hinterthan.

(1789) PRESSURE DISTRIBUTION ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Measurements of pressure distribution and resistance with photographs of wave profiles and flow lines for a series of ship models. Data are to be used for the design of turbulent boundary layer stimulators and the improvement of resistance prediction technique.
(g) A bank of diaphragm-type pressure gages has been constructed to determine the pressure distributions, and tests on a specific model are in progress. Tests on the first model have been completed.

(1790) PROPELLER THEORY, ARBITRARY DISTRIBUTION OF CIRCULATION.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of moderately loaded propellers with a finite number of blades and an arbitrary distribution of circulation. Comparison is made between the theory based on "induction factors" and the theory assuming the condition of normality for the induced velocity.
(f) Application to basic theory of propellers.
(g) Problems have been solved both for a free running and wake adapted propeller.

(2018) SERIES 60-RESISTANCE OF VARIOUS RELATED HULL FORMS.

(b) Bureau of Ships; Maritime Commission; David Taylor Model Basin.
(d) Experimental testing.
(e) The dependance of resistance upon the coefficients of hull form for a practical range of single-screw ship forms is to be determined. The history of the project, the scope of the proposed series is given in (h) for Series 57. The resistance results of the original Series 57 models were somewhat disappointing and therefore careful thought was given to the problem of improving the original parents. As a result, new parent forms have been drawn out, together with necessary contours and models run for resistance. The new family was designated number Series 60.
(g) It is believed that the new Series 60 contours now are such as to justify their use as a starting point for future research in a number of fields. Suggestions as to such systematic research were made in the earlier paper, and include the evaluation of the effect of LCB position, L/B and B/H ratios etc.

(2019) PROPELLER EXCITED VIBRATION.

(b) David Taylor Model Basin and Society of Naval Architects and Marine Engineers.
(d) Experimental basic research.
(e) Investigation, measurement and prediction of propeller excited vibratory forces on ship models.

(g) Development of the instrumentation and testing technique for single screw vessels has been completed. Tests are being conducted to verify model results with full scale results on Gopher Mariner. An investigation of the principal main hull, propellers and rudder parameters will be conducted in order to determine the effect of such parameters on the vibratory force. Measurements of instantaneous pressure have been made on the hull of USS TIMMERMAN in the vicinity of the port propeller. Tests will be conducted on a 30-foot model of the USS TIMMERMAN equipped with pressure gauges to determine whether the pressures recorded on trial can be repeated at model scale.

(2229) NEAR SURFACE EFFECTS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A mathematical study of the forces and moments acting on bodies due to the proximity of a free surface. The studies will include both the case in which the surface is initially undisturbed and the case in which there are disturbances originating at a distance.
(g) Methods have been developed for computing the forces and moments acting on bodies of revolution, both due to waves generated by the body itself and to regular trains of waves.

(2230) THEORY OF SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A theoretical and experimental study of factors affecting the seaworthiness of ships, for the purpose of developing procedures for predicting their motion.
(g) Tests have been completed on two geometrically similar ship models of different lengths. The analysis of these tests will aid in estimating the validity of model tests for predicting full-scale behavior.
A ship model has been oscillated in heave and pitch to determine the dependency of the damping and added mass forces on speed, frequency and amplitude of oscillation. Comparisons will be made with theoretical methods currently used to compute these forces.
(h) "A Procedure to Impart Specified Dynamical Properties to Ship Models", by Howard R. Reiss, TMB Report 986, March 1956.
"The Dynamics of a Gravity Towing System", by Howard R. Reiss, TMB Report 1040, in review.
"A Study of the Forces and Moments on a Surface Ship Performing Heaving Oscillations", by Paul Golovato, TMB Report 1074, August 1956.

(2231) HYDRAULIC ROUGHNESS STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Theoretical and experimental research on methods for analyzing and predicting the frictional resistance of arbitrary rough surfaces, especially the painted surfaces of ship hulls. The geometrical characteristics of arbitrary rough surfaces are to be analyzed by amplitude-frequency spectra while the hydrodynamic characteristics are to be analyzed by similarity laws.
(g) The low frequency characteristics of the roughness records necessitate the development of a low frequency spectrum analyzer. The analytical procedures for predicting the frictional resistance of arbitrary rough surfaces from similarity laws have been completed for issuance in a TMB report.

(2232) PRESSURE AND VELOCITY DISTRIBUTIONS ON TWO-DIMENSIONAL AND AXISYMMETRIC THREE-DIMENSIONAL FORMS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Potential flow research.
(e) Investigate analytic techniques for determining the pressure and velocity distribution on two-dimensional and axisymmetric three-dimensional forms. The solution is to be amenable to coding for UNIVAC computation.
(g) An iterative solution has been developed and coded for the UNIVAC. The pressure distribution for a number of bodies whose pressure distribution is known have been completed and verified. Some difficulty is experienced however, with convergence in certain portions of the calculations.

(2233) THE STRUCTURE OF TURBULENCE IN BOUNDARY LAYERS AND WAKES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Turbulence research.
(e) A study to investigate the behavior of the basic turbulence quantities in boundary layer and wake flows.
(g) Experimental results indicate that the intensity decay and width increase of the turbulent wake in its downstream course behind three-dimensional bluff bodies (discs and plates) are in agreement with those theoretically predicted. Future tests will be extended to include practical configurations which will be investigated in both unpowered and powered conditions.

(2234) SURFACE WAKES BEHIND TOWED STRUTS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism of plume and wake formation of surface piercing struts, including the determination of wave drag, spray drag, and induced drag for geometrically varied series.
(g) Tests on a series of struts have been completed.
(h) "The Hydrodynamic Characteristics of Surface Piercing Struts", by J. P. Breslin and J. W. Belleur, Stevens Institute of Technology, Report No's. 596 and 597.

(2235) LIBERTY SHIP SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Thorough seaworthiness investigations of a Liberty Ship and a modified Liberty Ship Hull. The aspects of this investigation includes speed reduction, ship motion, and slamming. Model experiments have been conducted with 5-foot models in waves. This work will be extended to 20-foot models and full-scale sea trials.

(2236) OSCILLATING PRESSURES IN THE VICINITY OF PROPELLERS.

(b) David Taylor Model Basin.
(d) Experimental and theoretical; applied research.
(e) Studies of the oscillating pressures on boundaries and in the free space produced by propeller operation. The purpose of the work is to determine the magnitude of the hydrodynamic propeller excited vibratory forces acting on ship's hulls and the effect of operating parameters.
(g) Experimental results are being obtained.

(2237) LIFTING SURFACE THEORY OF PROPELLERS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of the corrections on lifting line theory which arise from the finite extent of the blades.
(f) Application of an approximate lifting surface theory is completed. Development of a rigorous theory temporarily inactive.
(g) The available results are being applied to propeller design methods.

(2238) THE EVALUATION OF THE EFFECT OF SHIFTING THE LONGITUDINAL CENTER-OF-BUOYANCY (LCB) UPON THE RESISTANCE AND PROPULSIVE CHARACTERISTICS OF VARIOUS RELATED HULL FORM OF SERIES 60.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) Four models for each of the five block coefficients, to which the parent models were built, were constructed from the Series 60 contours. Resistance tests were conducted for each of these hulls to find the effect on resistance of varying the LCB. Concurrently, the relation between the propulsion coefficients and LCB position was obtained from propulsion tests.

(g) The effect of the LCB positioning on the propulsive coefficients has been obtained. Also an optimum location of LCB for each block coefficient, of this series, has been established from the resistance characteristics of this hull.
(h) "Series 60 - The Effect Upon Resistance and Power of Variation in LCB Position", by Dr. F. H. Todd and P. C. Pien, A Society of Naval Architects and Marine Engineers paper, May 1956.

(2239) PROPULSIVE CHARACTERISTICS OF VARIOUS RELATED HULL FORMS SERIES 60.

(b) Bureau of Ships; Maritime Commission; David Taylor Model Basin.
(c) Experimental testing.
(e) The dependence of propulsion characteristics upon the coefficients of hull form and propeller diameter for a practical range of single-screw ship forms are to be determined. Series 60 parent models are used for this project.
(g) The dependance of wake, thrust deduction, propulsive coefficient, etc. upon the block coefficient, propeller diameter, trim etc. has been obtained.

(2462) PITCH REDUCTION STUDIES.

(b) Bureau of Ships.
(d) Experimental and theoretical.
(e) To investigate the effect of horizontal fin appendages on the motion of surface ships in a seaway. A motion prediction theory is being developed and experimental investigations will be conducted.
(h) "Pitch Reduction with Bow Fins of the Series 60, 0.60 Block Coefficient Model", by U. A. Pournaras, TMB Report 1061.
"Seaworthiness of a Mariner Class Ship Equipped with Bow Antipitching Fins", by U. A. Pournaras, TMB Report 1084.

(2463) STUDIES OF LOW ASPECT-RATIO CONTROL SURFACES.

(b) David Taylor Model Basin; laboratory project.
(d) Experimental investigation; basic research.
(e) Determine the aerodynamic characteristics of a family of low aspect-ratio control surfaces which can be used by the designer of submarines and surface ships. Phase I is an investigation of a family of all-movable control surfaces. Phase II is an investigation of the same family with plain flaps of different chord length.
(f) Phase I, completed; Phase II, active.
(g) The results of Phase I indicate that many of the aerodynamic characteristics of low aspect-ratio surfaces can be accurately predicted from lifting surface theory.
(h) The results of Phase I and comparisons with lifting surface theory are presented in DTMB Report No. 933, now being reviewed prior to publication.

(2464) THE EVALUATION OF THE EFFECT OF CHANGING THE LENGTH TO BEAM (L/B) AND BEAM TO DRAFT (B/H) ON THE RESISTANCE CHARACTERISTICS AND PROPULSIVE COEFFICIENTS FOR THE VARIOUS RELATED HULL FORMS OF SERIES 60.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) For each block coefficient (C/B) models are being built from the offsets of the model with the optimum location of the longitudinal center-of-buoyancy. This model will have been established by the program - "The Evaluation of the Effect of Shifting the Longitudinal Center-of-Buoyancy upon the Resistance and Propulsive Characteristics of Various Related Hull Forms of Series 60".
(g) The majority of this work has been completed and the results will be presented in a paper to the Society of Naval Architects and Marine Engineers in November 1957.

(2466) TOWING EQUIPMENT AND MOTION RECORDING INSTRUMENTATION FOR SHIP MODEL TESTS IN WAVES.

(b) David Taylor Model Basin Laboratory Project; specifically for TMB's proposed Maneuvering Basin.

(d) Experimental and theoretical.
(e) The purpose of the equipment and instrumentation is respectively, to tow models in waves and to measure and record various types of model motions. Surface models will be tested under partially-restrained conditions, the restraints being those of yaw and sway; or, of yaw, sway, and roll. Model tests will be conducted in head and following seas.
(f) Specifications were completed while the design of the equipment and instrumentation is being done presently.

(2467) DEVELOPMENT OF OCEANOGRAPHIC RESEARCH VESSEL.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Prediction and experimental determination of the motion of research vessel in seaway.
(f) Completed.
(h) "The Behavior of a Proposed Oceanographic Research Vessel in Waves", by F. V. Reed, TMB Report 1055, August 1956.

(2468) EFFECT OF WAVES ON STANDARDIZATION TRIALS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental.
(e) To establish a method for determining the conditions under which standardization trials might be adversely affected. Experimental studies are underway on models of three typical vessels of varying block coefficients to determine the combination of speed, wave length and wave height which influence smooth water speed. As a by-product, this work will furnish general information on factors governing speed reduction in a seaway. A theoretical method has been developed to determine added resistance due to waves. It is intended to compare experiment with theory.
(f) Completed.
(h) "Speed Reduction in Waves", by Margaret D. Bledsoe, TMB Report 1083 (awaiting publication).

(2469) INTERNATIONAL COMPARISON TESTS--SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin laboratory project.
(d) Experimental and theoretical.
(e) To obtain seaworthiness information for comparison purposes by means of a 10 foot fiber glass plastic self-propelled model of the Series 60, 0.60 block coefficient form. The effect of self-propulsion on the motion and speed reduction characteristics of this model is compared with the effects previously studied by means of a gravity type towing arrangement. Comparison between results obtained in three large basins (DTMB, Wageningen, Haslar), equipped to handle 10 foot self-propelled models, will also be made.

(2470) HELMHOLTZ RESONATOR.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical investigation of the excitation of Helmholtz Resonator by fluid flow.
(e) Studies to determine the mechanism of excitation of the Helmholtz Resonator by fluid flow past orifice will be undertaken. The experimental investigation will employ the Low-Turbulence Wind Tunnel. The amplitude of pressure fluctuation in the cavity will be investigated as function of the size, shape and number of orifices, as well as the turbulence characteristics in the boundary layer flow. It is hoped that design criteria for orifices and cavities on ships may be formulated.
(h) "Excitation of Cavity Resonance by Air Flow", by M. C. Harrington was presented at the 52nd meeting of the Acoustical Society of America at Los Angeles, California.

(2471) THEORY OF CONTRA-ROTATING PROPELLERS.

(b) Cooperative with the Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of the theory of contra-rotating propellers without assumptions regarding the orientation of the resultant induced velocity.
(g) Application to open water and wake adapted propellers.

(2472) COOPERATIVE TESTS ON A VICTORY SHIP DESIGN.

(b) David Taylor Model Basin; Skin Friction Committee of the International Towing Tank Conference.
(d) Experimental testing; basic research.
(e) The investigation was authorized by the International Committee on "Scale Effect on Propellers and on Self-Propulsion Factors" as part of the international cooperative test program in ship basins. The International Committee will compare the results from the various basins and present a report to the coming International Conference. The tests will be carried out with a wax model of scale 1:23 equipped with different kinds of stimulators. The friction corrections will be calculated by the various basins according to their methods.
(g) The specified program of model testing has been completed. The required calculation for the power predictions have to be done before the evaluation work can proceed.
(h) Results will be published before the coming International Towing Tank Conference.

(2473) FRICTIONAL RESISTANCE OF GEOSIM MODELS.

(b) David Taylor Model Basin; Skin Friction Committee of the International Towing Tank Conference.
(d) Theoretical; basic research.
(e) Representatives of the various towing tanks of the ITTC have been unable to agree on a friction line. The Skin Friction Committee of the ITTC was therefore directed to develop a universally acceptable "Engineering Line" for use in extrapolating from ship models to full-scale. Model resistance data for geosim series are therefore being assembled and analyzed according to each of several currently proposed friction lines. Resistance data for geosim models tested at TMB are being distributed to other basins for analysis and TMB will analyze all model data from other tanks using the Schoenherr formula.
(f) Completed.
(g) According to present status, the Schoenherr line seems to represent a reliable average friction line.
(h) A report of the TMB contribution to this work has been published.
"Report On Geosim Analysis According to Schoenherr Line" by W. B. Hinterthan, TMB Research and Development Report 1064 published July 1956.

(2474) CALCULATION OF GOLDSTEIN FACTORS FOR 3, 4, 5 AND 6 BLADED PROPELLERS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Calculation of Goldstein factors, particularly for the case of large advance ratios where the approximations made in the original equations are not valid.
(f) Completed.
(g) Application to propeller design.
(h) "The Calculations of Goldstein Factors for Three, Four, Five and Six Bladed Propellers", by A. J. Tachmindji and A. B. Milan, DTMB Report No. 1034.

(2727) THE EFFECT OF HUB DIAMETER ON THE OPTIMUM DISTRIBUTION OF CIRCULATION OF PROPELLERS.

(b) David Taylor Model Basin.
(d) Theoretical; applied research.
(e) Studies of the effect of hub diameters on the optimum distribution of circulation.
(g) Calculations are now proceeding.
(h) "The Potential Problem of the Optimum Propeller with Einite Hub", by A. J. Tachmindji, David Taylor Model Basin Report No. 1051.

(2728) SEAWORTHINESS OF U. S. COAST GUARD VESSELS.

(b) U. S. Coast Guard; David Taylor Model Basin.
(d) Experimental (research and development).
(e) Three designs for a 160 ft. Water Patrol Craft were investigated for seaworthiness characteristics. Experiments were conducted for several wave conditions in order to determine the best design with respect to amplitudes of motions and accelerations, speed reduction in waves, wetness, etc.

(f) Completed.
(g) The results of the model experiments were used as the basis for selecting one of the three designs, to be used in the construction of a new Coast Guard Patrol Craft.
(h) "Seaworthiness of Three Designs for a United States Coast Guard 160 Foot Water Patrol Craft", by G. P. Stefun, DTMB Report 1009, February 1956.

(2729) HULL FORM RESEARCH BY USING A FLEXIBLE MODEL.

(b) David Taylor Model Basin.
(d) Development and experimental work.
(e) A flexible model which can be quickly changed to have any fullness and any shape of section area curve is to be developed first. The effect of section area curve parameters, such as t_F, t_A, C_{PF}, C_{PA}, L_E, L_X, $\overline{X_F}$, $\overline{X_A}$, etc., upon resistance will be systematically investigated by using this flexible model.
(g) The design work of the flexible model has been completed. The construction of this model has been started.

(2730) MOLECULAR - PHYSICAL SKIN EFFECT.

(b) David Taylor Model Basin.
(d) Experimental; applied research.
(e) The frictional resistance of a "new" plate consisting of a special molecular coating will be compared with the frictional resistance of a hydraulically smooth brass plate and of a mirror smooth glass plate. The test equipment will be designed and constructed to study wave and spray formation for the determination of the true wetted surface. The plate will be tested with maximum speed of 15.0 knots and with various stimulation devices.
(g) The design and construction work of test equipment have been completed and is now in the stage of testing.

U. S. DEPARTMENT OF THE NAVY, NAVAL BOILER AND TURBINE LABORATORY.

Inquiries concerning Projects Nos. 1523 and 2731 should be addressed to Commanding Officer and Director, U. S. Naval Boiler and Turbine Laboratory, Philadelphia Naval Base, Philadelphia 12, Pennsylvania.

(1523) HIGH PRECISION POWER INSTRUMENTS.

(b) Bureau of Ships and Office of Naval Research, Department of the Navy.
(d) Experimental; applied research.
(e) For improvement of fluid flow measurement. Work is currently being undertaken to determine the effect of two phase flow. Data to date have been obtained for moisture contents in the order of 20 percent.
(g) Preliminary results indicate that additional correction for wet steam is essential over and above compensation for density.

(2731) EFFECT OF PIPE ROUGHNESS ON ORIFICE METER ACCURACY.

(b) American Gas Association.
(d) Experimental; applied research.
(e) This project is under the cognizance of the A.G.A. Supervisory Committee to Study Pipe Roughness. The scope of the project is, initially, limited to investigation of the effect of pipe roughness on two-inch meter runs using water as a media.

U. S. DEPARTMENT OF THE NAVY, NAVAL ORDNANCE TEST STATION.

Inquiries concerning Projects Nos. 2475 to 2477, incl., should be addressed to Commander, U. S. Naval Ordnance Test Station, Attn: Mr. G. G. Mosteller, 3202 East Foothill Blvd., Pasadena, California.

(2475) WATER-ENTRY ACCELERATION.

(b) Laboratory project.
(d) Experimental; applied research.
(e) One- and two-inch-diameter models containing accelerometers are launched into water obliquely under conditions of Froude-number scaling for axial acceleration data and conditions of Froude and cavitation-number scaling for transverse acceleration data. Water-entry forces in the form of dimensionless force coefficients versus dimensionless time are obtained for various missile nose shapes. Methods for applying these data to obtain both axial and lateral forces on full-scale missiles are worked out.
(g) Force coefficients for disk-cylinder and hemispherical noses have been obtained.
(h) "Experimental Measurement of Water-Entry Deceleration of Models", by G. G. Mosteller. Unclassified article published in the TORPEDO QUARTERLY, February 1955. (NAVORD Report 3425, NOTS 1026), CONFIDENTIAL.
The following reports are in preparation:
"Water-Entry Accelerations; an Annotated Bibliography", by G. G. Mosteller.
"Experimental Determination of Axial Deceleration at Oblique Water Entry of 2-Inch-Diameter Models with Hemisphere and Disk-Cylinder Noses, by G. G. Mosteller.
"Experimental Determination of Transverse Acceleration at Oblique Water Entry of 2-Inch-Diameter Models with Hemisphere and Disk-Cylinder Noses", by G. G. Mosteller.

(2476) HYDROBALLISTICS RANGE DEVELOPMENT.

(b) Bureau of Ordnance, Navy Department.
(d) Experimental; applied research.
(e) The purpose of this project is to develop a technique to determine accurately the detailed fully wetted motion of free-flying momentum-propelled models as a function of time. From these data the hydrodynamic coefficients are to be derived. This project is part of a coordinated program involving several laboratories, the purpose of which is to provide numerical values of all the coefficients needed to calculate a fully wetted trajectory. Calculated trajectories will be compared with observed trajectories to evaluate the test techniques employed for coefficient determination.
(g) A simple hydroballistics range was established in which four degrees of freedom of fully wetted, free-flying underwater missile motion can be measured as functions of time. These include missile range and vertical positions and pitch and roll. The drag coefficients of a theoretical missile, the Basic Finner, and of a low-drag modification of this missile, the Basic Finner Mod A, were measured.
(h) "Drag Coefficient of Fully Wetted Basic Finner Missile", by G. W. Stubstad and J. G. Waugh, China Lake, Calif., 7 June 1956. (NAVORD Report 5269, NOTS 1483.)

(2477) WATER ENTRY MODELING.

(b) Bureau of Ordnance, Navy Department.
(d) Experimental; basic research.
(e) For missile water entry at high speeds, the initial regime of underwater trajectory motion takes place with a cavity. It is known that cavity size and shape affect the underwater trajectory behavior of the missile. Hence successful modeling of underwater trajectory in cavity motion necessarily includes modeling of the cavity. The purpose of this experimental project is to investigate the importance of gas-density scaling in conjunction with Froude and cavitation-number scaling in water-entry cavity modeling.
(g) Modeling studies were conducted with a 2-inch-diameter hemisphere-head missile as a prototype, and with 1- and 1/2-inch-diameter models of the prototype. The observations of the cavities formed by vertical entry of these models showed that excellent agreement exists under the conditions of one-to-one scaling of Froude and cavitation number, and of gas density. There was also good agreement with one-to-one scaling of Froude number and gas density, but no agreement under one-to-one Froude and cavitation-number scaling.
(h) "Water-Entry Cavity Modeling", by J.G.Waugh and G.W.Stubstad, China Lake, Calif., NOTS.

U. S. DEPARTMENT OF THE NAVY, OFFICE OF NAVAL RESEARCH.

For sponsored projects see the following:

TENNESSEE VALLEY AUTHORITY, Hydraulic Data Branch.

Inquiries concerning all TVA projects should be addressed to Mr. Albert S. Fry, Hydraulic Data Branch, Tennessee Valley Authority, Knoxville, Tennessee.

Hydraulic Operations and Tests Section.

(731) SOUTH HOLSTON DAM, SURGE TANK MODEL STUDY.

(d) Experimental; for design.
(e) A 1:50 model of the penstock and surge chamber was used to determine (1) the orifice size and characteristic shape to produce favorable pressure and water surface elevations to be expected in the surge chamber; and (2) the operational characteristics or the selected design.
(f) Model studies completed.
(g) With the proper orifice between the riser and the surge chamber as satisfactory results can be obtained as with the differential riser type of surge tank.
(h) Report in preparation.

(739) CHEROKEE DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Measurement of discharges and differential pressures in the sluices, supplemented by model test data, will be used to establish the discharge ratings for the eight sluices. Tables of discharge for any gate opening at any headwater elevation within the operating range are to be prepared.

(745) FONTANA DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Model tests, checked by field measurements, are to be used in determining the discharge ratings for all anticipated operating conditions. Discharge tables for operating purposes will be prepared.
(f) Model studies completed.

(758) CHEROKEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be made on the various hydraulic appurtenances to determine the operating characteristics of the structures and the effect of operation on the structures.
(g) Measurement of pressures in the sluice barrel have been obtained and will be compared with pressures obtained in model tests. The apron and sluice barrels were inspected in 1953 to determine the effect of intermittent operation during the past 11 years.
(h) Report in preparation.

(759) DOUGLAS DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be made on the various hydraulic appurtenances to determine the operating characteristics of the structures and the effect of operation on the structures.

(g) Measurement of pressures in the sluice barrel have been obtained and will be compared with pressures obtained in model tests. The apron and sluice barrels were inspected in 1953 to determine the effect of intermittent operation during the past 10 years.
(h) Report in preparation.

(760) FONTANA DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Plaster surface impressions of carefully located sections are taken after each extended period of tunnel operation to obtain evidence of damage. Entire tunnel is examined for erosion, cavitation damage, or structural failure.
(g) Inspections made in Sept. 1946, Oct. 1949, and May 1950.

(761) KENDUCKY DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements are made of lateral pressures on the face of the spillway piers and on the submerged baffle piers on the spillway apron to be compared with the results of the model tests.
(g) Field measurements of crest and baffle block pressures were made in 1946 and 1950.

(762) SOUTH HOLSTON DAM, SURGE TANK PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped to allow testing in a manner similar to that used in the model studies which established the design. A check on the model accuracy can thus be obtained.
(g) Initial tests made in Feb. 1950.

(763) HIWASSEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Measurements of pressure in sluices are being obtained for comparison with pressures measured in model tests.
(g) Field measurements of sluice pressures were made in 1943 and 1954. The sluice barrels and apron were inspected in 1954.

(1038) HALES BAR DAM, SPILLWAY APPROACH STUDIES.

(d) Experimental; for design.
(e) Tests are made on a 1:65 model to determine effect of the remains of cofferdam structures upstream of the spillway on the spillway discharge and to determine amount of the obstructions which should be removed.
(f) Model tests completed.
(h) Report in preparation.

(1277) WATAUGA DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Outlet tunnel surfaces are inspected after completion and after extended periods of operation to determine erosion, cavitation damage, or structural failure.
(g) Initial inspection in Dec. 1949.

(1534) FORT PATRICK HENRY DAM, SPILLWAY MODEL STUDIES.

(d) Experimental; for design.
(e) Tests are being conducted on a 1:50 scale and 1:112.5 scale model to determine the apron design, training wall dimensions, and other related data.
(f) Model studies completed.

(g) An apron using a single row of rectangular baffle blocks was developed on the 1:50 scale model. This apron was then used in the 1:112.5 scale model and the necessary appurtenant structures developed. Of main interest in the developed design was the lack of training walls. Studies to determine the effect of vegetative growth on the island areas below the spillway showed which areas must be kept free of growth and which may be allowed to grow up.
(f) Installation completed and instruction manual partially completed and issued.
(h) Report in preparation.

(1536) VHF RADIO GAGES FOR REPORTING RAINFALL AND RIVER STAGES.

(d) Experimental; development.
(e) Standard FM tone modulated 169 - 172 Mc. radio equipment has been modified to transmit pulsed signals produced in a specially designed electro-mechanical converter unit (keyer). This keyer can be directly operated for river stage measurement by the conventional float system. By use of an electrical servo system, rainfall caught in a standard weighing type gage can be transmitted to the keyer unit. Standard VHF radio station transmitter-receiver units have been modified for use as automatic repeater units. A printing type recorder operated by a standard VHF, FM receiver suitably modified, records and prints all transmitted signals on a 5-inch tape. All transmitting units are supplied with at least 3 days emergency power in case of AC power failure. Suitable signals indicate when any gage is on emergency power.
(g) Seven receiving systems which include 19 stream gages, 22 rainfall gages, 13 repeater stations, and 7 receivers have been installed. Some units have operated for three years very satisfactorily. Keyer unit has been patented.

(1794) WATTS BAR LOCK PROTOTYPE TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped with piezometers to allow checking of culvert and port pressures and discharges. The culverts and ports were designed from model studies. Thus, measurement on the prototype would provide model-prototype verification data.
(f) Complete field tests were conducted in 1952.
(h) Reduction of data is being completed.

(1796) KINGSTON STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDIES.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets draw water from and discharge into Watts Bar Reservoir (Tennessee River). During the warmer portions of the year this reservoir becomes stratified and the inflowing waters pass through the reservoir as density currents. By means of theoretical considerations and field observations, the proper location and shapes for the intakes and outlets were determined and the probable intake temperature calculated.
(g) Six-point recording temperature gages were installed on the Tennessee, Clinch, and Emory Rivers and data obtained during the period of stratification in 1953 and 1954. Velocity and temperature profile measurements were made at eight sections in the Clinch and Emory Rivers for periods of steady flow to define thermal density underflow. Theoretical analyses were made to show the benefits that could be derived by the installation of a submerged dam in the Clinch River below the mouth of the Emory River to divert the density underflow up the Emory River. Studies indicate that temperature reductions effected by the structures will result in coal savings of $100,000.00 annually. The cost of the structures is about $400,000.00.
(h) Report in preparation.

(1797) GALLATIN STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDY.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets are to draw water from and discharge into the proposed Old Hickory Reservoir (Cumberland River). The entire setup is to be analyzed to determine the type of flow conditions to be expected in the reservoir; the temperatures to be expected at the inlets; and the best design for the inlets and outlet structures.

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(g) Single-point temperature recorders were installed at six stations which, in combination with turbine intake temperature recorders at three upstream dams, will be used to determine temperature increases between points on the Cumberland River for various conditions. Data are being collected and evaluated.

(2029) APALACHIA POWER TUNNEL, PROTOTYPE CHECK TESTS.

(d) Field investigation; operation.
(e) Periodic inspections of the power tunnel will be made to determine change in subsurface roughness. Field test measurements will be made to determine the change in friction and roughness coefficients.
(g) The tunnel was inspected in 1953 after 10 years of continuous operation. Field pressure measurements were made in March 1954 to determine change in friction coefficients as compared to those obtained as reported in Project 757 in Hydraulic Research in the United States, Vol. 14, 1950. These tests are now being analyzed.
(h) "Friction Measurements in Apalachia Tunnel", by Rex A. Elder, ASCE Proceedings Paper No. 1007, Journal of Hydraulics, June 1956.

(2241) KINGSTON STEAM PLANT - CONDENSER COOLING WATER CONDUIT LOSS.

(d) Experimental; for design.
(e) Longitudinal interior support was required for 96-inch concrete pipe conduit. A study was made of the relative loss for a six-inch thick vertical concrete wall, I beams separated by 4-1/2 inch pipe columns and I beams separated by streamlined 4-1/2 inch pipe columns.
(f) Laboratory studies completed; partial field tests performed.

(2479) WILSON LOCK HYDRAULIC MODEL STUDIES.

(d) Experimental; for design.
(e) The new Wilson lock will be 110 feet long, 675 feet center-to-center pintles with a 100-foot maximum lift. Three models are projected: A 1:36 scale model of a single transverse lateral with 12 ports to determine proper lateral and port designs; a 1:16 scale model of lock chamber, intakes, culverts, gates, and other details to determine overall designs; and a 1:10 scale model of the river and navigation channel confluence to study navigation problems.
(g) Basic design for a single transverse lateral has been developed in the 1:36 scale model. Several possible design schemes to improve navigating conditions at the confluence at the navigation channel and the river have been determined for the 1:100 scale model. Model studies for the remainder of the project are continuing.

Hydraulic Investigations Section.

(764) DETERMINATION OF SEDIMENT CARRIED IN SUSPENSION BY TENNESSEE RIVER AND TRIBUTARIES.

(d) Field investigation; basic research.
(e) To provide data for estimating effective life of storage reservoirs, and loss of soil from the land. Samples of water were collected periodically at stream gaging stations in the watershed, analyzed to determine the sediment content, and correlated with river discharge to determine the suspended sediment load at each station.
(h) Report in preparation.

(765) EVAPORATION IN THE TENNESSEE BASIN.

(d) Field investigation; applied research.
(e) To provide data for estimating reservoir losses and derive a general rule, applicable to the Basin, permitting computation of evaporation from pans at six locations in Basin, together with standard meteorological readings.
(h) "Precipitation in Tennessee River Basin", published in monthly and annual bulletins.

(768) PRECIPITATION IN TENNESSEE RIVER BASIN.

(d) Field investigation; basic research.
(e) A comprehensive study of rainfall and other weather phenomena for purposes of water dispatching and improvements in water control; storm studies as related to maximum precipitation, rainfall-runoff, spillway design and operation, etc.
(h) Monthly bulletin, "Precipitation in Tennessee River Basin." Also annual summary.

(769) RESERVOIR AND STREAM TEMPERATURES.

(d) Field investigation; basic research.
(e) Study of water utilization and water movement as concerns industrial plant locations and stream pollution. Variations in temperature from surface to bottom in reservoirs throughout the year are determined by soundings, and by continuous recording gages in natural streams.

(771) GALLERY DRAINAGE IN LARGE DAMS.

(d) Field investigations; design.
(e) Weirs are placed in main galleries and drainage measured as check on tightness and stability.

(785) SEDIMENTATION OF EXISTING RESERVOIRS.

(d) Field investigation; basic research.
(e) Selected ranges in reservoirs are probed and sounded, volumetric samples are collected and analyzed, quantity and distribution of sediment are computed to determine deposition by stream, probable life of reservoir, effect of sediment storage on navigation channels and sedimentation of downstream reservoirs, and probable sedimentation in future reservoirs.

(786) WATER TRAVEL IN NATURAL STREAMS.

(d) Field investigations; applied research.
(e) Sanitary and chemical changes in water during passage downstream are determined. A given mass of water is identified by electrical conductivity or chemical titration.
(f) No work done in recent years.

(787) MOVEMENT OF WATER THROUGH LARGE RESERVOIRS.

(d) Field investigation; applied research.
(e) Because of slow water travel, samples are collected by traverse through lake.
(f) No work done in recent years.
(g) Water entering a reservoir does not intermix with the rest of the reservoir, but remains as a density current as a result of the difference in temperature between the inflowing water and that in the reservoir. During certain seasons of the year, in Watts Bar Reservoir the cold water released from Norris Reservoir passes upstream along the bottom of the Emory River arm of the former reservoir.

Hydrology Section.

(777) RUNOFF-EROSION INVESTIGATIONS ON SMALL WATERSHEDS.

(b) Certain projects involve cooperation with North Carolina State College of Agriculture and Engineering and The University of Tennessee.
(d) Field investigation and office analysis; basic and applied research.
(e) To evaluate, hydrologically, existing and changed land-use practices or management. Data are obtained on rainfall and runoff on watersheds, and in some instances include groundwater levels, soil moisture storage and transmission, potential evapo-transpiration, vegetal covers, and soils as well as characteristics of runoff from agricultural and forested watersheds.

(g) During the 10-year period 1941-1950 the cover improvement and erosion control in the Pine Tree Branch watershed (formerly Henderson County project) have resulted in a decrease in surface runoff volumes and an increase in ground-water discharges, marked reductions in summer and winter peak flood discharges, a reduction in overland surface velocities, a prolongation of the period of draining of surface runoff from the channel system, and a 90 percent reduction in the sediment load. During the 21-year period 1935-1955, the forest cover improvement in the White Hollow watershed has resulted in greater watershed protection with measurable decrease in water yield, no change in volume of either surface runoff or ground-water runoff, marked reductions in summer peak rates of discharge with lesser reductions in winter rates, a prolongation of the period of draining of surface runoff from the channel system, and a 96 percent reduction in the sediment load.

(h) "Influences of Reforestration and Erosion Control upon the Hydrology of the Pine Tree Branch Watershed - 1941 to 1950", Technical Monograph No. 86, Knoxville, Tennessee, 1955. TVA, Treasurer's Office, Knoxville ($1.50). Report in preparation covering the forest cover improvement influences on hydrologic characteristics of White Hollow watershed (1935-1955).

(779) MAXIMUM POSSIBLE PRECIPTATION IN TENNESSEE VALLEY.

(b) Cooperative with U. S. Weather Bureau.
(d) Theoretical; applied research.
(e) Hydrometeorological analysis of large storms with upward adjustments of controlling factors to maximum limits as applied to the Tennessee Valley and subdivisions.
(g) Results to be published as one of current series of hydrometeorological reports by the U. S. Weather Bureau and cooperating agencies.

(780) MONTHLY EVALUATION OF GROUND-WATER STORAGE.

(d) Theoretical; operation.
(e) By analysis of current records of stream discharge, the volumes of runoff in ground-water and channel storage are determined for use in operation of multi-purpose reservoirs.
(g) Results reported monthly and weekly within the organization.

Procedures Development Section.

(1801) RAIN GAGE LOCATION STUDIES--SOUTH CHICKAMAUGA CREEK WATERSHED.

(d) Field investigation; applied research.
(e) A study to learn the most applicable location and necessary density of rain gages to obtain an accurate record, particularly for river forecasting purposes, in a basin having numerous parallel ridges, and to compare several methods of computing average rainfall and of estimating runoff. Three recording and 11 nonrecording rain gages, in addition to 4 existing nonrecording gages, were established in the South Chickamauga Creek Watershed, which has a drainage area of 428 square miles.
(f) Completed.
(h) "Study of Rainfall Station Locations in South Chickamauga Creek Watershed", condensed paper published in Trans. Amer. Geophys. Union, Vol. 36, No. 6, Dec. 1955, pp. 1021-28. Report completed for internal use.

(2032) DEVELOPMENT OF RIVER FORECASTING METHODS.

(d) Experimental; applied research.
(e) Studies to develop improvements to river forecast procedures with particular application to streams and local inflows into reservoirs operated by the TVA. Procedures include (1) rainfall-runoff relations involving the effect of soil moisture, evapo-transpiration and interception losses, geological features of the watersheds, and seasons; (2) unit surface-water and ground-water hydrographs; (3) streamflow routing procedures; (4) coordinated studies with an established unit of the U. S. Weather Bureau for determination of natural flows at pertinent river points.

(2248) RAIN GAGE LOCATION STUDIES--FLINT RIVER WATERSHED.

(d) Field investigation; applied research.
(e) A study, similar to that on the South Chickamauga Creek Watershed (1801), to determine the most advantageous location and necessary density of rain gages to obtain the desired accuracy in storm rainfall for river forecasting purposes, on a watershed having in general a gently rolling topography. In addition to one existing nonrecording rain gage and two existing recording rain gages in or adjacent to the area, eight nonrecording gages were established on the watershed, which has a drainage area of 342 square miles. These gages were located to provide approximately uniform distribution throughout the watershed.
(f) Daily observations beginning November 1, 1954, and ending April 30, 1956. Statistical analysis of data is in progress.

(2480) FONTANA RESERVOIR BANK STORAGE.

(d) Experimental; applied research.
(e) Bank storage is indicated if during the annual operation of a storage reservoir more water enters into or is withdrawn from storage than is determined from the topographic storage curve. This bank storage is defined as the water that is stored in the bottom and sides of the reservoir. A study is being made to evaluate the amount of bank storage in Fontana Reservoir during the large annual fluctuations of 1953 and 1954. Reservoir storage volumes will be computed from inflows and outflows by using U. S. Geological Survey average daily flows and making proper allowance for rain falling directly on the reservoir surface, evaporation from the reservoir surface, leakage, and diversion. The difference between these computed storage volumes and those indicated by the topographic reservoir storage curve will represent the bank storage.
(f) Completed.
(g) Results indicate that discrepancies in observed data used for study obscure the effect of bank storage.
(h) Report in preparation for internal use.

UNIVERSITY OF ALBERTA, Hydraulics Laboratory.

(2732) A STUDY OF SCOUR AT OBSTRUCTIONS IN NON-COHESIVE BED.

(b) Laboratory project.
(c) Prof. T. Blench, Department of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada.
(d) Experimental and theoretical; basic research, master's thesis.
(e) Fit recorded field and model data of scour at obstructions by a formula of regime type and obtain fresh model data. Also observe on the models the three-dimensional behaviour and effects of self-launching stone aprons extending across rivers.
(f) Complete.
(g) (1) A regime type of formula appeared suitable for scoured depths for models and prototypes in spite of large horizontal distortion in models. (2) Quantitative features of launching of three-dimensional aprons were found similar to those in two dimensions, but scale distortions were noted. (3) Aprons for short submarine crossings showed effects not found for aprons preceded by long weir floors. (4) Opinions were formed on the causes of scour downstream of heavily protected bridge piers.
(h) "A Study of Scour at Obstructions in Non-Cohesive Bed", by P. Andru. Part requirement for degree of M. Sc. from University of Alberta, 1956.

UNIVERSITY OF BRITISH COLUMBIA, Hydraulics Laboratory.

(1044) FRASER RIVER MODEL.

(b) Hydraulic model studies cooperative with the Department of Public Works of Canada, Vancouver, B. C.
(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.
(d) Experimental project to aid engineering studies of navigation requirements involving river regulation and control.
(e) An outdoor erodible-bed tidal river model to study methods for improving and maintaining the navigation channels of the Fraser River estuary. Horizontal scale 1:600, vertical scale 1:70. The model occupies approximately 4 acres of the campus and represents the tide-water reaches of the lower Fraser River extending from its seaward end at the Strait of Georgia to the head of tide water at Sumas, a distance of approximately 60 miles. Pitt River and Pitt Lake (30 square miles in area) are subject to tidal influence and are included in the model. Natural tides and river discharges can be synchronized and simulated on the model and are controlled automatically by electronic servo-systems. Sand injection can be controlled automatically as a function of river discharge. Instantaneous water surface slopes can be obtained over the whole model by automatic electrically-recording point gauges situated at controlling points. Natural river sand of appropriate grain size is used for the bed material.
(h) Progress and technical reports submitted periodically to the Department of Public Works of Canada.

(2733) GREAT CENTRAL LAKE DAM AND FISHWAY, VANCOUVER ISLAND, B. C.

(b) Hydraulic model studies cooperative with the Department of Fisheries of Canada, Vancouver, B. C.
(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.
(d) Experimental project to aid engineering studies for developing and checking the hydraulic design of a sluiceway to create favorable flow conditions at the fishway entrance in the tailwater pool below the dam.
(e) The model is 10 feet wide and 14 feet long and was constructed in a large concrete flume in the hydraulic laboratory. The model has an undistorted scale of 1:25 and the topography of the bed and banks is moulded in concrete. The proposed dam is located on the crest of a natural waterfall which in itself presents difficulty to salmon migration. The dam is

provided with an overflow spillway. However since the sluicegates can pass the maximum discharge expected during the salmon migration period, the fishway is designed to operate during these periods only. The proposed prototype fishway is of the single-vertical-slot type with pools 8 feet wide and 10 feet long. A maximum differential of 18 feet in water surface elevation can occur between headwater and tailwater, thus necessitating 18 pools with a drop of one foot between the successive pools in the fishway.

(h) A report will be prepared by the Department of Fisheries of Canada.

(2734) HOWELL-BUNGER VALVES FOR REGULATING FLOW DIVERSION AT THE LA JOIE FALLS HYDRO-ELECTRIC POWER PLANT.

(b) Hydraulic model studies cooperative with the B. C. Engineering Company, Ltd., Vancouver, B. C.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to aid engineering studies in finding the most efficient way to dissipate the energy in the jet and eliminate cavitation when a 48-inch diameter valve discharges into a 9-foot diameter pipe closed at the upstream end.

(e) A laboratory model of one of the two valves was tested for the design heads and flows at various openings when discharging into a plexiglass tube. The diameter of the tubing available necessitated a scale of 1:18.8 in the model. Flow conditions could be observed and sub-atmospheric pressures measured. The discharges and heads were accurately controlled.

(f) Completed.

(g) The studies indicated that it would be feasible to use the two valves which were already available and not being used, in conjunction with 9-foot diameter steel pipe left over from a previous project and readily available.

(h) A report will be prepared by the B. C. Engineering Company, Ltd.

(2735) HYDRAULICS OF FLOW THROUGH GRAVEL BEDS.

(b) Laboratory flume studies cooperative with the International Pacific Salmon Fisheries Commission, New Westminster, B. C.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to determine the flow conditions in gravel which was taken from an actual salmon-spawning bed in the field.

(e) The gravel was placed in a glass-sided flume and flows of accurately controlled amounts and depths were discharged over it, to simulate conditions which occur in nature. The flow paths through the gravel were traced by dye and the velocities recorded. Comparisons were made between a natural gravel mixture and gravel of almost uniform particle size.

(f) Completed.

(h) A report will be prepared by the International Pacific Salmon Fisheries Commission.

(2736) FRASER RIVER HYDRO AND FISHERIES RESEARCH PROJECT.

(b) Project financed by a grant from the B. C. Electric Co. Ltd.

(c) Dr. G. M. Shrum, Chairman, Fraser River Hydro and Fisheries Research Project Committees.

(d) Engineering research on the design of fish-handling facilities at power dams.

(e) A study of existing facilities including fish ladders, fish locks of the pressure and gravity types, power-house collecting systems, auxiliary flow systems, spillways, turbine intakes, fingerling by-passes, aerial and inclined tramways, rotary-drum screen installations and hatcheries was made at the multipurpose projects on the Columbia River and elsewhere in Washington and Oregon. The purpose of the study was to find if suitable methods could be evolved for passing upstream and downstream migrant salmon at two proposed power dams on the Fraser River, one 700-feet high at Moran, and the other 100-feet high in the lower Fraser Canyon. The anadromous salmon of the Fraser River system include the spring, sockeye, coho, pink, chum and steelhead.

(h) "Fish Handling Facilities in Connection with Proposed Power Dams on the Fraser River with Reference to Existing Facilities in the U.S.A.", prepared by E.S. Pretious, L.R. Kersey and G.P. Contractor.
"Passage of Adult and Young Fish over Proposed Low and High Head Dams Across the Fraser River", prepared by J. F. Muir.

(2737) CURVED CHANNEL FLOW INVESTIGATION.

(b) Laboratory project - assisted by National Research Council Grant.
(c) Dr. A. W. Marris, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.
(d) Project theoretical to date, plans in progress for future experimental investigation; basic research.
(e) Expressions for the mean transverse velocity distributions, sediment concentration and temperature distributions, are developed on a phenomenological eddy diffusivity basis for the case of fully developed turbulent flow in a channel of constant radius of curvature and for which the mean motion is two-dimensional. Vorticity transfer ideas are employed since such are known to yield a substantially correct velocity distribution for the case of flow under zero transverse pressure gradient, for example, turbulent flow in a free vortex or between rotating coaxial cylinders.
(g) The theory agrees with existing experimental data, provided the radius of curvature of the channel is relatively small. An experimental investigation is proposed to investigate further the effect of radius of curvature and channel width on the radial mean velocity distribution.
(h) "On Fully Developed Turbulent Flow in Curved Channels", Canadian Journal of Physics, Nov. 1956.
"On the Distribution of a Fine Suspension for Turbulent Flow in a Curved Path". Presented at National Research Council Symposium on Flow of Suspensions, Nov. 1956.
"Steady State Heat Transfer to Fully Developed Turbulent Flow in a Curved Channel", in preparation for submission to Canadian Journal of Physics.

ÉCOLE POLYTECHNIQUE DE MONTRÉAL, Hydraulics Laboratory.

(266) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.

(f) Suspended.

(268) CALIBRATION TESTS OF A SHARP-CRESTED PARABOLIC WEIR.

(f) Completed.
(h) Report in preparation.

(2483) MODEL STUDY OF ENERGY DISSIPATOR FOR THE CITY OF MEGANTIC DEVELOPMENT ON THE CHAUDIÈRE RIVER, QUEBEC, CANADA.

(f) Completed.
(h) Report in preparation.

NATIONAL RESEARCH COUNCIL, Division of Mechanical Engineering.

Inquiries concerning projects Nos. 1806, 2041, 2485, 2488, 2490, 2491, and 2738, should be addressed to Mr. J. H. Parkin, Director, Division of Mechanical Engineering, National Research Council, Montreal Road, Ottawa, Ontario, Canada.

(1806) ST. LAWRENCE RIVER MODEL--PRESCOTT-CARDINAL REACH.

(b) Department of Transport.
(d) Experimental; for design and development.
(e) A 1:240 x 1:48 scale model of the St. Lawrence River between the towns of Prescott and Cardinal has been constructed to study the effect of engineering works on the water level relationships throughout the reach.
(g) Testing program is nearly completed.

(2041) ST. LAWRENCE RIVER MODEL - CORNWALL ISLAND REACH.

(b) St. Lawrence Seaway Authority.
(d) Experimental; for design and operation.
(e) A 1:480 x 1:96 scale model of about five miles of the St. Lawrence River in the vicinity of Cornwall has been constructed to study the design of proposed engineering works in connection with the seaway.
(g) Testing programs in connection with the power and navigation problems in this area of the river have been underway for over two years.
(h) Reports have been submitted to the sponsor.

(2485) MODEL OF SOULANGES LOCK.

(b) St. Lawrence Seaway Authority.
(d) Experimental; for design.
(e) A 1:30 scale model of an 800 ft. x 80 ft. navigation lock with a lift of 45 ft. has been constructed to evaluate the hydraulic characteristics. Two of these locks are to be constructed in series in the St. Lawrence Seaway. The filling and emptying times and the hawser stresses on a vessel during these operations are the factors of primary interest.
(g) The model has been in operation for eight months. Several configurations of ports and culverts have been tested and several design improvements have been suggested as a result of the model tests.
(h) A report is now in preparation and will be issued to the sponsor.

(2488) MODEL OF PORT AUX BASQUES, NEWFOUNDLAND.

(b) Department of Public Works, Canada.
(d) Experimental; for design.
(e) A 1:128 scale model of the harbour has been constructed. A wave machine and wave profile recorders have been built and have worked successfully on the model. A testing program is underway for the purpose of designing breakwaters and other harbour improvements to reduce wave agitation.
(g) It has been found possible to effect a scheme for the protection of the harbour.
(h) The report will be issued to the sponsor.

(2490) FLOW OF FIBRE SUSPENSIONS.

(b) Laboratory project.
(d) Experimental study for basic research.
(e) Mechanics of flow of fibre suspensions, particularly those used in the pulp and paper industry are being studied in a specially constructed pipeline. It is hoped to evaluate the properties of the suspension by means of velocity and pressure measurements.
(g) Preliminary measurements have been made on a suspension of synthetic fibres. This has shown that for concentrations under 2 percent, the suspension behaves as a Newtonian fluid. More extensive study was made of a typical sulphite pulp. This material was found to have three regimes of flow. For low velocity there is a plug containing all the fibre in the centre of the pipe surrounded by an annulus of water in laminar flow. As the velocity increases the flow changes to one of a plug surrounded by a turbulent annulus and, finally, to fully turbulent flow. In many cases friction factors of the order one-half those for water have been measured.
(h) "Fibre Orientation in Pipe Flow", W. D. Baines and C.I.H. Nicholl, Pulp and Paper Magazine of Canada, Vol. 57, No. 6, pages 119-120, May 1956.
"Application of Hydraulic Models to Flows of Pulp Stock", W. D. Baines, to be published by the Technical Association of the Pulp and Paper Industry, New York. Additional reports are now being written.

(2491) INSTRUMENT FOR MEASUREMENT OF TURBULENT PRESSURES.

(b) National Research Council.
(d) Experimental; for basic research.

(e) An instrument is being developed for the measuring of turbulent pressures in water. It is designed to resolve eddies 4" in diameter and larger, and to be used within one foot of the water surface.
(g) The instrument has been calibrated with both steady and unsteady pressures. It has been found to operate satisfactorily with mechanical pressure cells. An attempt is being made to convert the operation to electric cells.

(2738) SPILLWAY MODEL.

(b) Shawinigan Engineering Company, Limited, Montreal, Canada.
(d) Experimental; for design.
(e) A model of a spillway, to be constructed in the Province of Quebec, has been tested for the purpose of designing the spillway slope and walls.
(h) A report is being prepared for the sponsor.

ONTARIO AGRICULTURAL COLLEGE, Department of Agricultural Engineering.

(2492) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project.
(c) Prof. D. F. Witherspoon, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; applied research.
(e) Relationship of precipitation and snow melt to runoff characteristics on four watersheds of 20 acres each under various land use practices is being evaluated.
(g) Winter surface runoff from watersheds with good grass-legume cover is greater than from watersheds plowed the previous fall.
(h) Publication in press.

(2493) THE EFFECT OF SLOPE AND TILLAGE TREATMENT ON DEPRESSION STORAGE AND SURFACE DETENTION.

(b) Laboratory project.
(c) Prof. H. D. Ayers, Ontario Agricultural College, Guelph, Ontario.
(d) Experimental; basic research, master's thesis.
(e) By simulated rainfall on an impermeable concrete surface mounted on a variable slope carriage, depression storage and surface detention were measured for the different conditions of micro-topography resulting from soil tillage.
(f) Completed.
(g) It was found that there was no definite relationship between depth of detention and slope for the rising side of the hydrograph. The depth of detention was generally greater for the surface with corrugations across the slope than for flat surfaces or surfaces with corrugations in the direction of slope. The same general relationship was true for depths of depression storage with a general decrease in depth for increases of slope.

(2494) EFFECT OF THE UPPER END OF SUBSURFACE DRAINS ON THE WATER TABLE.

(b) Laboratory project.
(c) Prof. R. W. Irwin, Ontario Agricultural College, Guelph, Ontario.
(d) Field investigation; applied research.
(e) By the use of water table pipe the drawdown curves axially and normal to field tile are being determined in relation to time.
(f) Suspended.

(2495) SURFACE DRAINAGE OF TIGHT SOILS.

(b) Laboratory project.
(c) Prof. R. W. Irwin, Ontario Agricultural College, Guelph, Ontario.
(d) Field investigation; development.

(e) Land smoothing and land grading with parallel surface ditches are being evaluated as methods for the surface drainage of an area of heavy clay soil of very low permeability.
(f) Discontinued.

(2496) TILE DRAINAGE DEPTH AND SPACING FORMULA EVALUATION.

(b) Laboratory project.
(c) Prof. F. R. Hore, Ontario Agricultural College, Guelph, Ontario.
(d) Field investigation; applied research.
(e) The purpose of this study was to determine the validity of existing tile drainage depth and spacing formulae for Brookston Clay Soils, by measuring the factors used in the formulae.
(f) Completed.
(g) Because of the questionable accuracy of present methods for making hydraulic conductivity determinations and the uncertainty of criteria for determining adequate drainage, it was concluded that none of the depth and spacing formulae evaluated should be used for field design purposes for fine textured soils in Ontario.

(2498) THE USE OF INFILTRATION DETERMINATIONS FOR RUNOFF ESTIMATES.

(b) Laboratory project.
(c) Prof. H. D. Ayers, Ontario Agricultural College, Guelph, Ontario.
(d) Experimental; basic research, development (one phase for master's thesis).
(e) The purpose of the project is to evaluate the separate factors affecting infiltration and to develop a technique for runoff estimation on a watershed utilizing infiltration data.
(f) Suspended.
(g) Infiltration tests on Guelph loam soil with the Type F infiltrometer indicated an infiltration capacity after 60 minutes of approximately 1.7 inches per hour when there was a good growth of grass and legume covering the soil surface. The same soil with no protective covering had an infiltration capacity of approximately 0.9 inches per hour after a period of 1 hour. It was also found that the mass infiltration for the first ten minutes of applied rainfall varied approximately as the 1/3 power of the non-capillary storage capacity in the upper 2 feet of soil.

(2739) PERMEABILITY OF SOIL IN THE FROZEN STATE.

(b) Laboratory project.
(c) Prof. D. F. Witherspoon, Ontario Agricultural College, Guelph, Ontario.
(d) Experimental; basic research.
(e) Air permeabilities will be obtained of soils at various moisture content in the frozen state. The results will be used to determine if there is a correlation of moisture content and permeability of frozen soils on experimental watersheds.

(2740) MAIN TILE DRAIN SIZES FOR COMPOSITE DRAINAGE OF BROOKSTON CLAY SOIL.

(b) Laboratory project.
(c) Professor F. R. Hore, Ontario Agricultural College, Guelph, Ontario.
(d) Field investigation; applied research.
(e) Discharge measurements from lateral tile drains in Brookston clay soil are being made to determine the proper drainage coefficient to use in the design of main tile drains and to determine the effect of lateral tile drain spacing on the drainage rate.

QUEEN'S UNIVERSITY, Hydraulics Laboratory.

(2044) ECONOMICAL CONSTRUCTION OF SAFE PULPWOOD HOLDING GROUNDS.

(b) Pulp and Paper Research Institute of Canada Limited, 3420 University Street, Montreal, Quebec, Canada.

(c) Prof. R. J. Kennedy, Dept. of Civil Engineering, Queen's University, Kingston, Ontario, Canada.
(d) Applied research; experimental field and laboratory investigation.
(e) Field and laboratory model investigation of forces acting on various types of pulpwood holding grounds.

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THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major field laboratories in Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside front cover.

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Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat and Power. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment. AEC Radiation Instruments.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Gas Chemistry. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Specifications. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

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- Office of Basic Instrumentation
- Office of Weights and Measures

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics. Microwave Circuit Standards.

Hydraulic Research in the United States

Guides to projects conducted by various hydraulic and hydrologic laboratories in the United States and Canada during 1951, 1952, 1953, 1954, 1955, and 1956. Project reports cover work done at 72 private or State laboratories in the United States, 23 Federal laboratories, and 6 Canadian laboratories. These publications outline individual projects on nearly 200 subjects in the field.

Order:

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