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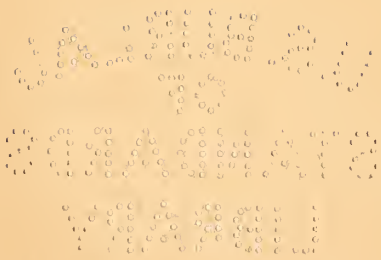
U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
Lyman J. Briggs
Director

NATIONAL BUREAU OF STANDARDS
HYDRAULIC LABORATORY BULLETIN
SERIES A

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

BULLETIN V-1
JANUARY 1, 1937.

WASHINGTON



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DIRECTORY.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES

Compiled by the National Bureau of Standards,
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Hydraulic Laboratory Bulletin, Series A.

Volume V, Number 1. January 1, 1937.

INTRODUCTION.

The following list shows which issues of National Bureau of Standards Hydraulic Laboratory Bulletins, Series A and Series B are still available.

Series A. Current Hydraulic Laboratory Research in the United States.

Bulletin I-1, April 1, 1933, out of print
" I-2, July 1, 1933, " " "
" I-3, October 1, 1933, " " "
" II-1, January 1, 1934, " " "
" II-2, July 1, 1934, " " "
" III-1, January 1, 1935, " " "
" III-2, July 1, 1935, " " "
" IV-1, January 1, 1936,
" IV-2, July 1, 1936.

Series B. Hydraulic Laboratories in the United States (1933).
Hydraulic Laboratories in the United States, 1st revision, 1935.

Attention is called to the means by which additional information regarding the projects reported in this bulletin may be secured. You will note by reference to the "key" below that item (e) is intended to list for each project the name of the person with whom correspondence should be had regarding it.

(Key)

(a) Title of project:
(b) Project conducted for:
(c) Conducted as:
(d) Investigators:
(e) Correspondent:
(f) Purpose:
(g) Method and scope:
(h) Progress:
(i) Remarks:

CURRENT PROJECTS IN HYDRAULIC LABORATORIES.

BALDWIN-SOUTHWARK CORPORATION.

(498) (a) EFFICIENCY AND HORSEPOWER TESTS - BOULDER DAM MODEL TURBINE
(b) U. S. Reclamation Service.
(c) Research preparatory to final design and manufacture of turbines for Boulder Dam.
(d) Baldwin-Southwark Corporation staff.
(e) K. W. Beattie, Research & Test Engineer.
(f) Determination of correct design of complete turbine, including spiral casing and draft tube to secure the best performance.
(g) An exact model was made of the turbine, draft tube and casing, and tested with alternative designs of casings and runners. Pitot tube traverses below the runner used in determining runner modifications. Hydraulic load on model guide vanes measured.
(h) Tests completed.
(i) Data secured used in design of main turbine parts.

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(499) (a) EFFICIENCY AND HORSEPOWER TESTS - PASSAMAQUODDY TIDAL POWER DEVELOPMENT.
(b) U. S. Engineers.
(c) Commercial research.
(d) Baldwin-Southwark Corporation staff in collaboration with U. S. Engineers.
(e) K. W. Beattie, Research & Test Engineer.
(f) Determination of effect on turbine performance of variations in casing and draft tube design, with particular reference to variations affecting unit spacing and excavation.
(g) An existing high specific speed turbine model was used. Model draft tubes and casing were built to permit modifications in width and depth, including changes in piers and insertion of a horizontal baffle in draft tube. Tests were made with each arrangement covering a wide range of operating conditions corresponding to variations in head at the Passamaquoddy Development from 5 ft to 25 ft.
(h) Tests completed.
(i) Data secured used in design of proposed Passamaquoddy Power Development.

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(578) (a) EFFICIENCY AND HORSEPOWER TESTS - MODEL HYDRAULIC TURBINE WITH VARIOUS DRAFT TUBE DESIGNS.
(b) Baldwin-Southwark Corporation.
(c) Elbow draft tube design studies.
(d) Baldwin-Southwark Corporation staff.
(e) K. W. Beattie, Research & Test Engineer.
(f) Investigations for improving turbine performance through revised draft tube design.
(g) Modifications in the draft tube water passages of several draft tubes have been made, each arrangement being used in tests of the same propeller type turbine.
(h) Tests are in progress.
(i) Some modifications have resulted in improved turbine efficiencies.

.....

(579) (a) EFFICIENCY AND HORSEPOWER TESTS - MODEL PROPELLER TYPE HYDRAULIC TURBINE.
(b) Baldwin-Southwark Corporation.
(c) Tests of propeller type turbine runner.
(d) Baldwin-Southwark Corporation Staff.
(e) K. W. Beattie, Research & Test Engineer.
(f) Determination of improved design for runner blades.
(g) Blades of various shapes made and tested in complete turbine setting. Blades constructed of copper to facilitate alterations in shape.
(i) Tests in progress.

.....

CASE SCHOOL OF APPLIED SCIENCE.

(580) (a) HYDRAULIC MODEL STUDY OF SPILLWAY AND OUTLET WORKS, KEYSTONE DAM.
(b) The Central Nebraska Public Power & Irrigation District.
(c) To furnish data for design.
(d) Professor George E. Barnes and Staff; Mr. George N. Carter, Resident Engineer for the District.
(e) Professor George E. Barnes.
(f) To determine capacity and safety of the works.
(g) Model of morning glory spillway modeled to a 1 to 40 scale. A morning glory spillway 90 feet in diameter, gate controlled, with 28-1/2 ft diameter shaft and tunnel; control tower with cylinder gates and 20 ft outlet tunnel; two tunnels leading to a common stilling basin. Calibration of discharge capacity, determination of hydraulic gradients, performance of stilling basin.
(h) Model in process of erection.

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(581) (a) DETERMINATION OF SCOUR ACCOMPANYING HIGH VELOCITIES IN BRULE CLAY.
(b) The Central Nebraska Public Power & Irrigation District.
(c) To determine data for design.
(d) Professor George E. Barnes and Staff; Mr. George N. Carter, Resident Engineer for the District.
(e) Professor George E. Barnes.
(f) To determine permissible velocities in stream bed of brule clay.
(g) Construction of model channel with natural clay and delivery of water at velocities expected in nature.
(h) In process of erection.

.....

(582) (a) HYDRAULIC PERFORMANCE OF JOHNSON POWER DROP.
(b) The Central Nebraska Public Power & Irrigation District.
(c) To furnish data for design.
(d) Professor George E. Barnes and Staff; Mr. George N. Carter, Resident Engineer for the District.
(e) Professor George E. Barnes.
(f) To determine hydraulic performance of Taintor gate control and canal drop.
(g) 1 to 40 scale model undistorted.
(h) Scheduled for erection.

.....

COLUMBIA UNIVERSITY.

(583) (a) DETERMINATION OF CHARACTERISTIC "FRICTION FACTOR - REYNOLDS NUMBER" GRAPHS FOR PITTED PIPE.
(b)
(c) Research.
(d) A. E. Matzke, Research Assistant, and others under direction of Prof. J. K. Finch.
(e) Prof. J. K. Finch, Department of Civil Engineering, Columbia University.
(f) The characteristic form of friction graph for smooth pipe and for pipe with a uniform quality of interior roughness (Nikuradse) have been established. Data are lacking, however, on the form of such graphs for pipe which deteriorates in carrying capacity through pitting. Proposed tests will begin with smooth pipe and will determine effect of artificial pitting of increasing amounts.
(g) Pipe 2 or 3 inches in diameter will be used, and experiments will be carried up to a Reynolds Number of one million or over.
(h) Funds are available. Plans now under way. Experiments will be made during Spring and Summer, beginning about April 15th.

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(584) (a) FLOW THROUGH GRANULAR MATERIALS.
(c) Research.
(d) N. V. Feodoroff under the direction of Prof. B. A. Bakhmeteff and Prof. J. K. Finch.
(e) Prof. B. A. Bakhmeteff and Prof. J. K. Finch, Department of Civil Engineering, Columbia University.
(f) The purpose of this investigation is a study of the application of the basic pipe resistance formula $h_f = f \frac{z}{d} \frac{v^2}{2g}$ to the case of flow through granular material. This involves a study of the behavior of f in the above expression as the Reynolds number varies. Does f in this case vary in a manner similar to the way it varies in the case of a pipe? Is there a "Poiseuille line" for laminar flow breaking off into a "Blasius line" or into one of "Nikuradse's lines" when turbulent flow is attained. What is the effect of variation of grain size and of mixtures of grain size on this phase of flow in granular materials? Is f a function of $\frac{C}{R^{(2-n)}}$? It is the purpose of this investigation to answer these questions.
(g) See (f) above. Water is permitted to flow at different velocities through a three inch pipe filled with lead shot varying in size from "Dust" to a size having a diameter of about 1/4 inch. Measurement of head lost per unit length, discharge, and temperature of water are made. This makes it possible to study the variation of f with a "synthetic" expression of the Reynolds Number type based on the physical features of the case. Experiments of this type will also be performed on sand and gravel.
(h) The experimental work is about 2/3 completed at present.

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(585) (a) THE HYDRAULIC JUMP IN A SLOPING CHANNEL.
(b)
(c) Research.
(d) A. E. Matzke, Research Assistant, under the direction of Prof. B. A. Bakhmeteff and Prof. J. K. Finch.
(e) Prof. B. A. Bakhmeteff and Prof. J. K. Finch, Department of Civil Engineering, Columbia University.
(f) Almost all of the work both theoretical and experimental, which has been done thus far on the hydraulic jump has dealt with a horizontal channel floor. This project includes a theoretical and experimental investigation of the hydraulic jump in channels of various slopes.
(g) See (f) above. The experimental work has been performed in the tilting flume of the Hydraulic Research Laboratory of the Department of Civil Engineering of Columbia University. The experiments have been done on floor slopes up to 0.07 in an attempt to cover the practical range of bottom slopes. Four series of experiments were run at various slopes, the kinetic flow factor remaining constant while the slope varied in each of the series. An attempt was also made to cover the practical range of kinetic flow factors.

(h) The work has been completed and will soon be ready for publication in a journal of one of the engineering societies.

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(586) (a) A STUDY OF SUBMERGED FLOW.
(c) Research.
(d) A. E. Matzke under the direction of Prof. B. A. Bakhmeteff and Prof. J. K. Finch, Department of Civil Engineering, Columbia University.
(e) Prof. B. A. Bakhmeteff and Prof. J. K. Finch, Department of Civil Engineering, Columbia University.
(f) A systematic study of flow through submerged sluices, and over submerged weirs will be made in an attempt to clarify the understanding of these phenomena and to make them more applicable for practical use by engineers.
(g) Submerged flow will be produced and studied in the flume of the Hydraulic Research Laboratory of the Department of Civil Engineering. Pressures, surface profiles, and velocities will be measured. The definite scope of this project will depend to a great extent on the results obtained and the questions raised by the early experiments.
(h) Preliminary experiments on a broad crested weir and on a sluice gate have been made. Installation of apparatus for the systematic study of the sluice is practically completed, and experiments will be run in the very near future.

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CORNELL UNIVERSITY.

(587) (a) LARGE A. S. M. E. FLOW NOZZLES WITH WATER.
(b) National Bureau of Standards.
(c) Co-operative research.
(d) F. C. Morey, E. W. Schoder, A. N. Vanderlip.
(e) Professor E. W. Schoder.
(f) Finding of coefficients and loss of head.
(g) Alternately circulating an established gravity flow through the nozzle and measuring it volumetrically, using a weir as index of change; water column gages up to 12 ft head, mercury manometer (reservoir type) for higher heads. Three sizes: - 23 1/4 inch x 5.625 inch, 10.02 inch, 13.00 inch.
(h) The two smaller nozzles have been tested, and work is about to begin on the 23 1/4 x 13.00 inches.
(i) For the present it is assumed that the location of the downstream piezometer in the outer pipe wall just upstream from the tip of nozzle is a satisfactory tentative standard position.

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(588) (a) SMALL WOODEN FLUME.
(b) Departmental investigation.
(c) General scientific research.
(d) E. W. Schoder, A. N. Vanderlip.
(e) Prof. E. W. Schoder or Mr. A. N. Vanderlip.
(f) Preliminary to proposed checks on the classic data that lead to Kutter and Manning formulas.

(g) Volumetric measurements of discharge; water level and point or hook gages for slope and depth; micrometer calipers (under water) for widths. All these tentative.
(h) A fair start has been made with one slope.

.....

(589) (a) NORMAL DISTRIBUTION OF VELOCITIES FOR WATER IN BRASS PIPE.
(c) Graduate thesis.
(d) C. Y. Ling.
(e) Professor E. W. Schoder.
(f) To assist in finding nature of turbulent flow near wall.
(g) A 5-inch brass pipe, gravity flow, tiny hypodermic-needle Pitot tube, mean velocities up to 35 fps, are the main features.
(h) Work in progress.

.....

(590) (a) CHENANGO RIVER MODEL TEST.
(b) U. S. Corps of Engineers.
(c) Co-operative engineering research.
(d) U. S. Engineers and Cornell Staff.
(e) Professor S. C. Hollister.
(f) To find effect of proposed improvements in river bed and in bridge piers in the lower Chenango at Binghamton, at which place the July 8, 1935, flood caused a depth of 24 ft and a discharge of over 80,000 cfs.
(g) Details of method and scope now under consideration.
(h) About 150 ft of the outdoor canal (16 ft wide and 10 ft deep) is being roofed over to house the model and permit work to proceed during the winter.

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UNIVERSITY OF FLORIDA.

(591) (a) MODEL TEST OF A LABORATORY VENTURI FLUME.
(b) Graduate thesis.
(c) Laboratory research preliminary to design of full-scale structure for proposed new hydraulic laboratory for the University and Engineering Experiment Station.
(d) Robert M. Johnson.
(e) Professor Thomas M. Lowe.
(f) To determine the characteristics of Parshall's improved Venturi section in a narrow channel and its applicability as a form of weir for measuring the rate of flow through a rectangular laboratory flume.
(g) Wooden model of a portion of flume and Venturi section installed in laboratory and water circulated by a centrifugal pump. Orifice and Venturi meters in pump circuit used to measure rate of flow. Specially constructed gauges, piezometers, etc., were used to obtain the necessary hydraulic data.
(h) Study completed. Thesis will be placed in the University of Florida library February 1, 1937.
(i) Thesis also contains sectional views and floor plans of proposed hydraulic laboratory, and layout of experimental and instructional equipment.

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HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(390) (a) VELOCITY DISTRIBUTION IN STREAM CHANNELS.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton, C. W. Force and Laboratory staff.
(e) Robert E. Horton.
(f) Investigation comprises two parts: (1) A mathematical investigation of the form of velocity curves in open channels called for by the Manning formula; (2) An analysis and study of several hundred vertical velocity curves obtained in natural river channels, with a view to comparing the actual and theoretical curves.
(h) Investigation nearly completed and publication expected within a few months. See abstract in Bulletin III-1.

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(391) (a) BACK-WATER BY THE MANNING FORMULA.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and Laboratory staff.
(e) Robert E. Horton.
(f) Improvement in methods of analysis of problems of non-uniform flow.
(g) An integral of the back-water function in terms of the Manning formula has been obtained and tables of back-water functions have been computed therefrom for rectangular channels. It is believed that the method has important advantages because of the fact that where, as is ordinarily the case, back-water calculations are based on the Chezy formula, with a constant coefficient, serious errors are involved when the depth varies because the coefficient is itself a function of the depth.
(h) Investigation completed but results not yet written up in form for publication.

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(392) (a) DISPERSION CURVES OF MANNING'S COEFFICIENT OF ROUGHNESS.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and laboratory staff.
(e) Robert E. Horton.
(f) The purpose is to provide a means of presentation of experimental values of the coefficient of roughness n in such a manner that the percentage of cases in which the observed coefficient has been found to be greater or less than a given value can at once be determined, thus leading to a more direct and certain method of selection by judgment of values of the coefficient of roughness applicable to a given case.
(g) All available values of the coefficient n for certain particular types of channels have been collated and plotted in the form of frequency curves. The analysis does not, however, cover all types of channels and covers only a limited number of classes of pipe surface.
(h) Investigation completed but results not yet written up in form for publication.

.....

(293) (a) FLOOD WAVES SUBJECT TO FRICTION CONTROL.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and laboratory staff.
(e) Robert E. Horton.
(f) To provide a basis for practical determination of the crest velocity and change of form of natural flood waves in large rivers.
(g) This research relates to the theoretical aspects of the subject. It is founded on an experimental investigation conducted some years ago at the same laboratory, using a slope table 120 feet in length, for the purpose of determining experimental forms of flood wave crests. The experimental research was conducted in part for the Sanitary District of Chicago. The present research relates mainly to the analysis of the results and is predicated on the idea that the movement of a flood wave in rivers is not, on the one hand amenable purely to momentum control, like waves in still water; neither is it, on the other hand, subject solely to friction control, as in the case of non-uniform flow in channels.
(h) Experimental investigation completed; theoretical investigation in progress. Sugges tions are desired from other laboratories interested in this same problem.
See Abstract in Bulletin III-1.

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(294) (a) RELATION OF CARRYING CAPACITY OF CAST IRON PIPE CONDUITS TO AGE IN SERVICE.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton.
(e) Robert E. Horton.
(f) Contribution to knowledge of the variation with age of the carrying capacity of water supply conduits and distribution mains.
(g) This investigation comprises mainly an analysis of continuous records covering five periods averaging one to three years each of variation in discharge coefficient with length of time in service since cleaning of a 24-inch water supply conduit at Utica, N. Y. It is shown that in this case the carrying capacity after cleaning decreases as an inverse exponential function of the time in service but does not approach zero as a limiting value. Causes of this are discussed and a comparison is made with other experimental data on the decrease in carrying capacity of pipe with age in service.

.....

(385) (a) SURFACE RUNOFF PHENOMENA.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and laboratory staff.

(e) Robert E. Horton.
(f) To determine (1) the law governing depth and velocity of overland or sheet flow under natural conditions; (2) to provide a means of analyzing the hydrograph into its various component elements, including surface runoff, infiltration, accretion to soil moisture and ground-water flow; also to determine depth of surface detention during runoff; phenomena of surface runoff, amount of channel storage following surface runoff, and law governing depletion of channel storage.

.....

(386) (a) WIND VELOCITY NEAR THE GROUND.
(b) Scientific research.
(c) Scientific research.
(d) Robert E. Horton and laboratory staff.
(e) Robert E. Horton.
(f) Scientific research.
(g) Records of wind velocity 1 foot above ground at about sixty stations in the United States have been compared with measured wind velocities at nearby U. S. Weather Bureau Stations at various heights up to 200 feet above the ground and these results compared with existing formulas of Stevenson, Hellman and others and with their experimental data.
(i) Comparison is also made between the law governing wind velocity distribution and that of water in a wide stream channel for turbulent flow conditions. Consideration is also given to the conditions under which air flow over the ground surface is laminar. See Bulletin III-3 for conclusions reached.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(311) (a) TRANSPORTATION OF BOTTOM LOAD IN OPEN CHANNELS.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Professor F. T. Mavis and Te Yun Liu.
(e) Professor F. T. Mavis.
(h) Laboratory studies of capacity for traction completed for four unigranular samples of Iowa River sand and for two mixtures. Report being prepared.

.....

(314) (a) LABORATORY STUDY OF GROUND WATER FLOWLINES.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. F. T. Mavis and T. P. Tsui.
(e) Professor F. T. Mavis.
(h) Continuation of studies previously reported. Scheduled for completion in June, 1937.

.....

(316) (a) HYDROLOGIC STUDIES - RALSTON CREEK WATERSHED.
(c) Cooperative project - Iowa Institute of Hydraulic Research, U. S. Department of Agriculture, and U. S. Geological Survey.
(e) Professor F. T. Mavis.
(h) Continuous records since 1924 of precipitation, runoff, groundwater levels, and cover. Drainage area, 3 sq mi of rolling agricultural land near east city limits of Iowa City.
(i) Bulletin 9, University of Iowa Studies in Engineering by F. T. Mavis and Edward Soucek entitled, "A Summary of Hydrologic Data, Ralston Creek Watershed, 1924-1935", is in press.

.....

(317) (a) COOPERATIVE STREAM GAGING IN IOWA.
(b) Iowa Institute of Hydraulic Research.
(c) Cooperative project - U. S. Geological Survey.
(d) R. G. Kasel, District Engineer, and staff.
(e) Prof. F. T. Mavis.
(h) Stream gaging stations are maintained cooperatively at stations on major watersheds in Iowa. Report on stream flow records in Iowa 1873-1932 was prepared cooperatively by U. S. Geological Survey, Iowa Institute of Hydraulic Research, and Iowa State Planning Board, and published by the Iowa State Planning Board.

.....

(455) (a) FUNCTIONAL DESIGN OF FLOOD CONTROL RESERVOIRS.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. C. J. Posey and Fu-Te I.
(e) Professor F. T. Mavis.
(f) Analysis of flood routing problems.

.....

(456) (a) THE HYDRAULIC JUMP IN ENCLOSED CONDUITS.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. E. W. Lane and C. E. Kindsvater.
(e) Prof. F. T. Mavis.
(f) To check the applicability of computations based on momentum relations to the hydraulic jump in enclosed conduits.

.....

(506) (a) THE EFFECT OF SCALE RATIO ON SCOUR BELOW MODEL STILLING POOLS.
(b) Mechanics and Hydraulics Department.
(c) Graduate College project and thesis.
(d) Prof. F. T. Mavis, Prof. E. W. Lane, and P. C. Stein.
(e) Prof. F. T. Mavis.
(f) To investigate similitude relations in model tests of scour below spillways.
(h) Laboratory work largely completed; report being prepared.

.....

(507) (a) THE CONVERSION OF KINETIC INTO POTENTIAL ENERGY.
(b) Am. Soc. C. E. Committee on Hydraulic Research.
(c) Independent research.
(d) Prof. F. T. Mavis and Dr. A. Lukasch.
(e) Prof. F. T. Mavis.
(f) To investigate basic physical phenomena of flow in divergent conduits with particular reference to the conversion of energy.
(h) Preliminary studies of flow in a transparent expanding conduit have been completed.

.....

(508) (a) TESTS OF PROPORTIONAL FLOW (SUTRO) WEIRS.
(b) Iowa Institute of Hydraulic Research.
(c) Independent research.
(d) Edward Soucek, H. E. Howe, and F. T. Mavis.
(e) Prof. F. T. Mavis.
(g) Discharge coefficients for Sutro weirs, for which discharge is directly proportional to head above a fixed datum, are generalized in terms of weir proportions.
(h) Published: "Sutro Weir Investigations Furnish Discharge Coefficients", by E. Soucek, H. E. Howe, and F. T. Mavis, Engineering News-Record, Nov. 12, 1936, pp. 679-680.
(i) Correction: In formula (1) of above paper, square-root sign should include term $2g$ only.

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(592) (a) A STUDY OF SAND WAVES AND THEIR EFFECT ON HYDRAULIC ROUGHNESS.
(c) Independent research.
(d) Prof. E. W. Lane.
(e) Prof. E. W. Lane.
(f) To investigate the conditions giving rise to sand waves in large rivers and their effect on the hydraulic roughness of the river channels.

.....

(593) (a) A MODEL STUDY OF PIPING BENEATH MASONRY DAMS ON EARTH FOUNDATIONS.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. E. W. Lane and K. W. Liu.
(e) Prof. F. T. Mavis.
(f) To investigate the hydraulic gradient theory of piping below masonry dams on earth foundations.

.....

(594) (a) DISCHARGE COEFFICIENTS OF DAMS WITH NAPPE SHAPED CRESTS.
(b) Mechanical and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. E. W. Lane and W. H. Leung.
(e) Prof. F. T. Mavis.
(f) To determine the discharge coefficients of spillways constructed to fit the under surface of the nappes from level crested weirs for various heads.

.....

(595) (a) A STUDY OF THE CARRYING CAPACITY OF RIVERS FOR SILT IN SUSPENSION.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. E. W. Lane and G. H. Dunstan.
(e) Prof. F. T. Mavis.
(f) To derive quantitative relations for the silt-carrying capacity of streams.

.....

(596) (a) MODEL STUDY OF RALSTON CREEK CONTROL.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Edward Soucek, J. S. McNown, and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To compare rating curves for two models and prototype of existing control at Ralston Creek gaging station.

.....

(597) (a) CONTROL OF SILT DEPOSITS NEAR CONDENSER INTAKES OF A STEAM POWER PLANT.
(b) Iowa Institute of Hydraulic Research and Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Edward Soucek, E. R. Van Driest, and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To study methods of controlling deposits in pond and in condensers themselves.

.....

(598) (a) MODEL DRAFT TUBE STUDIES.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Dr. A. Luksch, H. H. Chang, and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To study flow at constant head through model spreading tube with different cones and with different angularities of entering water.
(i) Continuation of studies previously reported.

.....

(599) (a) STUDY OF VACUUM FORMATIONS IN WATER SUPPLY SYSTEMS OF BUILDINGS.
(b) Iowa Institute of Hydraulic Research and National Association of Master Plumbers, Inc.
(c) Institute project.
(d) Dean F. M. Dawson, A. A. Kalinske, and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To investigate vacuum formations in practical installations and methods of preventing back-siphonage from submerged inlet fixtures.
(h) Two-inch water riser 4-stories high has been installed with interchangeable branch connections at each floor. Pressures and rates of water and air flow have been observed in preliminary investigations. Progress report due June, 1937.

.....

(600) (a) HYDRAULICS OF VERTICAL STACKS WITH CONNECTING DRAINS LAID AT DIFFERENT SLOPES.
(b) Iowa Institute of Hydraulic Research.
(c) Institute project.
(d) A. A. Kalinske and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(g) Transparent sections in stack and connecting drain to facilitate observation of flow in conduit partially filled with water.
(h) Apparatus being assembled.

.....

(601) (a) HYDRAULICS AND PNEUMATICS OF VERTICAL PIPES FLOWING PARTLY FULL.
(b) Iowa Institute of Hydraulic Research.
(c) Basis for further investigation of hydraulics and pneumatics of plumbing drainage systems.
(d) Dean F. M. Dawson and A. A. Kalinske.
(e) Prof. F. T. Mavis.
(f) To determine minimum drain, stack, and vent sizes for plumbing installations and to study phenomena of non-uniform flow of water in circular conduits not directly open to the air.
(h) Experimental studies were completed by investigators (d) at the Hydraulics Laboratory of the University of Wisconsin. Report is ready for publication.

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(602) (a) HYDRAULIC JUMP IN TRAPEZOIDAL CHANNELS.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. C. J. Posey and P. S. Hsing.
(e) Prof. F. T. Mavis.
(f) To test limits of satisfactory jump action and agreement with the momentum theory over the range of commonly used shapes of trapezoidal channels with especial attention to scale effect.

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(603) (a) DETERMINATION OF SHAPE OF NAPPE AND COEFFICIENT OF DISCHARGE OF A VERTICAL, SHARP-CRESTED WEIR, CIRCULAR IN PLAN, WITH RADIALLY INWARD FLOW.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. J. W. Howe and C. S. Camp.
(e) Prof. F. T. Mavis.
(f) To determine relation of head-radius ratio to shape of nappe and to discharge coefficient.

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(604) (a) COEFFICIENT OF DISCHARGE FOR TAINTER GATE WITH HORIZONTAL SILL.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) Prof. J. W. Howe and J. K. Peng. (e) Professor F. T. Mavis.
(f) To determine relation between coefficient of discharge and head and angle of lip.

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(605) (a) SLOPE-RATIO STUDY OF A MOVABLE-BED RIVER MODEL.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) P. C. Stein, Lieut. J. D. Lang, and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To compare slopes, rates of flow, and stream bed formations in a movable-bed model under stable conditions using different bed materials.
(i) A modified extension of (451) previously reported.

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(606) (a) SCOUR BELOW DAMS WITH SHALLOW BACKWATER.
(b) Mechanics and Hydraulics Department.
(c) Graduate thesis.
(d) P. C. Stein, Lieut. A. S. Frye, Jr., and Prof. F. T. Mavis.
(e) Prof. F. T. Mavis.
(f) To study relative efficiency of various aprons in minimizing scour below dams without stilling pools.

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(509) (a) FLOW OF WATER AROUND 6-INCH CELLULOID PIPE BENDS. (See Agricultural Engineering report in this Bulletin.)
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative, government and Iowa Institute of Hydraulic Research.
(d) U. S. Department of Agriculture Staff.
(e) David L. Yarnell, Senior Engineer.
(f) To determine losses, changes in pressure, velocity and direction of current flowing through 6-inch pipe bends with various amounts of total curvature, on hyperbolic and elliptical-shaped bends, on an abrupt 90-degree elbow, as well as on a bend of circular cross-section with varying radius of curvature. The research included cases with uniform and other cases with non-uniform velocity distribution in the pipe approaching the bend.
(g) The investigation included tests on nine different bends. Pressure and velocity measurements taken at a great many points on the bends, as well as on the tangents, for velocities ranging from 2 to 14 fps. The practicability of using a bend as a flow meter was fully investigated.
(h) The research has been completed and the report is now ready for the press.
(i) The tests revealed many interesting facts which are here summarized very briefly:
1. All bends act as obstructions to flow, resulting in additional loss of head.
2. With uniform or normal velocity distribution in the approach conduit to the bend, the velocities of the filaments along the inside wall of the bend are increased while those along the outside wall are reduced.
3. Using a standard-radius 6-inch, 90-degree celluloid bend as a basis for comparison, and with uniform or normal velocity distribution in the approach conduit to the bend, the 45-degree bend gave a loss of head about 3/4 that on the 90-degree bend; the 180-degree bend with continuous curvature in one direction gave about 1 1/4 times that on the 90-degree bend; the 180-degree

reversed curve bend about 3.1, the 270-degree bend about 3.7, and the 90-degree abrupt elbow about 7.0 times that on the standard-radius 6-inch, 90-degree celluloid bend.

4. For a given pipe bend, and quantity of flow, the head lost in the bend depends upon the velocity distribution in the approach tangent. The loss of head may be many times greater for one condition of velocity distribution than for another type of velocity distribution.

5. After a pipe bend has been calibrated, it may be used as a flow meter and discharges may be determined by merely measuring the difference in pressure between the inside and outside of the bend.

6. The losses in the pipe bends experimented upon appear to vary as the square of the velocity and not as the 2.25 power as suggested by some writers.

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(510) (a) HYDRAULIC JUMP ON SLOPING APRONS. (See Agricultural Engineering.)
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative, Government and Iowa Institute of Hydraulic Research.
(d) U. S. Department of Agriculture Staff.
(e) David L. Yarnell, Senior Engineer.
(f) To investigate the best methods of dissipating the energy in the high-velocity water at the foot of such aprons and to develop the cheapest and most efficient method for accomplishing this.
(g) The experiments are being conducted in a flume 30 inches wide equipped with transparent walls. Many pressure and velocity measurements are being taken for various quantities of flow and various depth of approach water, and tail water and for aprons having different slopes. Many lateral drainage ditches discharge through chutes into main ditches. Similar structures are used for irrigation systems in dropping the water down steep aprons. The failures of such structures are caused by the inefficient dissipation of the energy in the water at the foot of such structures.
(h) Investigations are now being made.
(i) The theory of the hydraulic jump on sloping aprons has been developed. When the discharge, upstream and downstream depths are increased by the model ratio law, it appears from the limited number of tests so far made that the lengths of the roller and the jump also increase in the same ratio. A progress report on the investigation is now under way.

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(511) (a) FLOW OF WATER AROUND 180-DEGREE BENDS OF SQUARE AND RECTANGULAR SECTION. (See Agricultural Engineering.)
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative, Government and Iowa Institute of Hydraulic Research.
(d) U. S. Department of Agriculture staff.
(e) David L. Yarnell, Senior Engineer.
(f) To determine losses, changes in pressure, velocity and direction of current flowing around both open and closed bends of various curvatures.

(g) Investigation included measurements of pressure and velocity for various quantities of flow for channels 10" x 10" with 5" inner radius, 5" wide by 10" deep with 5" inner radius, and 5" wide by 10" deep with 10" inner radius. Effect of non-uniform velocity of approach on losses investigated.
(h) Investigation completed and report issued in October, 1936, as Technical Bulletin No. 536 of the U. S. Department of Agriculture.
(i) While the report gave much data on pressure and velocity distribution in the bend, information on losses obtained was not as complete as desired, because of the limited capacity of the laboratory at the time the tests were made. Annotated bibliographies on flow of water around bends in mimeographed form may be had by addressing Chief, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

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(109) (a) STUDY TO IMPROVE HYDRAULIC SYSTEM OF NAVIGATION LOCKS, GENERAL MODEL.
(b) Corps of Engineers, U.S.A.
(c) Institute project and graduate thesis.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To eliminate as many as possible of the features now found to be unsatisfactory in river navigation locks and to increase the efficiency of the hydraulic systems of such locks.
(g) A typical barge lock was constructed 1/15th full size and was subsequently altered to conform to changes indicated by tests. The model reproduced the complete hydraulic system of a lock.
(h) A final report is in preparation.

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(213) (a) MISSISSIPPI R., LOCK AND DAM NO. 26, ALTON, ILL., GENERAL.
(b) Corps of Engineers, U. S. A., St. Louis District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To study changes in river regimen caused by the project structures at each of two sites, to design means of preventing erosion around bridge piers immediately downstream from one site, to determine the best composition for the dam and backwater caused by it during and after construction, and to design adequate stilling basins.
(g) Tests were run in two distorted, movable bed, river models, one movable bed model of a section of dams and bridges, and a single Tainter gate model.
(h) Tests are complete and final report is in preparation.

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(387) (a) KANAWHA R., WINFIELD LOCK AND DAM, WINFIELD, W. VA., GENERAL.
(b) Corps of Engineers, U. S. A., Huntington District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the effects of Winfield Lock and Dam, their construction cofferdams, and a proposed power plant on backwater, velocities, and navigation conditions of the river in the vicinity of the site.
(g) Tests were made in a fixed bed, undistorted river model 1/135th full size.
(h) Tests are complete and a final report is in preparation.

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(388) (a) KANAWHA R., WINFIELD LOCK AND DAM, WINFIELD, W. VA., STILLING BASINS.
(b) Corps of Engineers, U. S. A., Huntington District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To develop a stilling basin to protect the structure against erosion.
(g) Stilling basin designs were developed in a model of a single roller gate. Extent of scour in a sand bed downstream and observation through the glass side of the test flume served as the basis for effectiveness. Pressure studies on the gate sill were made in the above model and a model of a section of gate and sill.
(h) Tests are complete and a final report is in preparation.

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(393) (a) ROLLER GATE COEFFICIENTS (RI).
(b) Corps of Engineers, U. S. A., Rock Island District.
(c) Institute project and graduate thesis.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine coefficients of discharge for roller gates operating singly and in groups under typical upper Mississippi River conditions.
(g) A model was set up in a canal 16 ft wide, supplied with water from the Iowa River. Three 20 x 80-ft roller gates and adjacent piers were simulated by a 1/18th scale model. Calibrations were made with the gates raised and submerged; both free flow and submerged flow conditions were investigated in the latter case.
(h) Project completed.
(i) Information relative to the final report may be obtained from the District Engineer, U. S. Engineer Office, St. Paul, Minn. A thesis entitled, "The Effect of End Contraction on Roller Gate Coefficients", dealing with this study was submitted in partial fulfillment of the requirements for the degree M. S. in Hydraulic Engineering at the State University of Iowa by Clarence N. Morang (November, 1936).

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(402) (a) OHIO R., MONTGOMERY ISLAND LOCK AND DAM.
(b) Corps of Engineers, U. S. A., Pittsburgh District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To investigate methods of eliminating cross currents at the upper lock entrance and the effectiveness of fixed weirs at the ends of the spillway, to determine the backwater effect of the structure and the effect of Montgomery Island on current conditions in the lower lock approach.
(g) Investigation was carried out in a fixed-bed, undistorted model 1/125th full size.
(h) Tests are completed and a final report is in preparation.

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(404) (a) MONONGAHELA R., NEW DAM NO. 4.
(b) Corps of Engineers, U. S. A., Pittsburgh District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To test the proposed apron design and to make alterations if found necessary to guard against erosion below the dam.
(g) Models of spillway and stilling basin 1/20th full size were tested in a glass-sided flume. In the course of tests, detailed studies were made of pressure and velocity distribution over two fixed spillway shapes. Good correlation was obtained between model and prototype.
(h) Project completed.
(i) Information relative to the report on this project may be obtained from the District Engineer, U. S. Engineer Office, St. Paul, Minn.

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(445) (a) MISSISSIPPI R., LOCK AND DAM NO. 26, ALTON, ILL., COFFERDAMS.
(b) Corps of Engineers, U. S. A., St. Louis District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the effect of channel restriction upon protective works designed for the auxiliary lock, and to measure backwaters caused by the various cofferdams.
(g) A movable-bed, distorted model of a short reach of river including the site of Dam No. 26 and bridges downstream from it was built for this study. Various expedients suggested to prevent scour were tested at critical points around different cofferdams and the locks.
(h) Tests are complete and a final report is in preparation.

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(446) (a) ROLLER GATE COEFFICIENTS (St.P)
(b) Corps of Engineers, U. S. A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine discharge coefficients for gates as constructed in Mississippi River Dams Nos. 5, 5A, and B.
(g) Tests were made on single, submergible roller gates set up to simulate each dam on a scale of 1/38. Models were accurately machined from aluminum castings.
(h) Tests are complete and a final report is in preparation.
(i) Flow under the rollers has been expressed in nomographic charts. Flow over the gates has been worked up into fields of discharge coefficients.

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(447) (a) TAINTER GATE COEFFICIENTS.
(b) Corps of Engineers, U. S. A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine discharge coefficients for gates as constructed in Mississippi River Dams Nos. 5, 5A, and B.
(g) Tests will be made on models representing a single Tainter gate in each of the dams listed above. The models will be machined from aluminum castings on a scale of 1/17.2 and will be set up in a glass-sided flume.
(h) Models are under construction.

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(448) (a) WEEP HOLES.
(b) Corps of Engineers, U.S.A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the conditions under which gravel will be discharged from weep holes in lock floors and stilling basins.
(g) An apparatus was set up in which metal pipes represented weep holes 6 and 10 in. in diameter, each diameter 1 1/2 and 4 ft long, to 1/1 scale. Increasing discharges were passed through two gradings of gravel in each set up until the gravel was washed out of the pipe.
(h) Tests are complete and a report is in preparation.

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(512) (a) ILLINOIS R., PEORIA-LA GRANGE DAMS.
(b) Corps of Engineers, U. S. A. 1st Chicago District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the leakage through the wicket section of the dam for various heads and the discharge capacities and hydraulic characteristics of the butterfly valve section of the dams for various heads.

(g) A 1/7th scale model was set up in a 10-ft canal supplied with water directly from the Iowa River. Peoria dam butterfly valves were set up on one side of the canal and La Grange valves on the other, with wickets between. Discharges were measured over V-notch or suppressed, rectangular weirs, depending on the quantity, and upper and lower pools were measured with hook gages. Lower pools were controlled by a flap gate.
(h) Tests are complete.
(i) Results will not be generalized but will be presented so as to be applicable only to the specific conditions.

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(514) (a) TENNESSEE R. GUNTERSVILLE LOCK HYDRAULIC SYSTEM.
(b) Corps of Engineers, U. S. A., Nashville District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To study the arrangement and design of filling and emptying ports for the Guntersville Lock.
(g) A model of the entire hydraulic system for this lock was tested. Pressures and velocities were measured at critical points and observations were made to determine rate and time of filling.
(h) Tests are complete and a final report is in preparation.

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(516) (a) TENNESSEE R., CHICKAMAUGA LOCK AND DAM.
(b) Corps of Engineers, U. S. A., Nashville District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the effect on navigation of the diversion of North Chickamauga Creek into the channel downstream from the locks and to develop remedial measures if the diversion caused adverse currents.
(g) Tests were made in a fixed bed model of a portion of the Tennessee River and adjacent valley wall. The model scale was 1/60. The effects of various changes were compared by means of float and velocity measurements.
(h) Tests are complete.

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(517) (a) PILE FOUNDATION TESTS.
(b) Corps of Engineers, U. S. A., Upper Mississippi Valley Division.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To solve, by tests on scale models, problems of load capacities of pile groups as compared with single piles, loads to be applied both vertically and horizontally.
(g) Model piles 1/6th, 1/12th, 1/18th and 1/24th as large as standard wood piles 35, 40, and 45 ft long will be driven and loaded in a fine, clean river sand of uniform grading. The sand bed is contained in a pit so arranged that different seepage rates can be

maintained through it. Vertical and horizontal loads are being applied on single piles and deflections measured. Later tests will be made on groups of piles.

(h) Initial tests have been made to determine the vertical load bearing capacity of single 1/24th scale piles. Results are encouraging.

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(607) (a) CHANGING WICKET CALIBRATION.
(b) Corps of Engineers, U. S. A., Ohio River Division.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To establish rating curves for discharge through and over wicket dams under the varying conditions which obtain in the Ohio River.
(g) A 10-ft canal, supplied with water from the Iowa River, is used for these tests. In it a section of typical wicket dam, 1/7th actual size, has been set up. Tests will be run to calibrate variously shaped and sized openings between wickets and to calibrate different arrangements of tripped wickets.
(h) The model is being completed.

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(608) (a) MISSISSIPPI R., LOCK AND DAM NO. 3, RED WING, MINN.
(b) Corps of Engineers, U. S. A., St. Paul District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To develop suitable protection against erosion in the upper lock approach and immediately downstream from the locks while river flow is passed through the locks during construction.
(g) A model was constructed with a vertical scale 1/40th and a horizontal scale 1/70th full size, covering a short reach of the river adjacent to the dam site. The area around the locks was formed of "Haydite", a commercial term for material resembling crushed, blast furnace slag. Small areas were later formed of Barnsdall concrete admix, a very fine, granular material, in order that scour in those areas might be accelerated.
(h) Tests are complete.

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(609) (a) TENNESSEE R., WATTS BAR LOCK HYDRAULIC SYSTEM.
(b) Corps of Engineers, U. S. A., Nashville District.
(c) Institute project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine lock filling and emptying characteristics for a lift of 71 ft.
(g) Tests were made in a model which simulated a complete lock on a scale of 1/20. Filling curves (water surface = ordinate, time = abscissa) were established for various methods of intake valve operation.

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LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE.

(28) (a) HYDROLOGICAL STUDY OF CITY PARK LAKE DRAINAGE AREA.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and Assistants.
(e) Dr. Glen N. Cox.
(f) Study of rainfall, runoff and evaporation.
(g) The rainfall is measured in five standard cans and a Ferguson Weighing Recording Rain Gage, placed at various points over the 507 acre drainage area. The control is a concrete weir. An attempt will be made at arriving at the evaporation from the lake by knowing the amount of water that is being turned into the lake during dry periods and the amount that is being discharged.
(h) Records have been taken since April 1, 1933.

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(224) (a) FACTORS AFFECTING THE EVAPORATION FROM A LAND PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Dr. Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) To determine the effect of the various meteorological factors on evaporation.
(g) Records of evaporation are taken on a standard U. S. Weather Bureau Land Pan, and meteorological data are obtained from a nearby station maintained by the Geology Department of the University.
(h) Records have been taken since June 1, 1933.

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(225) (a) COMPARISON OF EVAPORATION BETWEEN A LAND PAN AND A FLOATING PAN.
(b) Cooperative between the U. S. Geological Survey and the College of Engineering, Louisiana State University.
(c) General scientific research.
(d) Glen N. Cox and assistants.
(e) Dr. Glen N. Cox.
(f) Evident from title.
(g) A U. S. Geological Survey type floating pan is used, about which a barricade has been placed to reduce wave action. A recording thermometer and an anemometer have been installed so that a continuous record of lake temperatures and of wind movement may be obtained.
(h) Records have been taken since October, 1933.

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(336) (a) TILE AND OPEN DITCH DRAINAGE.
(b) Cooperative between the U. S. Department of Agriculture and the College of Engineering, Louisiana University.
(c) General scientific research.
(d) B. O. Childs and Dr. Glen N. Cox.
(e) B. O. Childs, Houma, La., or Dr. Glen N. Cox.
(f) Study of rainfall, runoff, monthly water requirements of sugar-cane, water-holding power, etc.
(g) Records of rainfall have been kept on a tiled and on an open ditch area since October 1, 1930. All runoff is pumped and measured. Water-table readings have been taken at a large number of places daily.
(h) Using the four year record, a paper has been prepared for the open ditch area which shows the water requirements of sugar cane, the amount of water needed to raise the ground water level, and the amount of water needed to wet surface material without producing any effect on ground water. This paper has not been published to date.

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S. MORGAN SMITH COMPANY.

(610) (a) STRESS INVESTIGATION OF TURBINE TOP PLATE.
(b) S. Morgan Smith Company.
(c) Research.
(d) Henri Deplon, J. D. Scoville.
(e) J. D. Scoville, Asst. Chief Engr., S. Morgan Smith Company.
(f) To investigate the stresses in a quarter scale model of the top plate for the 60,000 HP turbine for the Bonneville Development on the Columbia River.
(g) The top plate model was of welded plate steel construction homologous to the structure for the Bonneville turbine. It was so constructed that it could be loaded hydraulically to produce the stresses which would be realized on the full size machine. Strain gages were used at a large number of places on the model to determine the maximum stresses which could be found, particular attention being paid to the concentrated stresses around holes and at the flanges. A number of Huggenberger tensometers were used and an Olsen-De-Shazer strain gage.
(h) Tests are completed.

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UNIVERSITY OF PENNSYLVANIA.

(371) (a) THE EFFECT OF INSTALLATION ON THE COEFFICIENTS OF VENTURIMETERS.
(b) For general information and for manufacturers of Venturimeters.
(c) Three meters of various ratios were placed in different types of flow and following the combinations of elbows, the effect on the coefficient being noted.
(d) To fix limits of installation.
(e) and (f) See (d)
(g) Described in article.
(h) Completed.
(i) These tests were described in the November issue of the Transactions of the A.S.M.E. 1936. Additional information will be given in closing discussion.

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(611) (a) THE BEHAVIOR OF INWARD PROJECTING TUBES.
(b) For my own information.
(h) Not yet published.

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(612) (a) THE VARIATION OF COEFFICIENTS OF VENTURI METERS WITH RATIO DIAMETERS.
(b) General information and the meter manufacturing companies.
(f) To establish the law of such variation.
(h) Is not complete and may never be published.

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(613) (a) THE EFFECT OF VARIATION OF ANGLE OF UPSTREAM CONE ON THE COEFFICIENTS OF VENTURI METERS.
(b) To be used in discussion of Dr. Knapp's paper on the laboratory of the California Institute of Technology before the A.S.M.E. December 2, 1936.
(h) This will be finished in the near future and will be submitted as a discussion of the above paper.

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PENNSYLVANIA STATE COLLEGE.

(137) (a) A STUDY OF VARIOUS TYPES AND KINDS OF STILLING DEVICES FOR USE IN CHANNELS OF APPROACH TO WEIRS AND FOR OTHER PURPOSES.
(b) The Pennsylvania State College.
(c) Research.
(d) Professors Elton D. Walker and H. K. Kistler.
(e) Either of above.
(f) The development of a standard stilling device, or possibly more than one device.
(g) Water is admitted to one end of a tank from a pipe, under such conditions as to produce a high velocity and considerable turbulence. The discharge is measured at the other end of the tank by means of a standard weir which has been calibrated. Velocity measurements are made at a number of points in a cross section about four feet downstream from the inlet both with and without any stilling devices in place. When stilling devices are tested, they are inserted about two feet below the inlet. Each device is tested with a number of different velocities, average velocities being determined by means of the weir readings and the cross section of the channel. We seek to relate the relative effectiveness of the various stilling devices to the magnitude and distribution of velocities in the cross section.
(h) Data covering a large number of experiments are being tabulated and studied, and a progress report in the form of a bulletin is under preparation.
(g) Further investigation that may be suggested by the results found will be undertaken as soon as the current preliminary studies are completed.

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PENNSYLVANIA WATER AND POWER COMPANY.

(614) (a) HOLTWOOD MODEL TESTS MADE IN CONNECTION WITH REHABILITATION WORK FOLLOWING THE FLOOD OF MARCH, 1936.

(b) Pennsylvania Water & Power Co.

(c) Commercial Testing.

(d) Alden Hydraulic Laboratory, Worcester Polytechnic Inst., Prof. C. M. Allen and L. M. Davis.

(e) N. B. Higgins, Chief Engineer, Pennsylvania Water & Power Co., Lexington Building, Baltimore, Md.

(f) 1. Recent floods had caused overflows far above those for which it was considered safe to use the Horton Formula, and it was considered necessary to have experimental data upon which to extend the rating curve of the Holtwood Dam.

2. To determine the effect of silt elevation above the dam upon the rating curve.

3. Inasmuch as there was little literature available concerning the pressures on the face of an ogee dam, it was considered desirable to determine the pressure distribution experimentally.

4. To see what changes in dam profile would favorably affect the pressure distribution.

5. To see whether some means of toe protection should be adopted which would give a degree of security commensurate with the cost.

6. To determine the most economical location of a new deflection wall to separate the tailrace from the main river channel, together with a study of means of reducing the surges and standing waves which add to the height to which it is necessary to build this wall.

(g) A 1/50 scale model of 150 ft section of the Holtwood Dam was installed in a 5 ft flume for tests covering items 1 to 5. A 1/50 scale model of the deflection wall and 300 ft of the spillway was used for item No. 6.

(h) These tests were completed in November, 1936.

(i) An interesting fact disclosed by these tests is that, although tests checked the Horton Formula with reasonable accuracy in the usual range of flows, nevertheless the coefficient of discharge of the spillway proved to be greater than anticipated at time of extreme flood flows. The silt elevation was found to have considerable effect on increasing the coefficient of discharge, particularly when the silt approaches the crest of the dam. The experiments resulted in very definite knowledge of the forces on the dam caused by the flowing water. It was found that no practical change could be made in the pressure distribution without radical change in profile. Studies led to the adoption of the height and shape of the deflection wall which is being altered in the field accordingly.

PURDUE UNIVERSITY.

(47) (a) FLOW OF FLUIDS THROUGH CIRCULAR ORIFICES AND TRIANGULAR WEIRS.
(b) Purdue Engineering Experiment Station.
(c) General scientific research.
(d) F. M. Greve and student assistant.
(e) Professor F. M. Greve, School of Civil Engineering, West Lafayette, Ind.
(f) To determine experimentally the effects of density, surface tension, temperature, and viscosity upon the discharge rate through small circular orifices and triangular weirs.
(g) No change has been made since the last semi-annual report.
(h) No work has been done on the project since the last report was issued. Operations will be resumed during the second semester of the present academic year.

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STEVENS INSTITUTE OF TECHNOLOGY.

(378) (a) THE STUDY OF THE FORCES ACTING ON SAILING YACHTS IN ACTUAL SAILING ATTITUDES.
(c) General scientific research.
(d) Professor Kenneth S. M. Davidson.
(e) Professor Kenneth S. M. Davidson.
(f) To determine the longitudinal resistance of sailing yachts heeled over and moving with leeway as they do under actual sailing conditions.
(g) Observations taken on board ships to determine relation between sail forces, speeds and heeled angles. Scale models are towed in the attitudes determined from the full size observations.
(h) Completed.
(i) Reported in a paper, "Some Experimental Studies of the Sailing Yacht", by Professor Kenneth M. Davidson, read before the Society of Naval Architects and Marine Engineers, November 1, 1936.

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(379) (a) THE CALIBRATION OF A NOZZLE FOR FLUID FLOW MEASUREMENTS.
(b) Stevens Institute of Technology.
(c) Graduate thesis for advanced degree.
(d) Howard W. Emmons.
(e) Professor Richard F. Deimel.
(f) For the purpose of adding to the knowledge of the behavior of fluids flowing through nozzles.
(g) The method used was to measure the theoretical and actual flow of water, steam and air through a flow nozzle designed at Stevens Institute of Technology.
(h) Completed.
(i) Thesis available in library of the Stevens Institute of Technology.

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THE UNIVERSITY OF TEXAS.

(615)(a) PRESSURE DROP IN NON-ISOTHERMAL FLOW OF LIQUIDS IN BRASS TUBES.
(c) Pure research.
(d) Professor B. E. Short.
(e) Professor B. E. Short.
(f) To check pressure drop data that were obtained for flow around tubes in baffled tube bundles with the liquid being cooled and to determine the possible effect of the Prandtl group on the friction factor.
(g) Pressure drop measurements are being made for different flow rates during both heating and cooling of the liquid. Wide range of flow rates being used and different kinds of liquids being used.
(h) Apparatus has been constructed and a few preliminary tests made with a slight variation in apparatus subsequently made.

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THE UNIVERSITY OF OKLAHOMA.

(617) (a) DETERMINATION OF DISCHARGE COEFFICIENTS FOR FLOW NOZZLES AND SQUARE-EDGED ORIFICES WHEN METERING OIL. Cooperative research project sponsored by the Special Research Committee on Fluid Meters of the A.S.M.E.
(b) Factors for use in commercial measurements of fluids.
(c) Cooperative research project sponsored by the Special Research Committee on Fluid Meters of the A.S.M.E.
(d) Professor M. M. Ambrosius and Mr. Isaac Lovelady.
(e) Professor W. N. Carson, Head, Department of Mechanical Engineering.
(f) Determine discharge coefficients for flow nozzles and square-edged orifices at low Reynolds numbers as encountered when metering oils.
(g) Set-up includes meter runs of 2, 3, and 4-inch pipe. May be supplied with oil from heat-exchanger which is thermostatically controlled. From the meter runs the oil is discharged to weighing tanks.
(h) Work about 2/3 completed.

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UNIVERSITY OF ILLINOIS.

(300) (a) USE OF AN ELBOW IN A PIPE LINE FOR DETERMINING THE RATE OF FLOW IN THE PIPE.
(b) Engineering Experiment Station.
(c) Laboratory investigation.
(d) W. M. Lansford.
(e) Professor F. B. Seely.
(f) To investigate the use of an elbow in a pipe line as a flow meter. Tests have been made on 1-, 2-, 4-, 6-, 8-, 10-, 12-, and 24-inch short-turn elbows.
(h) Results published in Bulletin 269, Engineering Experiment Station, University of Illinois.

(301) (a) STUDY OF THE FLOW OF WATER IN A CIRCULAR GLASS PIPE BY THE USE OF MOTION PICTURES.
(b) Engineering Experiment Station. A cooperative investigation of the Departments of Theoretical and Applied Mechanics and Mechanical Engineering.
(c) Laboratory investigation.
(d) C. P. Kittredge, John C. Reed.
(e) Professor F. B. Seely.
(f) To secure information relative to the characteristics of flow in circular conduits.
(g) Fine drops of an insoluble liquid (carbon tetrachloride and Benzene) of the same density as water, in suspension in water flowing in a 1-3/4 inch circular glass pipe, are photographed by a motion picture camera as they move through a thin, broad field intensely illuminated from the two sides of the pipe.
(h) A paper entitled "Study of the Flow of Water Through a Glass Pipe" by Edgar E. Ambrosius, John C. Reed, and Henry F. Irving, was presented before the 1934 Summer Meeting of the Aeronautic and Hydraulic Divisions, American Society of Mechanical Engineers, at Berkeley, California, and published by the George Reproduction Company, San Francisco, California.

This investigation is being continued with a more elaborate set-up and has some refinements not found on the old, such as maintaining constant head and a smooth belled entrance to the pipe in which the analysis is being made. The existing apparatus with its new and improved lighting equipment will permit the study of water velocities (using streak pictures) up to 4 fps.

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(500) (a) MAGNITUDE AND FREQUENCY OF FLOODS ON ILLINOIS STREAMS.
(b) Engineering Experiment Station.
(c) Research.
(d) G. W. Pickels.
(e) Professor G. W. Pickels.
(g) Analysis of flood data collected by U. S. G. S.
(h) To be published as a Bulletin of the Engineering Experiment Station, University of Illinois, about July, 1937.

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(501) (a) SYNTHESIS OF THE HYDROGRAPH.
(b) College of Engineering.
(c) Graduate thesis (Doctor's degree)
(d) W. L. Huang.
(e) Professor G. W. Pickels.
(g) Extension of work of Sherman, Bernard, and Horton.
(h) Thesis will be completed in February, 1937, and a copy filed in University library.

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(504) (a) MODEL OF SPILLWAYS ON WATER SUPPLY RESERVOIRS IN ILLINOIS.
(b) Engineering Experiment Station. A cooperative investigation with the Illinois State Water Survey and Departments of Theoretical and Applied Mechanics and Civil Engineering, University of Illinois.
(c) Investigation of capacities; use as measuring devices, and erosion problems.

(d) C. O. Reinhardt, R. T. Larson and J. J. Doland in cooperation with W. J. Putnam.
(e) Professor F. B. Seely.
(f) To establish rating curves for existing structures, study capacity requirements and suggest measures for reducing danger from undercutting.
(g) Construction and testing of models of five existing structures, one each at West Frankfort, Staunton, Carbondale, Centralia and Bloomington.
(h) Tests of West Frankfort model now in progress.

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(626) (a) VELOCITY DISTRIBUTION IN PIPES AT HIGH REYNOLDS NUMBER.
(b) Graduate Thesis (Master's degree)
(d) L. D. Stoyko - W. M. Lansford.
(e) Professor F. B. Seely.
(g) A pitot tube is used to determine the velocity distribution in pipes of various diameters, 24 inches and less.
(h) Experiments in progress.

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(627) (a) THE ANALYSIS OF THE FLOW IN NETWORKS OF CONDUITS OR CONDUCTORS.
(b) Engineering Experiment Station, University of Illinois.
(c) A simple analytical method of successive approximations for determining with a relatively small amount of calculation the flow of a fluid in a system or network of pipes, etc.
(d) Hardy Cross.
(e) Professor Hardy Cross.
(h) Published as Bulletin 286 of Engineering Experiment Station of the University of Illinois.

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STATE COLLEGE OF WASHINGTON.

(628) (a) RESISTANCE OF SPECIALLY DESIGNED BENDS FOR 6-INCH PIPE.
(b) (c) Private research in cooperation with Engineering Experiment Station.
(d) E. R. Fosdick.
(e) Professor J. G. Woodburn.
(f) To determine loss of head due to specially-designed 90-degree bends in 6-inch pipe, as compared to loss due to standard cast iron bend.
(g) Piezometers on bend and in approach and discharge pipes were used to measure the loss of head. Discharge was measured over 90-degree V-notch weir.
(h) Tests completed, paper being prepared.

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(629) (a) EFFECT OF LOW ARCH SKEW BRIDGES ON WATER STAGES IN RECTANGULAR FLOOD CHANNELS.
(b) (c) Model studies to supplement computations of channel capacities for Walla Walla Flood Control District.
(d) (e) Prof. J. G. Woodburn.
(f) (g) Models on scale of 1 to 40 of arch skew bridges were inserted into rectangular flume in which water was flowing at velocity and depth proportional to computed velocity and

depth in Mill Creek, Walla Walla. Depths of flow after insertion of bridge models were measured and found to agree closely with depths computed by contracted-area method. Changes from shooting to streaming velocity, occurrence of waves at certain stages, and probable location of channel bed erosion were also demonstrated.

(h) Results were incorporated in report to Flood Control District and will be compared with field measurements at first high water.

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(630) (a) STUDIES OF FLOW IN SMALL RECTANGULAR FLUMES.
(b) (c) General departmental research.
(d) Glen Gage and Alex. Hutchison, seniors; and other students.
(e) Professor J. G. Woodburn.
(f) This work is a continuing project with several purposes and phases.
1. Determination of coefficients of retardation and study of their variation with depth of flow.
2. Relation of center surface velocity, as shown by floats, to average velocity in cross-section.
3. Study of critical depth and hydraulic jump in relation to slopes to be avoided because of wavy water surface.
4. Effect of reverse bends on slope of water surface and on deposition of sand.

(g) A wooden flume 30 ft long, 15 in. wide and 10 in. deep was used for preliminary studies. This flume has been replaced by a concrete flume 25 ft long, 10 in. wide, and 10 in. deep. The slope of the flume is adjustable up to 0.01. Flows up to 1 cfs can be provided, with measurement by Venturi meter.
(h) Studies now in progress.

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UNIVERSITY OF CALIFORNIA. (and U. S. Tidal Model Laboratory.)

(16) (a) EVAPORATION BY FREE CONVECTION.
(c) Master's thesis.
(d) B. F. Sharpley.
(e) Professor M. P. O'Brien.
(h) Project completed. Thesis of Sharpley will be available for loan shortly.

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(276) (a) DISCHARGE COEFFICIENTS OF SHARP-CRESTED WEIRS IRREGULAR IN PLAN.
(c) Undergraduate thesis.
(d) Gray.
(e) Professor M. P. O'Brien.
(h) Project completed. Summary included in this bulletin. Thesis available on loan.

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(280) (a) ORIFICES AND NOZZLES FOR MEASURING DISCHARGE AT END OF PIPE LINE.
(c) Laboratory project in cooperation with Fluid Meters Committee of A.S.M.E.
(d) Professor M. P. O'Brien and Dr. R. G. Folsom.
(e) Professor M. P. O'Brien.
(f) To standardize a set of orifice plates and nozzles for field measurement of pump discharge. Design of orifice plates are a modification of the International Standard Orifice.
(h) Report on orifices in Transactions, A. S. M. E., January, 1937. Nozzle tests in progress.

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(281) (a) MODEL OF ESTUARY OF COLUMBIA RIVER.
(b) Corps of Engineers, U.S.A.
(d) Professor M. P. O'Brien.
(e) Professor M. P. O'Brien.
(f) To investigate channel improvements in the estuary of the Columbia River.
(g) Investigations were made with fixed bed models having horizontal scale of 1:6600 and vertical scale of 1:120. Tides and waves were reproduced.
(h) Summary of results in preparation.

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(419) (a) DETERMINATION AND CORRELATION OF VIRTUAL MASS OF SHIP MODELS AND SPECIAL SHAPES.
(c) Graduate thesis.
(d) J. P. Murphy.
(e) Professor M. P. O'Brien.
(h) Experimental work completed and thesis is being written.

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(420) (a) BROAD CRESTED WEIRS.
(c) Undergraduate thesis.
(d) Joe and Thomson.
(e) Professor M. P. O'Brien.
(f) Comparison of models of broad-crested weirs with prototype or with models to larger scale.

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(421) (a) SIMILARITY OF MOVABLE-BED MODELS.
(c) Graduate thesis.
(d) E. H. Taylor.
(e) Professor M. P. O'Brien.
(h) Project completed. Thesis of Taylor will be available for loan shortly.

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(423) (a) FLOOD WAVES.
(c) Graduate thesis.
(d) J. O. Killian (Lieut.)
(e) Professor M. P. O'Brien.

(g) Investigation of flood waves in power canals by means of model channel.
(h) Continuation of laboratory test.

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(424) (a) IMPACT LOSS AT INTERSECTION OF STREAMS.
(c) Cooperation with special committee on Hydraulic Research, A. S. C. E.
(d) Morgan and Horowitz, R. L. Stoker.
(e) Professor M. P. O'Brien.
(f) To investigate the energy loss when open and confined streams intersect at various angles.
(h) At present the relationship between velocities and depths is being studied for converging open channel flow. Diverging flow will next be investigated.

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(425) (a) MODEL STUDY OF WAVE ACTION ON BEACHES.
(c) Graduate and undergraduate thesis.
(d) Lansley (Lieut.), Lillivang and Brant.
(e) Professor M. P. O'Brien.
(f) Models of shore at Santa Barbara and Santa Monica will be compared with field surveys to test reliability of models.
(h) Experimental work in progress.

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(426) (a) HYDRAULIC ROUGHNESS.
(c) Laboratory project.
(d) Folsom, Tripp and Skoglund.
(e) Professor M. P. O'Brien.
(g) Experimental investigations in water channel with brass walls and in air channel with wooden walls - both channels with variable relative roughness.
(h) Articles by Skoglund and Tripp in Journal of Aeronautical Sciences, November, 1936.

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(631) (a) HOT-WIRE ANEMOMETER.
(c) Laboratory project.
(d) R. L. Stoker.
(e) Professor M. P. O'Brien.
(f) To develop an instrument of the hot-wire anemometer type for measuring water velocities.
(h) Preliminary tests are being made.

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(632) (a) FLOW AT THE CRITICAL DEPTH.
(c) Undergraduate thesis.
(d) R. L. Stoker and T. C. Royce.
(e) Professor M. P. O'Brien.
(f) To investigate the surface phenomenon for open channel flow at depths near the critical depth for various values of the normal depth.
(h) Experimental work in progress.

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(633) (a) VELOCITY DISTRIBUTION IN OPEN CHANNELS.
(c) Undergraduate thesis.
(d) Yerby.
(e) Professor M. P. O'Brien.
(f) Application of theory of turbulent flow to the velocity distribution in rivers.
(g) Data of Mackenzie from Mississippi River at Burlington, Iowa, used to compute tractive force and effective roughness from measured velocity distributions.
(h) Work completed.
(i) Thesis available on loan. Summary in this bulletin.

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(634) (a) SAN DIMAS METERING FLUME.
(b) California Forest and Range Experiment Station.
(d) Wilm, Stoker, Burmel.
(e) Professor M. P. O'Brien.
(f) To continue work on development of a critical depth flume for metering debris-laden flows.
(g) Laboratory experiments on models.
(h) Models under construction.

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(635) (a) CONTRACTION WORKS IN RIVERS.
(c) Master's Thesis.
(d) Park (Lieut.)
(e) Professor M. P. O'Brien.
(f) To study the increase in depth resulting from reduction of stream width and to correlate results with data on bed-transportation.
(h) Experimental work in progress.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPT OF CIVIL AND SANITARY ENGINEERING.

(29) (a) AN EXPERIMENTAL INVESTIGATION OF THE RELIABILITY OF MODELS FOR DETERMINING WAVE ACTION ON SEA WALLS.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Doctor's degree.
(d) Professor R. C. Reynolds.
(e) Professor R. C. Reynolds.
(f) To determine if models can be used to investigate the action of waves on the beach adjacent to sea walls.
(g) A plunger at one end of a concrete basin 6 ft by 20 ft creates waves which run the length of the basin, break on a sandy beach and strike a vertical sea wall. Three models of the same sea wall were used with scale ratios of 30, 45, and 60. The sand, carried over the wall, is caught in a basket and weighed and a plot made of the rate of movement.
(h) Experimental work completed. Thesis in preparation.

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(362) (a) MODEL OF CAPE COD CANAL AND APPROACHES.
(b) Lt.-Col. A. K. B. Lyman, District Engineer, U. S. Engineer Office, Boston.
(c) Research in connection with proposed widening program for Cape Cod Canal.
(d) Professor K. C. Reynolds and staff.
(e) Professor K. C. Reynolds.
(f) To determine mean high and low water profiles, velocities and other hydraulic features connected with design of enlarged canal with 500-foot bottom width and 40-foot depth.
(g) A distorted fixed bed model has been built of the Canal including the approach in Cape Cod Bay and both the present and proposed approaches in Buzzards Bay from Wings Neck. Horizontal scale 1:600, vertical scale 1:60. Length of model 115 feet. The tides of the two bays are controlled by an electrically operated mechanism. Water surface elevations are electrically determined by using the water surface as one plate of a condenser. Both electrical mechanisms good to 1/100 inch elevation on model.
(h) Tests completed. Copies of report will be available (at cost of reproduction) from District Engineer, U. S. Engineer Office, 13th Floor, Custom House, Boston, Mass., or Professor Reynolds at M. I. T. See abstract in this Bulletin.

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(519) (a) EXPERIMENTAL STUDY OF BED LOAD TRANSPORTATION IN RIVER CHANNELS.
(b) River Hydraulic Laboratory, M. I. T.
(c) Graduate research for Master's degree.
(d) A. L. Jorissen.
(e) Professor K. C. Reynolds.
(f) To investigate effect of mechanical composition of sand on bed load movement.
(g) Wooden flume used 34 ft long, 24 in. wide, and 15 in. deep, with rails adjustable for slopes of 1:300, 1:600, 1:900. Two synthetic sand mixtures used.
(h) Thesis completed: "Experimental Study of Sand Transportation in River Channels".

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(522) (a) SHORT CIRCUITING IN MIXING CHANNELS AND TANKS WITH STIRRING DEVICES.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Student research.
(d) Professor Thomas R. Camp and students.
(e) Professor Thomas R. Camp.
(f) To determine relative efficiencies of different types of mixing tanks as measured by short circuiting.
(g) Measurement of short circuiting in models by means of salt and dyes.
(h) Bachelor's thesis submitted by A. H. Bagnulo and E. C. Knight, May, 1936, "A Study of Hydraulic Short Circuiting through Mixing Chambers". Other work to follow.

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(523) (a) HYDRAULICS OF LATERAL SPILLWAY CHANNELS.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) Student research.
(d) Professor Thomas R. Camp and students.
(e) Professor Thomas R. Camp.
(f) To determine friction losses in lateral spillway channels.
(g) Experimental measurement of drop-down curve and comparison with theoretical curve.
(h) Bachelor's thesis submitted by J. H. Carr, Jr. and A. A. Thomas, May 31, 1936, "Hydraulics of Lateral Spillway Channels". Other work in progress.

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(524) (a) STUDIES OF CLARIFICATION BY SEDIMENTATION.
(b) Sanitary Engineering Laboratory, M. I. T.
(c) General scientific research.
(d) Professor T. R. Camp and assistants.
(e) Professor Thomas R. Camp.
(f) To determine influence of various factors affecting clarification.
(g) Studies of flow through small settling tanks. Correlation of clarification in settling tubes with removal in tanks.
(h) In progress.
(i) See "A Study of the Rational Design of Settling Tanks", Sewage Works Journal, Sept. 1936, p. 742.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY, HYDRAULIC MACHINERY LABORATORY.

(86) (a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENON.
(b) Massachusetts Institute of Technology.
(c) General research.
(d) H. Peters - D. G. Rightmire.
(e) Professor H. Peters.
(f) 1. Study of properties of the liquid which influence the severity of cavitation damage.
2. Study of the periodic nature of cavitation.
(g) for (f) (1) An aluminum sample is vibrated in various liquids at various temperatures with an approximate frequency of 8000 cycles/sec and amplitude of about 0.01 mm. The loss of weight is used as a measure for the severity.
for (f) (2) Experimental work in a Venturi passage and theoretical work.
(h) Progress reports;
J. C. Hunsaker, Mechanical Engineering, April, 1935. Volume 57, No. 4.
J. C. Hunsaker, A.S.M.E. October, 1935, Volume 57, No. 7.
E. W. Spannhake, Thesis, Mass. Institute of Technology Library, "Theoretical Investigation of the Periodic Nature of Cavitation".

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(483) (a) I. INVESTIGATION OF ROTARY FLOW IN PIPE LINES.
II. INFLUENCE OF ROTATION UPON ORIFICE AND NOZZLE COEFFICIENTS.
(b) Massachusetts Institute of Technology.
(c) General study.
(d) Students.
(e) Professor H. Peters.
(h) In progress. I. Thesis, 1934.
II. Thesis, 1935.

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(484) (a) STUDY OF MIXING BETWEEN A JET OF FLUID OF VARIOUS DENSITIES AND A STILL FLUID.
(b) Massachusetts Institute of Technology.
(c) General study.
(d) J. Bicknell - H. Peters.
(e) Professor H. Peters.
(f) Study of turbulent mixing.
(g) Progress report at the annual meeting of the Institute of the Aeronautical Sciences, January, 1936.

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(485) (a) STUDY OF FLOW THROUGH RECTANGULAR CHANNELS.
(b) Massachusetts Institute of Technology.
(c) General study.
(d) Students.
(e) Professor H. Peters.
(f) Determination of frictional factors.
(g) Pressure measurements and velocity distribution.
(h) Just started.

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(486) (a) STUDY OF THE BOUNDARY LAYER ON SURFACES WITH PRESSURE GRADIENT.
(b) Massachusetts Institute of Technology and the National Advisory Committee for Aeronautics.
(d) H. Peters - J. Bicknell.
(e) H. Peters.
(f) Study of friction and of separation of laminar and turbulent flow.
(g) Airflow through a 2-dimensional Venturi passage.
(h) Just started.

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UNIVERSITY OF MINNESOTA.

(94) (a) TRANSPORTATION OF SEDIMENT.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(d) Lorenz G. Straub and graduate assistants.
(e) Professor Lorenz G. Straub.
(f) Investigations of transportation of bed sediment in alluvial rivers and the effect of contraction works on the river channel.
(g) Preliminary experiments were conducted in a wooden flume about 35 ft long, 12 inches wide, and 18 inches deep, sediment being added at the entrance to the flume and collected and weighed at the point of discharge. Water discharge was measured by means of a weir located at the entrance to the flume. Additional experiments are in progress using a specially designed steel tiltable flume about 60 ft long, 3 ft wide, and 15 inches deep. Sediments of various mechanical compositions are being used; some of the materials have been taken directly from the beds of midwestern rivers. Observations are made of the rate of sediment transportation for various flow conditions, the character of the riffle formations, the effect of channel contraction works on the regimen of the stream bottom, etc.
(h) Progress report prepared; investigations being continued.

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(99) (a) LAWS OF HYDRAULIC SIMILITUDE.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(d) Lorenz G. Straub and graduate assistants.
(e) Professor Lorenz G. Straub.
(f) Investigations of the limitations of the laws of hydraulic similitude.
(g) In connection with various research projects of the hydraulics laboratory in which models are used, wherever possible studies are being made on models of several different scales. The results recorded are being generalized to develop numerical limitations of the various laws of hydraulic similitude.
(h) In progress.

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(190) (a) FLOW CONDITIONS IN OPEN CHANNEL.
(b) University of Minnesota Engineering Experiment Station.
(c) University hydraulics research project.
(e) Professor Lorenz G. Straub.
(f) To determine conditions of laminar and turbulent flow in open channels.
(g) Flow conditions are observed in a small tiltable flume.
(h) Preliminary report has been prepared; further studies are being undertaken with an improved type of apparatus.

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(327) (a) EXPERIMENTAL STUDY OF FLUSH VALVES FOR WATER-CLOSETS.
(b) Minnesota State Board of Health.
(c) Cooperative research project with Sanitary Division of Minnesota State Board of Health and the Hydraulics Department of the University.
(d) Lorenz G. Straub, H. A. Whittaker, Jack J. Handy.
(e) Professor Lorenz G. Straub.
(f) Investigation of the suitability of various types of flush valves, particularly with the view of determining possibilities of back-siphoning into fresh water lines.
(g) A standard water-closet bowl is so arranged that the discharge variation may be recorded graphically. The set-up permits using various types of flush valves. Wide variations in pressure are possible on the feed water line.
(h) In progress.

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THE OHIO STATE UNIVERSITY.

(458) (a) CALIBRATION OF A VENTURI METER FOR A LARGE RANGE OF REYNOLDS NUMBERS.
(b) The Ohio State University Engineering Experiment Station.
(c) General engineering research.
(d) Professor S. R. Beitler.
(e) Professor S. R. Beitler.
(f) Further proof of the validity of the Reynolds Number theory to meters.
(g) A 1/2 x 3/4 inch Venturi is being calibrated with hot and cold water and with high accuracy/head and quantity measurements to determine accurately the variation of coefficient with Reynolds number over a Reynolds number range of from 2,000 to 500,000.
(h) Taking of data temporarily stopped in order to analyze results available.

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(525) (a) CALIBRATION OF PIPE ORIFICES WITH STEAM.
(b) Ohio State University Experiment Station in cooperation with the Bailey Meter Company.
(c) General engineering research.
(d) T. C. Barnes, S. R. Beitler.
(e) Professor S. R. Beitler.
(f) To give more positive demonstration of the fact that orifice coefficients determined with water can be used for the commercial measurement of steam.
(g) Two series of orifices, one in a 2 inch and one in a 3 inch line, are to be calibrated, using steam as the calibrating fluid. Tests will be run to cover the complete range of heads available. These orifices have already been calibrated with water so that direct comparisons may be made.
(h) Experimental work will be completed by the first of January, 1937. Report will be submitted to Bailey Meter Company at that time.

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(526) (a) DETERMINATION OF DISCHARGE COEFFICIENTS OF FLOW NOZZLES.
(b) Ohio State University Engineering Experiment Station in cooperation with the Special Research Committee on Fluid Meters of the A.S.M.E.
(c) Cooperative research.
(d) and (e) Professor S. R. Beitler.
(f) To determine the discharge coefficients of flow nozzles in various sized pipes using steam as the metered fluid.
(g) This is a part of the work of the Special Research Committee on Fluid Meters of the A.S.M.E. which is being undertaken in order to standardize nozzles and to determine the coefficients accurately. For this purpose steam at several different pressures and temperatures and with a wide range of differential heads across the orifice will be used. The results are to be correlated with the results on other fluids made in other laboratories.
(h) Data on I.S.A. nozzles in 3 inch pipe for steam and water practically completed. Both rough and smooth pipe have been used, and results show effect of pipe roughness and coefficient of these results. Work is proceeding on taking data on long radius nozzles in 3 inch pipe.

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(636) (a) STUDY OF THE EFFECT OF PULSATIONS ON ORIFICE METERS.
(b) Ohio State University.
(c) Student thesis.
(d) J. H. Nagle and W. A. Daberko.
(e) Professor S. R. Beitler.
(f) To determine the effect of pulsating flow on orifice meters and to attempt to design the practical pulsation eliminator.
(g) Two orifice meters in series are to be connected to the discharge of a reciprocating compressor. One of these will operate on pulsationless flow and the other with full pulsation. The quantity flowing, static pressure and speed of pulsation will be varied and the effect of the meter indication determined. An attempt will then be made to design and build a practical piece of apparatus which will eliminate this effect.
(h) Preliminary plans are completed. Work will start shortly after the first of January.

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UNIVERSITY OF WASHINGTON.

(637) (a) DESIGN AND CONSTRUCTION OF A DIRECTIONAL CURRENT METER.
(c) Laboratory project.
(d) William Morton.
(e) Professor C. L. Utterback.
(f) Investigation of River and Ocean Currents.

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WEST VIRGINIA UNIVERSITY.

(50) (a) DISCHARGE THROUGH THIN PLATE ORIFICES IN PIPE LINES.
(b) Thesis for M.S.C.E. Degree.
(c) General scientific research.
(d) A. E. McCaskey and H. W. Speiden.
(e) Professor H. W. Speiden, Dept. of Civil Engineering, West Virginia University, Morgantown, W. Va.
(f) To study the coefficients of various sizes of circular thin plate orifices in pipe lines.
(g) Similar series of orifices have been studied in 2 inch brass, 2 inch iron and 4 inch ironpipe.
(h) Project completed.
(i) Copies of the thesis which covers the majority of the work performed, are available for loan from the Library, West Virginia University.

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STEVENS INSTITUTE OF TECHNOLOGY.

(638) (a) TOWING A SPHERE UNDER WATER.
(b) Stevens Institute of Technology.
(c) General scientific research.
(d) Frederick W. S. Locke, Jr.
(e) Professor Kenneth S. M. Davidson.
(f) To find the critical velocity of flow around a sphere.
(g) Sphere will be towed under water in the Experimental Towing Tank.
(h) Apparatus being designed and assembled.

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PRINCETON UNIVERSITY.

(462) (a) AN INVESTIGATION INTO THE NATURE OF CAVITATION.
(b) Graduate thesis.
(c) Laboratory research.
(d) Hugh J. Davis.
(e) Professor Lewis F. Moody.
(f) To determine the critical point at which cavitation originates in a closed conduit system, to measure the corresponding absolute pressure at the point where the cavitation occurs, to find whether the conditions satisfy the Thoma principle $\sigma = H - H_b - H_s$, to investigate the effect of the separation of air contained in the water in a system under relatively low initial pressure, and to make visual observations of the flow at the cavitating point.
(g) See Bulletin IV-2, page 27.
(h) No report on project furnished for this issue of the bulletin.

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(527) (a) GROUND WATER FLOW.
(b) Graduate thesis.
(c) Laboratory research, analysis and application of results.
(d) Lieut. William Whipple, Jr., U.S.A.
(e) Professor Lewis F. Moody.
(f) To apply an original method, proposed by the investigator, for plotting lines of flow and determining pressure gradients in the percolation through porous foundations of dams, through earth dams, and the flow of ground water.
(g) See Bulletin IV-2, page 28.
(h) No report on project furnished for this issue of the bulletin.

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(528) (a) THE SUBMERGED HYDRAULIC JUMP WITH SUDDEN VERTICAL ENLARGEMENT.
(b) Graduate thesis.
(c) Laboratory research and analysis.
(d) Lieut. James V. Hagan, U.S.A.
(e) Professor Lewis F. Moody.
(f) To apply the momentum principle to the flow of water in an open channel having a sudden drop in its bed, and to compare the theory with actual measurements in the laboratory.
(g) See Bulletin IV-2, page 28.
(h) No report on project furnished for this issue of the bulletin.

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(529) (a) THE ROUND-CRESTED WEIR.
(b) Graduate thesis.
(c) Laboratory research.
(d) Capt. Warren N. Underwood, U.S.A.
(e) Prof. Lewis F. Moody.
(f) Investigation of a new form of crest proposed by the correspondent, in the effort to improve the characteristics of the weir as a measuring instrument. As stated in the paper: "As a means of measuring water, the sharp-crested weir possesses certain disadvantages. The principal one is that the underside of the nappe is unsupported. The amount of contraction there rests upon a delicate balance of dynamic forces. Slight changes in velocity due to minor disturbances in the flow near the crest, and differences in the distribution of velocities in the approach channel are likely to cause changes in the amount of contraction with resulting changes in the discharge." The new crest substitutes a quadrant of a transverse cylinder for the sharp crest, the section being a quarter circle. The object was to investigate the characteristics of such a weir from tests on a small model of one foot crest breadth.
(g) See Bulletin IV-2, page 29.
(h) No report on project furnished for this issue of the bulletin.

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RENSSELAER POLYTECHNIC INSTITUTE.

(530) (a) AN INVESTIGATION OF FRICTIONAL LOSSES IN FITTINGS FOR SMALL COPPER PIPES.
(b) General scientific research.
(c) Undergraduate thesis.
(d) Louis Foster Camp, Jr.
(e) Professor Grant K. Palsgrove.
(f) To supplement the rather meager amount of published information relative to the smaller sizes of copper pipes.
(g) See Bulletin IV-2, page 31.
(h) No report on project furnished for this issue of the bulletin.

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(531) (a) AN INVESTIGATION OF THE THEORY OF THE PITOT TUBE.
(b) General scientific research.
(c) Undergraduate thesis.
(d) James Francis McKenney.
(e) Professors Grant K. Palsgrove and William J. Moreland.
(f) To explain the transformation of kinetic energy of stream into potential energy in the region of the Pitot tube entrance, thereby arriving at a rational explanation for the expression, $h = V^2/2g$.

(g) See Bulletin IV-2, page 31.
(h) No report on project furnished for this issue of the bulletin.

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(532) (a) AN INVESTIGATION OF A PARSHALL FLUME.
(b) General scientific research.
(c) Undergraduate thesis.
(d) George E. Mussey.
(e) Professor Grant K. Palsgrove.
(f) Investigation of accuracy of a Parshall Venturi Flume for condition of free flow when indicated head is obtained from a diaphragm chamber.
(g) See Bulletin IV-2, page 31.
(h) No report on project furnished for this issue of the bulletin.

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STANFORD UNIVERSITY.

(541) (a) EFFECT OF ANGLE OF ATTACK AND PROFILE OF TURBINE RUNNER BLADES ON CAVITATION.
(b) Stanford University.
(c) General scientific research.
(d) Professor V. C. Finch and assistants.
(e) Professor V. C. Finch.
(f) To correlate previous and current studies of the cavitation phenomenon in an investigation to determine in a quantitative way the effect of angle of attack and profile of runner blades on pitting by cavitation.
(g) Work has been carried forward in the production of cavitation in a two-dimensional venturi section having a throat of 3" x 3" and a downstream angle of flare of 10.5 degrees. A stethoscope has been used to determine the location of the most violent collapse. (h) Work temporarily suspended.

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CARNEGIE INSTITUTE OF TECHNOLOGY.

(284) (a) CONSTRUCTION OF A MODEL OF THE ALLEGHENY-MONONGAHELA-UPPER-OHIO RIVER SYSTEM FOR USE AS AN INTEGRATING MACHINE FOR SOLVING PROBLEMS OF FLOOD-WAVE MOVEMENTS IN THIS RIVER SYSTEM.
(b) Carnegie Institute of Technology.
(c) Pure research.
(d) H. A. Thomas and student assistants.
(e) Professor H. A. Thomas.
(f) To investigate the feasibility of obtaining accurate solutions of flood wave problems by using a special type of model channel as an integrating machine, and to apply this method to a study of various problems arising in connection with flood protection by proposed reservoirs in the Allegheny-Monongahela River basin.
(g) See Bulletin IV-2, page 34.
(h) No report on this project furnished for this bulletin.

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(377) (a) MODEL STUDIES IN CONNECTION WITH THE RECONSTRUCTION OF THE EMSWORTH DAM ON THE OHIO RIVER 6 MILES BELOW PITTSBURGH.
(b) U. S. War Department.
(c) Laboratory investigation on a river model and on models of dam and gates.
(d) E. P. Schuleen and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) Improvement of river navigation by raising the Pittsburgh pool to eliminate Monongahela Dam No. 1 and Allegheny Dam No. 1.
(g) See Bulletin IV-3, page 33.
(h) No report on project furnished for this bulletin.

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(487) (a) MODEL STUDIES IN CONNECTION WITH THE CONSTRUCTION OF THE NEW GALLIPOLIS DAM ON THE OHIO RIVER.
(b) U. S. War Department.
(c) Laboratory investigation on a fixed-bed river model, and on models of dam and gates.
(d) E. P. Schuleen and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) Improvement of navigation on the Ohio River.
(g) See Bulletin IV-3, page 33.
(h) No report on project furnished for this bulletin.

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(488) (a) MODEL STUDIES ON THE SPILLWAY OF THE WARRIOR RIVER DAM AT TUSCALOOSA, ALABAMA.
(b) U. S. War Department.
(c) Laboratory investigation using glass-sided flume.
(d) E. P. Schuleen and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) Investigation included studies to determine the best elevation, width and shape of the spillway apron at different sections of this dam. Model was constructed to 1:20 scale in a glass-sided flume.

(h) No report on project furnished for this bulletin.

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(489) (a) MODEL STUDIES TO INVESTIGATE CAVITATION EFFECTS AT ENTRANCES OF OUTLET CONDUITS OF TYGART RIVER DAM AND OTHER HIGH DAMS.
(b) U. S. War Department.
(c) Laboratory investigation.
(d) E. P. Schuleen and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) Investigation includes the construction of apparatus suitable for making tests on model conduits under conditions such that the pressure of the atmosphere surrounding the model can be reduced in the model scale. Cavitation conditions in the model conduits are observed visually through a thick glass window, and are also studied by their erosion effects on the walls of the model conduits. Models of the conduits of the Tygart River Dam, of the Madden Dam and of the Bluestone Dam have been constructed and tes ted in this apparatus. The apparatus includes a special 8 inch centrifugal pump, air-tight tank with 8-inch piping, and a Nash vacuum pump. Model scales of about 1:15 can be used.

The primary purpose of the tests is to develop entrance designs for high-head conduit which will largely or wholly eliminate cavitation.

(h) No report on project furnished for this bulletin.

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(490) (a) INVESTIGATION OF TRAVELING WAVES IN STEEP CHANNELS.
(b) Pure research. This is an authorized project of the American Society of Civil Engineer's Special Committee on Hydraulic Research. During the past year the project was carried on in cooperation with the thesis work of Mr. R. F. Schnake, graduate student.
(c) Laboratory investigation and theoretical analysis, together with field investigation of traveling waves in steep channels connected with actual engineering structures.
(d) H. A. Thomas and R. F. Schnake.
(e) Professor H. A. Thomas.
(f) To investigate the fundamental hydraulic principles governing the formation and propagation of traveling waves and surges in channel of steep slope, and to correlate analytical findings with experimental results. To obtain data which will enable the designer of a steep channel to predict the probable maximum height and velocity of the traveling waves which may form in the channel under the given conditions.
(g) See Bulletin IV-2, page 35.
(h) No report on project furnished for this bulletin.

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(543) (a) MODEL STUDIES IN CONNECTION WITH THE DESIGN OF THE BLUESTONE DAM, NEW RIVER, WEST VIRGINIA.
(b) U. S. War Department.
(c) Laboratory investigation on a group of models.
(d) F. H. Brockman and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) and (g) Investigation includes the construction and testing of four models: (1) a 1:36 scale model showing two bays of the spillway, including crest gates, outlet conduits and stilling pool, to study the design of the crest profile, crest piers, spillway apron, conduit outlet deflectors, and stilling-pool dam; (2) a 1:160 scale model showing the entire dam, power house and adjacent river channel, to study cofferdam heights and to investigate river currents below the structure under various conditions of operation; (3) a 1:18 pyralin model of an outlet conduit and a longitudinal strip of the stilling pool, to study flow conditions in the conduits; and (4) a 1:15 scale model of a conduit entrance to study conditions with respect to the occurrence of cavitation.
(h) No report on project furnished for this bulletin.

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(544) (a) MODEL STUDIES ON THE STILLING POOL OF THE TYGART RIVER DAM.
(b) U. S. War Department.
(c) Laboratory investigation.
(d) E. P. Schuleen and H. A. Thomas.
(e) Professor H. A. Thomas.
(f) Supplementary investigation of current distribution in stilling pool.
(g) Construction and testing of a 1:80 scale model of a section of the spillway, outlet conduit and stilling pool, to supplement studies completed two years ago.
(h) No report on project furnished for this bulletin.

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UNIVERSITY OF CALIFORNIA, College of Agriculture, Davis, California.

(270) (a) THE EFFECT OF DEPTH TO WATER TABLE UPON THE LOSS OF WATER FROM THE SOIL SURFACE. (Part of project on principles of soil moisture in relation to irrigation.)
(b) California Agricultural Experiment Station.
(c) Experiment Station project.
(d) M. R. Huberty and F. J. Veihmeyer.
(e) Professor F. J. Veihmeyer.
(f) This study is part of a larger project to determine losses of water through plant transpiration and surface evaporation.
(g) Twenty-five tanks holding more than one ton of soil, equipped with Mariott constant water-level regulating devices, are being used. The amount of water evaporated is determined volumetrically and gravimetrically. The investigations have been under way for several years. The experiments have been conducted in such a way that a statistical analysis of the results of evaporation from the surface of the soils with the water table a constant distance below the surface can be obtained.
(h) The experiments will be continued for several additional years.

(271) (a) MOVEMENT OF MOISTURE THROUGH SOILS. (Part of project on principles of soil moisture in relation to irrigation.)
(b) California Agriculture Experiment Station.
(c) Experiment Station project.
(d) N. E. Edlefson and F. J. Veihmeyer.
(e) Professor F. J. Veihmeyer.
(f) This study is part of a general project to study movement of water in soils, both under saturated and unsaturated conditions. It also involved the movement of water to roots of plants, the energy relations involved by extraction of water by plants and the factors affec ting availability of water to plants.
(g) Extensive equipment of plant containers with suitable arrangements for determining water use ranging from small cans to tanks containing over one ton of soil are being used. In addition, numerous field plots with permanently rooted and annual plants, together with a specially equipped laboratory for the study of different phases of soil moisture movement, are in use.
(h) In progress. (No report on project furnished for this bulletin.)

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(272) (a) CHARACTERISTICS OF SPRINKLERS AND SPRINKLER SYSTEMS FOR IRRIGATION. (Part of larger project on farm irrigation structures and systems.)
(b) California Agricultural Experiment Station.
(c) Experimental Station Project.
(c) J. E. Christianson.
(d) Professor F. J. Veihmeyer.
(f) Determination of factors affecting uniformity of distribution, evaporation losses, and frictional losses in pipe lines with multiple outlets.
(g) Approximately 100 tests have been made on sprinklers of different makes and types to determine the distribution of water under varying conditions. Water is caught in a large number of cans (rain gages) and evaporation losses estimated from average depth caught as compared with water discharged. Effect of wind, pressure, speed of rotation of sprinkler, temperature, humidity, and various combinations of nozzles on performance of sprinklers studied. A large number of tests have been made on portable sprinkler pipe with sprinklers spaced at definite intervals to determine net pressure losses.
(h) In progress. (No report on project furnished for this bulletin.)

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CALIFORNIA INSTITUTE OF TECHNOLOGY, HYDRAULIC STRUCTURES LABORATORY.

(357) (a) INVESTIGATION OF HIGH VELOCITY FLOW AROUND BENDS IN OPEN CHANNELS.
(b) Los Angeles County Flood Control District.
(c) Cooperative study with Los Angeles County Flood Control District through C. H. Howell, Chief Engineer.
(d) Professor Robert T. Knapp and Arthur T. Ippen.
(e) Professor Robert T. Knapp.
(f) To determine the behavior of flow around curves in open channels when the velocity is higher than the critical.
(g) A special flume of 100 ft in length was constructed so that gradients up to 12% for the entire length could be obtained. Experiments were performed for a series of typical curves and gradients.
(h) No report received for this issue of the bulletin.

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(358) (a) A STUDY OF SURGE WAVE PROPAGATION AND TRAVEL IN CHANNELS OF STEEP GRADIENT.

and

(359) (a) A STUDY OF THE SPEED OF PROPAGATION OF FLOOD HYDROGRAPHS IN CHANNELS OF VARIOUS GRADIENTS.

These two studies were contingent upon the completion of (357). The latter developed into a much more comprehensive investigation than was originally contemplated and therefore has delayed the work on Projects (358) and (359). However, the analytical treatment resulting from Project (357) furnishes a new and much more satisfactory foundation for the attack on these correlative subjects.
(h) No report received for this issue of the bulletin.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, Cooperative Laboratory, Soil Conservation Service.

Research of the Cooperative Laboratory is still in too early a stage of development to warrant more than a preliminary survey at this time. Projects begun prior to completion of the new laboratory shelter, and major investigations to be undertaken as soon as laboratory is complete (about July 30, 1936), are as follows:-

1. Cutting of pilot channels.
2. Energy dissipation in small spillways.
3. Energy dissipation by jets.
4. Improvement of existing sand and gravel sample splitters.
5. Tests on weight-frequency sampling theory.
6. Use of log-probability graphs in sedimentation studies.
7. Mechanics of suspended-load transportation.
8. Mechanics of wear in stream sediment.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Cooperative Laboratory,
Soil Conservation Service. (Cont'd)

(360) (a) FUNDAMENTAL INVESTIGATION OF THE HYDRAULIC PHENOMENA INVOLVED IN SOIL EROSION.
(b) Division of Hydraulics and Sedimentation, Soil Conservation Service, U. S. Department of Agriculture.
(c) Cooperative research program with Soil Conservation Service.
(d) Various members of the permanent staff (10 men) of the Cooperative Laboratory.
(e) Professor Th. von Kármán, Professor Robert T. Knapp, Collaborators, or Vito A. Vanoni, Project Manager.
(f) to (i) The new one-story laboratory shelter 133 x 40 feet in size will house the suspended-load and wear flumes, and two glass-walled flumes, as well as a fineness laboratory for the physical analysis of sediment; photographic dark rooms; a work shop; and a field office. With a personnel trained in hydraulic, civil, and mechanical engineering and geology, fundamental research on the mechanics of stream-sediment transportation will be undertaken, emphasis being laid on the basic physical nature of the phenomena without losing sight of practical application to engineering work.
(h) No report received for this issue of the bulletin.

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CALIFORNIA INSTITUTE OF TECHNOLOGY, Hydraulic Machinery Laboratory.

(102) (a) INVESTIGATION OF VELOCITY DISTRIBUTION IN THE VOLUTE OF A CENTRIFUGAL PUMP IN THE NEIGHBORHOOD OF THE IMPELLER.
(b) Laboratory problem.
(c) Research for thesis for Ph. D. degree.
(d) R. C. Binder.
(e) Professor R. L. Daugherty or Professor Robert T. Knapp.
(f) The determination of the velocity value in the volute of a high-efficiency high-head centrifugal pump, including both average and instantaneous values in the region of the impeller discharge.
(g) A series of comprehensive surveys completely across the volute has been made at selected stations around the circumference of the impeller. Sufficient information has been obtained to determine the complete flow picture between the impeller and the volute at conditions of low, normal, and high discharge. By means of a precision dual-slide valve and special differential gage, instantaneous readings have been obtained to analyze the velocity distribution existing in the stream from a single impeller passage.
(h) No report received for this issue of the bulletin.

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(356) (a) STUDY OF THE CHARACTERISTICS OF HIGH HEAD CENTRIFUGAL PUMPS.
(b) Metropolitan Water District of Southern California.
(c) Large-scale model study.
(d) and (e) Professors Th. von Kármán, R. L. Daugherty, and Robert T. Knapp for the California Institute of Technology, Mr. R. M. Peabody for the Metropolitan Water District, plus staff of assistants.
(f) To determine the normal and reverse flow operating characteristics and the cavitation limits of the model pumps submitted by the contractors for the pumping stations to be installed on the Colorado River Aqueduct.
(g) For a brief description of the special laboratory equipment used for this work, reference should be made to National Bureau of Standards Hydraulic Laboratory Bulletin Series B, October 1, 1935.
(h) No report received for this issue of the bulletin.

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(545) (a) THE VARIATION OF RESISTANCE TO FLOW WITH THE AMOUNT OF OPENING OF VALVES OF BOTH THE FOLLOWER RING GATE AND CIRCULAR PASSAGE PLUG TYPES.
(b) Metropolitan Water District of Southern California.
(c) Model study for use in analyzing the transient behavior of the Metropolitan Water District Pumps, together with their pipe lines and control valves.
(d) Ralph M. Watson and Arthur T. Ippen.
(e) Professor Robert T. Knapp or Mr. R. M. Peabody.
(f) See (c).
(g) 6-inch valves of the desired types are being tested under carefully standardized conditions. Sufficient power is available to carry the Reynolds numbers, based upon the diameter of the valve, up to 3 to 4 million. The down-stream conditions are being investigated at closely-spaced piezometer stations for a distance of about 100 pipe diameters.
(h) No report received for this issue of the bulletin.

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(546) (a) INVESTIGATION OF THE EFFECT OF VARIATIONS IN INITIAL VELOCITY DISTRIBUTION UPON THE COEFFICIENTS OF A SERIES OF VENTURI TUBES.
(b) General laboratory research.
(d) Ralph M. Watson.
(e) Ralph M. Watson or Professor Robert T. Knapp.
(g) A series of carefully constructed Venturi meters is available in an installation in which they can be very precisely calibrated against a volumetric tank while in place. Provisions have been made for the use of direction-finding Pitot tubes at various points in the approach section ahead of the meter.
(h) No report received for this issue of the bulletin.

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HYDRAULIC RESEARCH IN CANADA.

ECOLE POLYTECHNIQUE DE MONTREAL.

(639) (a) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.
(b) Hydraulic Laboratory, Ecole Polytechnique de Montreal.
(c) General scientific research.
(d) Professor Raymond Boucher.
(e) Professor Raymond Boucher.
(f) To establish a comparison between the discharge capacities of different spillway designs.
(g) Studies are made on concrete models of existing and recommended spillway profiles. Pressure distribution on spillway crests determined. Coefficients of discharge are determined for various heads up to the designed head. The effect of gate piers of various designs is also investigated.
(h) In progress.

U. S. WATERWAYS EXPERIMENT STATION

(51) (a) SUSPENDED LOAD INVESTIGATIONS.
(b) Mississippi River and Tributaries.
(c) All experiments are prosecuted to the end of aiding in the development of plans for flood control, harbor improvement, navigation, etc. All have a direct practical application to the work of the Corps of Engineers, U. S. Army, in its administration of the Rivers and Harbors of the Nation. The U. S. Waterways Experiment Station holds as an unvarying principle the maintenance of the closest contact with the field in all experimental work. This contact is kept both by Station personnel visiting the prototype and by engineers from the field visiting the Station while any particular model study is in progress.
(d) All experiments are conducted at the U. S. Waterways Experiment Station by personnel of the Station under the direction of Lieutenant Francis H. Falkner, Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) Study of suspended load carried by the Mississippi River, its tributaries, and the Atchafalaya River - silting of reservoirs - study of the behavior of different sediment traps. Design of new traps.
(g) Field and laboratory investigations, analyses of samples, compilation of curves, comparison of results obtained from different traps.
(h) Completed.
(i) Report in Papers H & U, U. S. Waterways Experiment Station.

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(52) (a) SOIL INVESTIGATIONS.
(b) Navigable Waterways, U. S. A.
(c) (d) and (e) See (51).
(f) Study physical properties of soils, especially as they pertain to levee construction.
(g) Mechanical Analyses, Atterberg Limits, permeability tests, microscopic examinations, specific gravity determinations, shear and compression tests of samples undisturbed and otherwise, obtained under the supervision of the Station. Study of subsidences by use of pre-set plates established throughout the compressible strata at critical points for measuring the progress of consolidation in the strata. Checking observed results against anticipated settlement determined from study of undisturbed samples of foundation material.
(h) Studies in progress continually.

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(59) (a) LEVEE SEEPAGE.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study and observe hydraulic gradient and flow lines in levees and models of standard sections of various materials placed by various methods.
(g) Loop of levees, standard section, 10 feet high, of various materials and placed in various ways, kept full; measurements taken.
(h) Study inactive at present.

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(74) (a) TRACTIVE FORCE.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) To determine relation between physical properties of bed-load materials and tractive force required to move them. Also to determine laws governing rate of bed-load movement.
(g) Tests in special tilting flume checked by special runs in models.
(h) Experimental work on materials of low specific gravity is complete.
(i) Results of tests on synthetic sands are continued in T.M. 99-1. Results of tests on materials of low specific gravity are contained in T.M. 103-1.

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(77) (a) ISLAND NO. 35, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Develop methods of improving navigation conditions.
(g) Movable bed model of river from Mile 181.4 to 204.0 below Cairo. Model scales are 1:600 horizontal and 1:150 vertical.
(h) Completed.
(i) Reports of original experiment included in Technical Memoranda Nos. 29, 29-2, 3, 4, 5, 6, 7, 8, U. S. Waterways Experiment Station. Report on most recent study is to be found in Technical Memorandum No. 29-8.

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(91) (a) MISSISSIPPI RIVER MODEL NO. 4 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 560 TO MILE 655 BELOW CAIRO
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving flood control and channel stabilization between the limits specified in (a). Reaches studied: Millikens Bend, King's Point, Racetract Towhead, Diamond Point Cut-off, Buckridge Crossing, and Yucatan Point Cut-off. Most recent study made on Delta Point Reach.
(g) Model scales: 1 to 1000 horizontal and 1 to 100 vertical; movable bed. For most recent tests the movable bed was fixed.
(h) Model intermittently active.

(91) (continued)
(i) Results of these studies are described in Technical Memoranda Nos. 3-1, 3-2, 36-1, 37-1, 37-2, 37-3, 37-4, 37-5, 38-1, 38-2, 38-3, 72-1, U. S. Waterways Experiment Station. Technical Memorandum No. 38-1 contains results of most recent study.

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(92) (a) MISSISSIPPI RIVER MODEL NO. 5 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 650 TO MILE 762.5 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving flood control and channel stabilization within the limits specified in (a). Reaches studied: Bondurant Towhead, Waterproof Cut-off, Rifle Point, Cowpen Point Cut-off, Natchez Island, Esperance Point - Morville Landing, Glasscock Point Cut-off.
(g) Model scales: 1 to 1000 horizontal and 1 to 100 vertical; movable bed.
(h) Model temporarily inactive.
(i) Results of these studies are described in Technical Memoranda Nos. 32-1, 32-2, 32-3, 32-4, 42-1, 42-2, 42-3, 42-4, 42-5, 60-1, 82-1, 82-2, Waterways Experiment Station.

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(153) (a) ARTICULATED CONCRETE MATTRESS STUDY.
(b) U. S. District Engineer, Memphis, Tennessee.
(c) (d) and (e) See (51).
(f) Relative protection afforded banks by two types of articulated concrete mattress.
(g) Installation of full size mattress units on the banks of the creek from which Station water supply is derived. Observations of erosion from floods will be made.
(h) Work suspended.

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(163) (a) MISSISSIPPI RIVER MODEL NO. 1, INCLUDING THE MISSISSIPPI RIVER FROM MILE 390 TO MILE 810 BELOW CAIRO, THE RED RIVER FROM ITS MOUTH TO MILE 83 ABOVE LARBRE LANDING, AND THE ATCHAFALAYA RIVER FROM ITS HEAD TO MILE 35 BELOW LARBRE LANDING.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems affecting water surface elevations within the limits specified in (a). Problems studied: Ten proposed Cut-offs, Leland and Tarpley Neck Cut-offs, Brunswick levee Extensions, Natchez Levee Set-back, and Enlargement of the Atchafalaya River.
(g) Model scales 1 to 2400 horizontal and 1 to 120 vertical; fixed bed.
(h) Model temporarily inactive.
(i) Results of several studies are described in Technical Memoranda Nos. 25, 25-A, 25-B, 25-C, 25-D, 34, 34-2, 50-1, 50-2, U. S. Waterways Experiment Station.

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(165) (a) MISSISSIPPI RIVER BED MATERIAL SURVEY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) To determine characteristics of material composing the bed of the Mississippi River and its principal tributaries.
(g) Samples taken from bed of Mississippi River at about one-mile intervals from Cairo to Gulf of Mexico, and from beds of Ohio, Old, Red, Black and Atchafalaya Rivers and the Atchafalaya Basin. Supplementary samples later taken from Arkansas, White, Ouachita, Yazoo, St. Francis, Ohio, Tennessee, Cumberland, Wabash, Missouri, and Illinois Rivers. Special trap used for procuring samples. Mechanical and hydrometer analysis, specific gravity test, and microscopic examination were made of each sample. Petrographic study is being made.
(h) Completed.
(i) Report of analyses in Paper 17. Petrographic report in Technical Memoranda 62-1, and 62-2.

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(168) (a) HEAD OF PASSES, MISSISSIPPI RIVER.
(b) U. S. District Engineer, 1st N. O. District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods of improving navigation conditions at Head of Passes.
(g) Movable bed model extending from 8 miles above to 6 miles below Head of Passes. Model scales 1 to 600 horizontal and 1 to 150 vertical.
(h) Original and supplementary tests completed.
(i) Report on original studies included in Technical Memoranda Nos. 46-1, -2, -3, -4, -5, -6, -7, -8, U. S. Waterways Experiment Station. Report on supplementary tests now being prepared.

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(170) (a) MISSISSIPPI RIVER MODEL NO. 2, INCLUDING THE MISSISSIPPI RIVER FROM MILE 370 TO MILE 445 BELOW CAIRO, 60 MILES OF THE ARKANSAS RIVER AND 16 MILES OF THE WHITE RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Determine effects of separating mouths of Arkansas and White Rivers; also effects of cut-offs on these rivers upstream from mouth and miscellaneous problems for channel stabilization and navigation.
(g) Model scales 1 to 1000 and 1 to 100; fixed bed.
(h) Model temporarily inactive.
(i) Results of this study are described in Technical Memorandum No. 51-1.

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(198 (a) FIDLER BEND, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study for improvement of navigation and miscellaneous hydraulic problems.
(g) Model scales 1 to 500 and 1 to 150; movable bed.
(h) Temporarily inactive.
(i) Results to date of this study are described in Technical Memorandum No. 58-1.

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(253) (a) CAT ISLAND, MISSISSIPPI RIVER.
(b) U. S. District Engineer, Memphis, Tennessee.
(c) (d) and (e) See (51).
(f) Study of proposed regulating works.
(g) Movable bed model from Mile 241.3 to Mile 275.0 below Cairo. Model scales 1 to 1000 horizontal and 1 to 125 vertical.
(h) Inactive.
(i) Report included in Technical Memorandum No. 63-1, U. S. Waterways Experiment Station.

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(256) (a) MISSISSIPPI RIVER MODEL NO. 3 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 236 TO MILE 581 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving the river within the limits specified in (a). Reaches studied: Walker Bend - American Cut-off, Worthington Point Cut-off, Kentucky Bend and Cracraft Chute.
(g) Model scales 1 to 1000 horizontal and 1 to 100 vertical; movable bed.
(h) Model intermittently inactive.
(i) Results of studies are described in Technical Memoranda Nos. 59-1 and 74-1, U. S. Waterways Experiment Station.

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(257) (a) DIRECTIVE ENERGY STUDY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Experiments to determine relations between length of tangent, length of pool, total length, slope, and bed material of rivers.
( ) Outdoor flume, 50 feet x 15 feet with movable bed, being used.
(h) Model temporarily inactive.
(i) Results of experiments to date are included in Technical Memoranda Nos. 61-1, -2, -3, and -4, U. S. Waterways Experiment Station.

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(409) (a) STUDIES OF PIPE LINE MIXERS.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tennessee.
(c) (d) and (e) See (51).
(f) To study the effect of rifles in dredge discharge pipes on the percentage of solids that can be pumped without increasing the power of the dredge. Size, pitch, and spacing of rifles will be studied, and the efficiency of various designs compared with the efficiency of the smooth discharge pipe.
(g) Tests being made in 4-inch observation pipe.
(h) Sand tests completed. Investigations of other materials in progress.
(i) Preliminary reports contained in progress reports, consolidated report being prepared.

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(414) (a) MODEL STUDY TO DETERMINE EFFICACY OF SUB-LEVEES AND THEIR EFFECT IN CONTROLLING THROUGH AND UNDER SEEPAGE FOR MAIN LINE LEVEES.
(b) The District Engineer, U. S. Engineer Office, Memphis, Tennessee.
(c) (d) and (e) See (51).
(f) To determine, by means of flow nets developed from models, the relative quantities of seepage, etc.
(g) Flume tests of models, permeability tests and mechanical analyses.
(h) Original tests completed. Additional tests in progress.
(i) Report in Technical Memorandum, 101-1.

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(415) (a) MISSISSIPPI RIVER MODEL - HELENA, ARKANSAS TO DONALDSONVILLE, LOUISIANA, INCLUDING THE MISSISSIPPI RIVER FROM MILE 398 TO MILE 900 BELOW CAIRO, AND ESSENTIAL PORTIONS OF ALLUVIAL VALLEY FROM HELENA, ARKANSAS TO THE GULF OF MEXICO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous flood control problems on the lower Mississippi River.
(g) Model scales, 1 to 2000 horizontal and 1 to 100 vertical; fixed bed.
(h) In progress.
(i) Result of studies to date are contained in Technical Memoranda 93-1, 93-2, 93-3, and 93-4, and in letters to the President, Mississippi River Commission.

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(417) (a) MARE ISLAND STRAIT, SAN FRANCISCO BAY, CALIFORNIA.
(b) U. S. District Engineer, San Francisco, California.
(c) (d) and (e) See (51).
(f) Study to determine means of eliminating shoaling in navigation channel.
(g) Model scales of 1 to 800 horizontal and 1 to 80 vertical, fixed bed. Tidal flow is to be simulated. Various proposed plans for eliminating shoaling to be tested.
(h) Model in verification stage.

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(471) (a) CHESAPEAKE AND DELAWARE CANAL MODEL.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pennsylvania.
(c) (d) and (e) See (51).
(f) To study methods of eliminating shoaling in the Delaware River entrance to the Chesapeake and Delaware Canal.
(g) Model scales of 1 to 300, horizontal, and 1 to 80 vertical. Movable bed. Tidal flow stimulated. Various proposed plans for eliminating shoaling tested.
(h) Temporarily inac tive.
(i) Results of tests are to be found in Technical Memorandum No. 93-1, U. S. Waterways Experiment Station. Additional details of the technique developed for operation of the tide reproduction mechanism are to be found in Technical Memorandum 93-2.

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(472) (a) BALLONA CREEK OUTLET MODEL.
(b) The District Engineer, U. S. Engineer Office, Los Angeles, California
(c) (d) and (e) See (51).
(f) Maintenance of flood channel at outlet into ocean.
(g) Model scales, 1 to 100 horizontal, and 1 to 50 vertical. Movable bed. Tidal flow, wave action and creek floods to be reproduced.
(h) Completed.
(i) Report in Technical Memorandum 100-1.

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(473) (a) MARACAIBO OUTER BAR MODEL.
(b) Standard Shipping Company, New York, N. Y.
(c) Investigation of progressive westward movement of the outer bar with view to ascertain any probably future development.
(d) See (51).
(e) See (51).
(f) To study outer bar action at entrance of Lake of Maracaibo, Venezuela.
(g) Scale of model 1 to 300, horizontal, 1 to 50 vertical. Tidal flow and wave action to be reproduced. Movable bed.
(h) Verification of model in progress.

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(477) (a) PHYSICAL AND CHEMICAL TESTS OF SOIL AND ROCK FROM SITE OF CONCHAS DAM, NEAR TUCUMCARI, NEW MEXICO.
(b) The District Engineer, U. S. Engineer Office, Tucumcari, New Mexico.
(c) (d) and (e) See (51).
(f) The determination of the suitability and action of the material represented by the samples for dam construction and the foundation of a contemplated earthen or rock fill dam.
(g) Classification tests, mechanical analyses and Atterburg Limits. Chemical analyses and determination of per cent of water soluble constituents on a weight basis of entire specimen. Detailed tests for design purposes, shear, consolidation, permeability, absolute specific gravity and water content for undisturbed and remolded samples of soil, also permeability and durability tests of rock samples.
(h) Tests completed.
(i) Consolidated report in Technical Memorandum 103-1.

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(479) (a) MEMPHIS DEPOT STUDY, MISSISSIPPI RIVER, MILE 736 TO MILE 734 BELOW CAIRO.
(b) The District Engineer, U. S. Engineer Office, West Memphis, Arkansas.
(c) (d) and (e) See (51).
(f) Determine method of improvement of navigational channel to the Memphis Engineer Supply and Repair Depot.
(g) Model scales, 1 to 450 horizontal and 1 to 150 vertical. Movable bed.
(h) Temporarily inactive.
(i) Results described in Technical Memorandum 89-1, and Technical Memorandum 89-2, U. S. Waterways Experiment Station.

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(480) (a) GALVESTON HARBOR MODEL.
(b) The District Engineer, U. S. Engineer District, Galveston, Texas.
(c) (d) and (e) See (51).
(f) Feasibility of model study being investigated.

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(481) (a) ABSECON INLET MODEL.
(b) The District Engineer, U. S. Engineer Office, Philadelphia, Pa.
(c) (d) and (e) See (51).
(f) Study to determine means of eliminating shoaling in navigation inlet.
(g) Design suspended awaiting field data.

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(533) (a) INVESTIGATION OF PARTIAL FAILURE OF MURRAY DAM, ARDMORE, OKLA.
(b) Works Progress Administration, Ardmore, Okla.
(c) (d) and (e) See (51).
(f) To determine the cause of failure and perform tests of soils for redesign and reconstruction.
(g) Classification tests, mechanical analyses, water contents, and Atterberg Limits. Detailed tests for design purposes, shear, consolidation and permeability.
(h) Field investigation and laboratory tests completed.
(i) Report in Technical Memorandum 108-1.

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(534) (a) CONCHAS DAM STILLING BASIN.
(b) The District Engineer, U. S. Engineer Office, Tucumcari, New Mexico.
(c) (d) and (e) See (51).
(f) To determine an economical stilling basin design for the Conchas Dam Project.
(g) Model scale, 1 to 50. Entire spillway section and stilling basin reproduced. Satisfactory basin determined by observation of stilling basin action, by scour patterns below the dam and by velocity measurements. Observations recorded by moving pictures and still photographs. Two distinct types of basins were studied; the roller and eddy type basin and the hydraulic jump basin.
(h) Tests completed.
(i) Report in Technical Memorandum 105-1.

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(35) (a) CHAIN OF ROCKS, MISSISSIPPI RIVER.
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) (d) and (e) See (31).
(f) Study for improvement of navigation and miscellaneous hydraulic problems.
(g) Model scales, 1 to 600 horizontal and 1 to 125 vertical. Movable bed. Mississippi River from Mile 183.0 to Mile 202.8 and Missouri River from Mile 0.0 to Mile 8.0.
(h) Verification of model in progress.

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(536) (a) PRYORS ISLAND REACH.
(b) The District Engineer, U. S. Engineer Office, Louisville, Kentucky.
(c) (d) and (e) See (31).
(f) Study for improvement of navigation and channel stabilization.
(g) Model scales, 1 to 600 horizontal and 1 to 150 vertical. Movable bed. Ohio River from Mile 899 to Mile 919.
(h) Model verification in progress.

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(537) (a) KANSAS CITYS FLOOD CONTROL MODEL.
(b) The Division Engineer, Missouri River Division, Kansas City, Missouri.
(c) (d) and (e) See (31).
(f) Study of proposed plans for flood control at the Kansas Citys.
(g) Model scales, 1 to 300 horizontal and 1 to 100 vertical; fixed bed.
(h) Original tests complete. Additional tests in progress.
(i) Report in T. M. 100-1.

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(538) (a) DOGTOOTH BEND - INCLUDING THE MISSISSIPPI RIVER FROM MILE 33.7 ABOVE CAIRO TO MILE 4 BELOW CAIRO.
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) (d) and (e) See (31).
(f) To determine means for improving navigation.
(g) Model scales, 1 to 600 horizontal and 1 to 50 vertical; movable bed.
(h) Verification of model in progress.

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(539) (a) SWIFT SHOE TOWHEAD - INCLUDING THE MISSISSIPPI RIVER FROM MILE 51.2 TO 67.3 BELOW CAIRO.
(b) The District Engineer, U. S. Engineer Office, St. Louis, Mo.
(c) (d) and (e) See (31).
(f) To determine means for improving navigation.
(g) Model scales, 1 to 600 horizontal and 1 to 120 vertical; movable bed.
(h) Verification of model in progress.

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(540) (a) GRAND TOWER - INCLUDING THE MISSISSIPPI RIVER FROM MILE 73.9 TO MILE 84 BELOW CAIRO.
(b) The District Engineer, U. S. Engineer Office, St. Louis, Missouri.
(c) (d) and (e) See (51).
(f) To determine means for improving navigation.
(g) Model scales, 1 to 600 horizontal and 1 to 500 vertical; movable bed.
(h) Verification of model in progress.

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(568) (a) EAST RIVER, NEW YORK HARBOR.
(b) The District Engineer, First New York District, U. S. Engineer Office, New York, N. Y.
(c) (d) and (e) See (51).
(f) To study tidal currents in the East River.
(g) Model scales, 1 to 480 horizontal and 1 to 80 vertical; fixed bed.
(h) Construction of model in progress.

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(569) (a) POSSUM KINGDOM DAM SPILLWAY AND STILLING BASIN.
(b) The District Engineer, U. S. Engineer Office, Mineral Wells, Texas.
(c) (d) and (e) See (51).
(f) To calibrate the spillway, and to determine an economical stilling basin design.
(g) Model scale, 1 to 70. Typical spillway study.
(h) In progress.
(i) Preliminary report in T. M. 111-1 and 111-2.

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(570) (a) SOILS SURVEY YERBA BUENA SHOAL, SAN FRANCISCO HARBOR.
(b) The District Engineer, U. S. Engineer Office, San Francisco, California.
(c) (d) and (e) See (51).
(f) To determine cause of subsidence, and investigate soil foundation.
(g) Classification tests, mechanical analysis, water contents, Atterberg Limits, and shear and consolidation tests.
(h) Field investigation in progress.

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U. S. BUREAU OF RECLAMATION.

(48) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE BOULDER DAM.
(b) (c) (d) (e) (f) (g) See this bulletin for April, 1933.
(h) Earlier reports on this work (referred to in this bulletin for October, 1933) were:
(1) "Hydraulic Capacity of the Diversion Tunnels of Hoover Dam", by B. W. Steele and S. P. Wing.
(2) (3) Technical Memorandums Nos. 332, 335, and 347 by E. W. Lane.
(4) Technical Memorandum No. 525, "Hydraulic Model Studies for the Design of the Boulder Dam, Book 5 ", by J. N. Bradley and J. E. Warnock has been completed. See "Abstracts of Completed Projects" in this bulletin.
A complete report of the hydraulic experiments for the Boulder Dam is in preparation and will appear in the near future as a part of the eleven-volume report covering all phases of the Boulder Canyon project. Some previously unreported data have been analyzed and all previous work will have been thoroughly reviewed and supplemented.
(i) Technical Memoranda of the Bureau of Reclamation are deposited with the Denver Public Library.

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(399) (a) MOON LAKE DAM SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) (f) (g) See this bulletin for January, 1936.
(h) Completed. Report available for loan:
"Hydraulic Model Studies for the Design of the Moon Lake Spillway", by J. N. Bradley and J. B. Drisko, Technical Memorandum No. 437. The tests were extended to include the stilling pool design for the outlet works. A report on the outlet works is in preparation.
(i) Technical Memoranda of the Bureau of Reclamation are deposited with the Denver Public Library.

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(547) (a) HYDRAULIC EXPERIMENTS FOR THE DESIGN OF THE GRAND COULEE DAM.
(b) (c) (d) (e) See this bulletin for July, 1936.
(f) Determine spillway crest and stilling pool designs; determine safe diversion procedure during construction. These tests are being extended to include studies of the sluice inlets.
(g) Models of spillway bucket tested at three scales; model of partially constructed dam at various stages and with alternate diversion sequences to determine the best procedure for avoiding adverse erosion of the river bed. The sluice entrance tests are being made at a specially constructed orifice aperture in a pressure tank. Accurate jet contraction measurements and velocity traverses are contemplated.
(h) All tests completed except sluice entrances. Reports in preparation. See also the paper, "Experiments Aid in Design at Grand Coulee", by J. E. Warnock in Civil Engineering, November, 1936.

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(548) (a) IMPERIAL DAM AND ALL-AMERICAN CANAL TESTS.
(Formerly listed as Nos. 350, 380, and 381).
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1935.
(h) Studies of the models of the headworks conducted at the Montrose laboratory have been completed. The testing of the "influent slot" for the desilting works has been completed. A model of the New River inverted siphon crossing and wasteway, and a model of Canal Drop No. 4 and power plant are under construction. A 1:6 model of the ejec tor to be installed on the overflow apron for excavating drainage galleries will be constructed in the new laboratory. Technical Memorandum No. 516, "Hydraulic Model Studies for the design of the Imperial Dam and Desilting Works, Book 5 ", by J. N. Bradley, has been completed and is on deposit with the Denver Public Library. See also "Abstracts of Completed Projects" at end of this bulletin.
(i) Of considerable interest in illustrating the flow through rectangular, diverging, 120-degree bends are the motion pictures taken at 64 frames per second.

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(549) (a) CABALLO DAM OUTLET WORKS AND SPILLWAY.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Tests completed. Report in preparation.
(i) An interesting feature of the stilling pool for the outlet works is the short drop followed by a normal pool floor at nearly the elevation of the river bed.

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(550) (a) BULL LAKE OUTLET WORKS.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.

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(551) (a) MORMON FLAT SPILLWAY.
(b) (c) (d) (e) (f) See this bulletin for July, 1936.
(g) A super-elevated, spiral channel spillway has been developed and tested with satisfactory results.
(h) Completed. Report in preparation.

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(552) (a) HORSE MESA SPILLWAY.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.
(i) Unexpected field conditions required a shift in the location of the tunnel spillway. To check the effect of changed approach conditions on the tunnel discharge, the previously completed model was reinstalled.

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(553) (a) ALAMOGORDO SPILLWAY.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.

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(554) (a) BARTLETT SPILLWAY.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.

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(555) (a) ROOSEVELT SPILLWAYS.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.

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(556) (a) Stewart Mountain Spillway.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.

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(557) (a) CASPER-ALCOVA SPILLWAY AND OUTLET WORKS.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Spillway tests completed. Report deposited in the Denver Public Library: Technical Memorandum No. 513, "Hydraulic Model Experiments for the Design of the Alcova Spillway", by J. B. Drisko. Outlet tests temporarily suspended.

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(558) (a) FRIANT OUTLET WORKS.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) A setting of the needle valves has been found for the Kern County outlet which requires neither sills nor extra tail-water for maintaining an efficient hydraulic jump in the pool under all necessary operating conditions. Tests still in progress to secure further improvements.

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(559) (a) FRESNO (MONTANA) DAM SPILLWAY.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Model construction temporarily suspended.

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(560) (a) NEEDLE VALVE AND RING-FOLLOWER AND CYLINDER-FOLLOWER GATE CHARACTERISTICS.
(b) (c) (d) (e) (f) (g) See this bulletin for July, 1936.
(h) Completed. Report in preparation.
(i) Of conspicuous importance are the effects on the needle-valve flow produced by partial gate openings in the feeder line and the closing or uplift forces acting on the gate leaf at partial openings as a result of converging or diverging flow beneath the edge of the leaf. A unique type of seal has been developed for the ring-follower gate.

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(571) (a) GIBSON SPILLWAY.
(b) U. S. Bureau of Reclamation.
(c) General laboratory study for design data.
(d) Hydraulic Laboratory Section, U. S. Bureau of Reclamation.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.
(f) To determine the discharge characteristics of the existing "glory hole" (vertical shaft) spillway, reconstructed and equipped with gates to permit storage at a higher pond level.
(g) Model of shaft and tunnel constructed in pyralin. Discharge observed at which intake submerges. Causes of periodic "flushing" studied.
(h) Completed. Report in preparation.
(i) Beyond a well-defined critical discharge, the periodic choking and flushing was found to be associated with suction heads which reached values as high as twenty-five feet at the bend (hypothetical prototype dimensions). Anticipated operating conditions, however, did not reach such extreme values.

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(572) (a) UNITY DAM SPILLWAY.
(b) U. S. Bureau of Reclamation.
(c) General laboratory study for design data.
(d) Hydraulic Laboratory Section, U. S. Bureau of Reclamation.
(e) Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.
(f) To evolve satisfactory stilling pool design and approaches.
(g) Model test. Observation of hydraulic jump and extent of erosion.
(h) Completed. Report in preparation.

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TENNESSEE VALLEY AUTHORITY.
Engineering Data Division, Hydraulic Laboratory Section.

(494) (a) PICKWICK LANDING DAM, SPILLWAY DESIGN.
(b) Tennessee Valley Authority.
(c) Investigation of stilling basin and shape of crest for Pickwick Landing Dam.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To determine a satisfactory and economical design of apron below the dam in order to dissipate energy, and to determine the best shape of spillway crest.
(g) Tests made on models built to three different scales. Action of stilling basin for 1:50 and 1:25 sectional models observed through glass panels in side of flume. Results checked on 1:100 model of entire dam. Discharge coefficients, pressures on face of spillway, and on spillway gate piers for various combinations of gate operation were carefully measured on a 1:25 model. Supplementary studies were also made to determine the size of air passages necessary for satisfactory aeration of the nappe.
(h) Tests completed.
(i) Report in progress.

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(495) (a) PICKWICK LANDING DAM, COFFERDAMS.
(b) Tennessee Valley Authority.
(c) Investigation of effect of cofferdamming and construction operation on river regimen.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To determine the effect of proposed cofferdams and dredging operations during construction on river stages, navigation, and scour; to determine the allowable constriction of the river channel by cofferdams in each of the various stages of construction.
(g) A model of 9000 feet of the Tennessee River including the dam site was built to a scale of 1:100. 3800 feet of the channel at the site was formed in fine sand in order to investigate scouring conditions. Scale models of all proposed construction features such a cofferdams, lock, power house, and spillways were put in place to simulate various proposed phases of construction, and the effects on the river were observed in order to determine the best sequence of operations.
(h) Tests completed.
(i) Report in progress.

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(573) (a) GUNTERSVILLE LOCK, NAVIGATION STUDIES
(b) Tennessee Valley Authority and Corps of Engineers, U. S. Army.
(c) Investigation of navigation conditions at entrance to Guntersville Lock.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To determine the proper location of lock, and length and angle of guide walls to give good navigation conditions in the neighborhood of the lock.
(g) Tests were made on a model built to a scale of 1:150. About one and one-half miles of river channel are included. Navigation conditions were studied by observation of the river currents and by operation of model barges through the lock. Conditions during construction were studied, as well as the final design.
(h) Tests completed.
(i) Report in progress.

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(574) (a) HIWASSEE DAM, SPILLWAY DESIGN.
(b) Tennessee Valley Authority.
(c) Investigation of stilling basin for Hiwassee Dam.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To determine the most satisfactory and economical design of stilling basin at the toe of the dam.
(g) Tests are being made on a 1:55 scale model placed behind a glass panel to allow visual observation of flow conditions in the stilling basin.

(h) A satisfactory apron and stilling basin have been developed to care for discharge over the spillway. The problem of sluiceway discharge is about to be taken up.

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(575) (a) SWAN LAKE MODEL EXPERIMENT.
(b) Tennessee Valley Authority.
(c) Study of effect of closing a small bridge in a long embankment crossing a wide river valley.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To investigate the direction and velocity of currents along the embankment of the Southern Railway due to closing the bridge across Swan Lake, near Decatur, Alabama.
(g) A model of the flood plain and river channel of the Tennessee River near Decatur, Alabama, was built to scales of 1:400 horizontal and 1 to 100 vertical. After verification, it was operated with the proposed changes in the railway embankment. The magnitude and direction of the resulting currents were recorded, as well as the changes in water surface elevation.
(h) Tests completed.
(i) Report in progress.

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(576) (a) UPPER CHICKAMAUGA POOL, NAVIGATION EXPERIMENT.
(b) Tennessee Valley Authority and Corps of Engineers, U. S. Army.
(c) Investigation of navigation conditions in the upper reach of the Chickamauga pool as influenced by the proposed Watts Bar lock and dam.
(d) Laboratory staff under direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.
(f) To determine the best location of lock and arrangement of guide and guard walls, also the best method of operating spillway gates, with relation to navigation through the lock.
(g) Tests made on a model at a scale of 1:150. One-half mile of channel above the dam site and about one mile below are included. All structures are built to the same scale. Velocities and directions of currents are observed visually and recorded photographically. Model barges are operated in the vicinity of the lock, and their motion recorded by motion pictures when desirable.
(h) Model constructed and tests under way.

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(577) (a) HEAD INCREASER, GUNTERSVILLE POWER HOUSE.
(b) Tennessee Valley Authority.
(c) Investigation of a combined spillway and power house unit whose object is increasing the effective head on the turbines by a reduction of tailwater depth over the draft tubes. This is to be accomplished by the formation of a hydraulic jump, using the spillway discharge.
(d) Laboratory staff under the direction of G. H. Hickox.
(e) A. S. Fry, Head Engineer, Tennessee Valley Authority, Knoxville, Tennessee.

(f) To determine the feasibility of the proposed unit for installation at the Guntersville dam site.
(g) Tests to be conducted on a 1:50 scale model. Provision is made for changing the proportion and dimensions of the spillway sluices, draft tubes, and tailraces. Transparent sections permit visual observation of flow conditions.
(h) Model under construction.

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NATIONAL BUREAU OF STANDARDS.

(42) (a) INVESTIGATION OF THE PHYSICS OF PLUMBING SYSTEMS.
(b) National Bureau of Standards.
(c) General research.
(d) R. B. Hunter, G. E. Golden, L. O. Olsen.
(e) The Director, National Bureau of Standards.
(f) To obtain data on which to base logical estimates of the capacities of drain pipes, vertical and sloping, in plumbing systems and to make a study of safety requirements with special reference to back-siphonage and venting.
(g) It is proposed to collect and correlate as far as possible existing data on these subjects and to make such supplementary experiments as may be necessary to meet the purpose of the investigation.
(h) An analysis of conditions in water supply and distributing systems conducive to back flow from plumbing systems has been completed and experiments for verification and evaluation of constants have been made. A preliminary report in the form of a technical paper is in preparation.

An investigation of the capacities of drains will be taken up at an early date.

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(43) (a) INVESTIGATION OF PIPE BENDS.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, G. H. Keulegan.
(e) The Director, National Bureau of Standards.
(f) To obtain the general laws of head loss in pipe bends; to correlate, insofar as possible, all available results of previous investigations; to obtain practicable formulas for use of engineers; and to extend the results to include flow of other fluids, such as oils, steam, etc.
(g) Laboratory tests are planned on smooth and rough pipe bends of various diameters and central angles; and on miter bends and cast fittings.
(h) A paper on the results of tests on 3/8 inch brass tubing with bends having central angles varying from 5 to 180 degrees is to be published in the January, 1937, number of the Journal of Research, National Bureau of Standards. See abstract in this bulletin.

A paper on tests on 4-inch steel pipe with 90 degree bends of radii varying from 6 inches to 7 feet is being prepared.

It has been found possible to bend coils of desired dimensions using 1-inch lead pipe. Pipe and coils are now being prepared for tests.

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(343) (a) FRICTION LOSSES IN STRAIGHT PIPES.
(b) National Bureau of Standards.
(c) General research.
(d) K. H. Beij, G. H. Keulegan.
(e) The Director, National Bureau of Standards.
(f) Study of hydraulic roughness in pipes.
(g) Correlation of friction losses with surface characteristics of pipes.
(h) A critical review of previous work has been completed, and the results are being prepared for publication.
(i) This investigation is carried on in connection with other projects as opportunity offers.

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(564) (a) CURRENTS IN LAKES AND RESERVOIRS.
(b) National Bureau of Standards.
(c) General research.
(d) B. H. Monish.
(e) The Director, National Bureau of Standards.
(f) To determine the laws governing and permitting the movement of a current of fluid relative to a body of fluid of different density.
(g) A current of clear water in a rectangular glass-walled closed channel is caused to flow over a salt solution of greater density situated in a depression in the floor of the channel. Relative velocity, velocity distribution and turbulence are indicated by the use of dyes and observed through the glass walls. Samples of fluids for density determinations are siphoned off by a tube inserted through the top of the channel.
(h) The apparatus is assembled, and a few preliminary runs have been made.
(i) While this project has been planned as fundamental research, the underlying object of the investigation is the explanation of the occasional occurrence of currents of silty water in reservoirs, such as exist at the Elephant Butte Dam and at Boulder Dam.

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(616) (a) FLOW IN OPEN CHANNELS.
(b) National Bureau of Standards.
(c) General research.
(d) G. H. Keulegan.
(e) The Director, National Bureau of Standards.
(f) To investigate the phenomena of open channel flow in the light of modern concepts of turbulent flow. This will involve a study of the dependence of the hydraulic friction factor on the cross-section of the channel and on the roughness of its surfaces, the apparent friction of the free surface and the depression of the filament of maximum velocity.

(g) The first step has been to review critically Bazin's work in open channels. This has involved a study of the utility of von Karman's velocity distribution law when applied to wavy and to rough surfaces. Future aspects of the investigation will include an experimental investigation of flow in channels having triangular cross-sections with included angles ranging from 22.5° to 135° and with different roughness characteristics. The friction characteristics of the rough surfaces will be determined by means of tests in closed channels having the same surfaces.

(h) The investigation of Bazin's data has given a positive result, in the sense that it has established the significance and limitation of the hydraulic radius, the equivalent sand roughness for some of the surfaces used, a rational basis for Manning's formula and the relation existing between the relative equivalent sand roughness and Manning's "n". A paper giving the results of this study is in process of preparation.

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(258) (a) STUDY OF DIVISORS FOR SOIL EROSION INVESTIGATIONS.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Data for calibration and design.
(d) H. L. Cook, D. A. Parsons, F. W. Blaisdell, G. C. Conners.
(e) Chief, Soil Conservation Service.
(f) Calibration of divisors now in use; study of relative accuracy of various types; development of new divisors.
(g) Calibrations are being made on various divisors, both with clear and with muddy water, to determine the effectiveness of the divisor in splitting off a definite percentage of the water and soil passing it. All old types, modifications of the old types and some divisors of new design are being studied.
(h) Work has been completed on all of the old types of divisors that have been in extensive use or that appeared to have the desired qualifications. Thus far, the Geib multislot divisors have given the best results. Plans and specifications for these have been prepared.
(i) Further work will be confined principally to the development of divisors having greater capacities than those previously studied.

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(341) (a) STUDY OF MEASURING FLUMES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(c) Data for calibration and design.
(d) H. L. Cook, J. B. Drisko, L. L. DeFabritis.
(e) Chief, Soil Conservation Service.
(f) The development and calibration of more suitable measuring flumes for the measurement of rates of runoff from experimental areas.
(g) Consideration is being given to all types, ranging from the straight-sided, free overfall to modified venturi flumes. Tests are being made on meters which appear to be capable of maintaining their ratings under service conditions and which are so designed that small rates of flow may be accurately determined.
(h) Ten flumes of different design, with numerous variations, have been tested with clear water.

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(497) (a) METHODS FOR SAMPLING AND ANALYZING SOIL-WATER MIXTURES.
(b) Soil Conservation Service, U. S. Department of Agriculture.
(d) H. L. Cook, J. O. Laws, S. R. Kline, E. P. Deatrick.
(e) Chief, Soil Conservation Service.
(f) Determination of best methods of sampling and analysis from the standpoints of accuracy and efficiency.
(g) The methods that are now in use and others that may suggest themselves will be used on synthetic mixtures of various concentrations of soils.
(h) Preliminary tests to two sample splitters of the Uhland-Woodruff type and of several tube samplers have been made. Studies of methods of analysis have been continued.

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(384) (a) TESTS OF SPILLWAY FLASHBOARD PINS.
(b) U. S. Forest Service.
(c) Cooperative project with the U. S. Forest Service for testing field designs under simulated field conditions in the laboratory.
(d) C. A. Wright (National Bureau of Standards). C. A. Betts (U. S. Forest Service.)
(e) The Director, National Bureau of Standards.
(f) To test spillway flashboard pins to failure under pressure due to static and overflowing water and also in a mechanical testing machine. The results are to be compared with values used in design.
(g) In addition to the tests described in Bulletin IV-1, a series of mechanical tests was made by the Engineering Mechanics Section of the National Bureau of Standards. Duplicate specimens of 3/4 in., 1 in., 1-1/4 in., 1-1/2-in., 2 in., 2-1/2 in., and 3 in. standard galvanized steel pipe 36 inches long were supported in a testing machine by means of the same pipe sockets utilized in the hydraulic tests. The pipes were tested to failure as horizontal cantilevers with one end fixed, and the deflection of the free end was measured.
(h) A comprehensive report upon the results of the investigation will be completed, available for loan after about March 1, 1937.
(i) A more general paper including the laboratory results, as well as methods of field construction and tests in service, is being prepared for submission to the American Society of Civil Engineers for publication in the Proceedings.

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(342) (a) STUDIES OF ARTIFICIAL CONTROLS FOR STREAM-FLOW MEASUREMENTS.
(b) U. S. Geological Survey, Water Resources Branch.
(c) Cooperative project with U. S. Geological Survey for comparative performance tests and general scientific research.
(d) R. B. Hunter, H. N. Eaton (National Bureau of Standards). W. S. Eisenlohr, Jr. (Geological Survey).
(e) The Director, National Bureau of Standards.
(f) To study the relative merits of the various designs of several district offices of the Survey, with a view to standardizing on a few selected types.

(g) Full-scale sections have been tes ted in the 12 ft wide flume with flows ranging from 0.1 to 30 cfs. The tests included calibrations under free overfall conditions and with various degrees of submergence, also a study of the effect of the filling up of the channel above the control.
(h) Work is continuing on the report of this investigation. A glass-walled flume 18 inches wide and 30 inches high is being constructed for continuing this study on small-scale models of the controls.

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(171) (a) INVESTIGATION OF THE PRESSURE VARIATIONS ON THE UPSTREAM AND DOWNSTREAM SIDES OF AN ORIFICE PLATE.
(b) Scientific data, National Bureau of Standards.
(c) National Bureau of Standards research.
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To obtain more complete data than are now at hand on the variations of pressure in the vicinity of an orifice plate, which will assist in bett er correlation of orifice coefficient data.
(g) Water from a constant head tank will be discharged through the orifice section of the line into either a weighing or calibrated tank. Simultaneous readings will be made of the pressure at 48 pressure openings extending from the orifice plate face to about 4 pipe diameters upstream and 10 pipe diameters downstream. It is planned to vary the ratio of orifice to pipe diameter from about 0.05 to over 0.8, and to vary the Reynolds number over at least 1 to 10 range for each orifice.
(h) Tests have been started, but improvements to the set-up are being made as the need arises and time permits.
(i) It is possible the same set-up will be used later for similar tests using air in place of water, but work on this project has been interrupted owing to work on Project (496).

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(496) (a) DETERMINATION OF DISCHARGE COEFFICIENTS OF FLOW NOZZLES: Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters.
(b) Factors for use in commercial measurement of fluids.
(c) Cooperative research sponsored by A.S.M.E. Special Research Committee on Fluid Meters, with cooperation of the National Bureau of Standards, University of California (Project 280), Ohio State University (Project 536), University of Oklahoma (Project 617), Cornell University (Project 587), Massachusetts Institute of Technology(Project not reported in this bulletin.)
(d) H. S. Bean, F. C. Morey.
(e) The Director, National Bureau of Standards.
(f) To determine discharge coefficients for "long-radius" flow nozzles; to determine the most satisfactory location for pressure holes; to check, compare and correlate American (U.S.) and European designs and practices.

(g) Tests are being made on nozzles in 2, 3, 4, 8 and 16-inch pipes, with oil, water, steam and air. Each nozzle used in this project is to be tested with two or more fluids in two or more of the laboratories listed.
(h) Test program about 1/4 completed.
(i) Program will require two to three years to complete.

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U. S. GEOLOGICAL SURVEY.

(265) (a) STUDY OF THE SIZE OF INTAKE OPENINGS OF WELL SCREENS IN RELATION TO THE YIELD OF WELLS AND THE PERMEABILITY OF WATER-BEARING FORMATIONS.
(b) United States Geological Survey, Water Resources Branch.
(c) General scientific research.
(d) A. G. Fiedler, M. A. Pentz.
(e) A. G. Fiedler, U. S. Geological Survey, Washington, D. C.
(f) The purpose of the study is to determine the effect of the size of intake openings of well screens on the yield of wells and also to determine the relationship between the yield of a well of a definite type to the permeability of the water-bearing formation.
(g) The permeability of the water-bearing formation will be determined by field pumping tests in accordance with the method suggested by Thiem as modified by L. K. Wenzel as the result of tests made in the Platte Valley, Nebr. Laboratory tests of permeability will also be made. Wells finished with screens having different sizes of intake openings, but otherwise of identical construction, will be drilled in a selected area. The wells will be pumped at different rates and observation of the drawdown of the pumped well, and the lowering of the water-table in other observation wells will be made, and the relationship between yield, size of screen slot and permeability will be determined.
(h) Field work has been completed: Project discontinued.

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(482) (a) THE CHANNEL-STORAGE METHOD OF MEASURING GROUND-WATER DISCHARGE.
(b) United States Geological Survey, Water Resources Branch.
(c) General scientific research.
(d) O. E. Meinzer, R. M. Leggette, R. C. Cady, V. C. Fishel.
(e) O. E. Meinzer, U. S. Geological Survey, Washington, D. C.
(f) The purpose of this project is to test the channel-storage method of determining ground-water runoff or effluent seepage.
(h) The results of this investigation were published in a paper, "The channel-storage method of determining effluent seepage", by O. E. Meinzer, R. C. Cady, R. M. Leggette and V. C. Fishel, Trans. American Geophysical Union, 1936, page 415.
Project completed.

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(562) (a) INVESTIGATION OF CURRENT METER PERFORMANCE IN MEASUREMENTS OF VELOCITY OF WATER IN SHALLOW DEPTHS.
(b) United States Geological Survey, Water Resources Branch.
(c) Determination of empirical coefficients for field use and general scientific research.
(d) W. S. Eisenlohr, Jr., A. H. Frazier, H. F. Cox, A. D. Ash.
(e) C. H. Pierce, U. S. Geological Survey, Washington, D. C.
(f) To determine a series of coefficients for various channel conditions, velocities, and depths of water, to be applied as a correction factor to the measured discharge of a stream obtained by a current meter used under adverse conditions, such as very shallow water. Also incidental related problems including position of meter in vertical, type of meter, and operation of meter near a vertical wall.
(g) Current-meter measurements are being made in the 12-foot flume at the National Hydraulic Laboratory, National Bureau of Standards, Washington, D. C. These measurements are made in water which will be varied from 0.3 foot to 1.3 feet deep and flow with a mean velocity of from 0.1 to 1.5 fps. Several types of channel bed will be used, including smooth concrete, 3/4-inch gravel and coarse gravel. The discharge of the flume as measured by a weir or Venturi meter, calibrated in place, will be divided by the discharge obtained by current meter measurement to obtain the correction coefficient. For each condition of flow several complete measurements are made, using different methods of measuring such as 0.6-depth, 0.2 and 0.8 depth methods and several others. Most of the work is being done with the Type A Price current meter, but other meters such as Pygmy meters of both cup and propeller type are being investigated.
(h) Work in smooth concrete channel and in channel with 3/4-inch gravel bed has been completed. Computations and interpretation of the current-meter-measurements are now being made.
(i) As the results of this investigation are expected to be used in the interpretation of current-meter measurements of natural streams where the width of channel is, in most cases, much greater than the width of the flume in the laboratory, special efforts are being made to eliminate uncertainties in regard to the manner in which the current meter is affected by conditions other than the flowing water and the flume bed.

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(618) (a) A NEW METHOD OF DETERMINING THE PERMEABILITY, SPECIFIC YIELD, AND ELASTICITY OF WATER-BEARING MATERIALS.
(b) United States Geological Survey, Water Resources Branch.
(c) General Scientific Research.
(d) C. V. Theis, assisted by T. W. Robinson and H. A. Waite.
(e) C. V. Theis, 303 Federal Building, Albuquerque, New Mexico.
(f) The purpose of this study is to establish the relation of the lowering of the piezometric surface and its recovery, to the rate and duration of discharge of a well that is supplied from ground-water storage. It is hoped that this study will lead to the development of a new practical method of determining permeability and specific yield.

(g) A paper published in the 1935 Transactions of the American Geophysical Union, pages 519 to 524, investigates in part the nature and consequences of a mathematical theory that considers the motion of ground water before equilibrium is reached and as a consequence involves time as a variable. An equation is derived showing the relationship between the period and rate of discharge of the well, and the drawdown, permeability, and specific yield. A corollary equation gives the relation of the above factors to the rate of recovery of the water level in a pumped well, and makes it possible to compute the permeability of the aquifer from observations of the rate of recovery.
(h) Observations are now being made on a number of artesian and water-table wells in the San Luis Valley, Colorado, and in the Mimbres Valley, N. Mex.

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(619) (a) A COMPARATIVE INVESTIGATION OF SEVERAL METHODS OF DETERMINING PERMEABILITY OF WATER-BEARING MATERIALS.
(b) United States Geological Survey, Water Resources Branch.
(c) General scientific research.
(d) R. M. Leggette, and L. K. Wenzel, assisted by C. E. Jacob and M. L. Brashears.
(e) R. M. Leggette, 226 Post Office Building, Jamaica, L. I., N.Y.
(f) A comparative investigation of several methods of determining permeability of water-bearing materials.
(g) The investigation is being made in Croton Valley near Ossining, New York. Several observation wells have been constructed and water-level measurements are being regularly made as a preliminary to the tests.

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(620) (a) INVESTIGATION OF THE EFFECT OF REFORESTATION ON STREAMFLOW.
(c) Cooperative between the U. S. Geological Survey and the New York State Department of Conservation.
(d) Arthur W. Harrington and assistants.
(e) Arthur W. Harrington, District Engineer, Water Resources Branch, U. S. Geological Survey, Albany, N. Y.
(g) Complete hydrologic studies will be made of several reforested and non-reforested areas over a long period of time.
(h) Project is still in its preliminary stage, but continuous records of precipitation, runoff, ground-water elevations, temperature and humidity are being collected on three small reforested areas in Central New York.

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BUREAU OF AGRICULTURAL ENGINEERING, U. S. DEPT. OF AGRICULTURE.

(509) (a) FLOW OF WATER AROUND 6-INCH CELLULOID PIPE BENDS. (See also report by Iowa Institute of Hydraulic Research.)

(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.

(c) Cooperative, government and Iowa Institute of Hydraulic Research.

(d) U. S. Department of Agriculture Staff.

(e) David L. Yarnell, Senior Engineer.

(f) To determine losses, changes in pressure, velocity and direction of current flowing through 6-inch pipe bends with various amounts of total curvature, on hyperbolic and elliptical-shaped bends, on an abrupt 90-degree elbow, as well as on a bend of circular cross-section with varying radius of curvature. The research included cases with uniform and other cases with non-uniform velocity distribution in the pipe approaching the bend.

(g) The investigation included tests on nine different bends. Pressure and velocity measurements taken at a great many points on the bends, as well as on the tangents, for velocities ranging from 3 to 14 fps. The practicability of using a bend as a flow meter was fully investigated.

(h) The research has been completed and the report is now ready for the press.

(i) The tests revealed many interesting facts which are here summarized very briefly:

1. All bends act as obstructions to flow, resulting in additional loss of head.

2. With uniform or normal velocity distribution in the approach conduit to the bend, the velocities of the filaments along the inside wall of the bend are increased while those along the outside wall are reduced.

3. Using the standard-radius, 6-inch, 90-degree celluloid bend as a basis for comparison, and with uniform or normal velocity distribution in the approach conduit to the bend; the 45-degree bend gave a loss of head about 5/4 that on the 90-degree bend; the 180-degree bend with continuous curvature in one direction gave about 1 1/4 times that on the 90-degree bend; the 180-degree reversed curve bend about 2.1, the 270-degree bend about 2.7, and the 90-degree abrupt elbow about 7.3 times that on the standard-radius 6-inch, 90-degree celluloid bend.

4. For a given pipe bend, and quantity of flow, the head lost in the bend depends upon the velocity distribution in the approach tangent. The loss of head may be many times greater for one condition of velocity distribution than for another type of velocity distribution.

5. After a pipe bend has been calibrated, it may be used as a flow meter and discharges may be determined by merely measuring the difference in pressure between the inside and outside of the bend.

6. The losses in the pipe bends experimented upon appear to vary as the square of the velocity and not as the 1.25 power as suggested by some writers.

(510) (a) HYDRAULIC JUMP ON SLOPING APRONS. (See also report by Iowa Institute of Hydraulic Research.)
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative, government and Iowa Institute of Hydraulic Research.
(d) U. S. Department of Agriculture Staff.
(e) David L. Yarnell, Senior Engineer.
(f) To investigate the best methods of dissipating the energy in the high velocity water at the foot of such aprons and to develop the cheapest and most efficient method of accomplishing this.
(g) The experiments are being conducted in a flume 30 inches wide equipped with transparent walls. Many pressure and velocity measurements are being taken for various quantities of flow and various depths of approach water and tail water and for aprons having different slopes. Many lateral drainage ditches discharge through chutes into main ditches. Similar structures are used for irrigation systems in dropping the water from a high level to a low level. Water storage dam spillways discharge water down steep aprons. The failures of such structures are caused by the inefficient dissipation of the energy in the water at the foot of such structures.
(h) Investigations are now being made.
(i) The theory of the hydraulic jump on sloping aprons has been developed. When the discharge, upstream and downstream depths are increased by the model ratio law, it appears from the limited number of tests so far made that the lengths of the roller and the jump also increase in the same ratio. A progress report on the investigation is now under way.

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(511) (a) FLOW OF WATER AROUND 180-DEGREE BENDS OF SQUARE AND RECTANGULAR SECTION. (See also report by Iowa Institute of Hydraulic Research.
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative government and Iowa Institute of Hydraulic Research.
(d) U. S. Department of Agriculture Staff.
(e) David L. Yarnell, Senior Engineer.
(f) To determine losses, changes in pressure, velocity and direction of current flowing around both open and closed bends of various curvatures.
(g) Investigation included measurements of pressure and velocity for various quantities of flow for channels, 10" x 10" with 5" inner radius, 5" wide by 10" deep with 5" inner radius, and 5" wide by 10" deep with 10" inner radius. Effect of non-uniform velocity of approach on losses investigated.
(h) Investigation completed and report issued in October, 1936, as Technical Bulletin No. 536 of the U. S. Department of Agriculture.
(i) While the report gives much data on pressure and velocity distribution in the bend, information on losses obtained was not as complete as desired, because of the limited capacity of the laboratory at the time the tests were made. Annotated bibliographies on flow of water around bends in mimeographed form may be had by addressing Chief, Bureau of Agricultural Engineering, U. S. Dept. of Agriculture, Washington, D. C.

CORPS OF ENGINEERS, BONNEVILLE HYDRAULIC LABORATORY.

(567) (a) MODEL STUDIES OF THE BONNEVILLE PROJECT ON THE COLUMBIA RIVER.

(b) United States Engineer Department, Second Portland District, Lieut. Colonel C. F. Williams, District Engineer; Major A. E. McKennett, Chief Engineer; Claude I. Grimm, Head Engineer, Division Office.

(c) A research program to check the hydraulic designs, to furnish data and assist in visualizing the problems connected with design, construction, and future operation of the Bonneville Project.

(d) A. J. Gilardi, Resident Engineer in charge of the Laboratory, J. C. Stevens, Consulting Engineer on model studies.

(e) United States District Engineer, Second Portland District, Portland, Oregon.

(f) To determine the best design of cofferdams and methods of placement of cribs for all stages of construction, handling of navigation, most favorable cross section of the spillway dam for scour prevention, best method of gate operation in the completed dam for handling flood waters, passing debris and ice, backwater effect and its reduction by means of channel improvements, best layout of fish ladders and other provisions for getting mature fish into the upper pool and small fish down to tailwater and to the sea. Other problems which have been investigated included the navigation lock which will handle seagoing vessels and will have the highest single lift in the world.

(g) An outdoor laboratory covering an area of about 2 acres has been built at the Government Moorings near Linnton Station, Portland, Oregon. Water is pumped from the Willamette River and circulated through the various models; however, pure city water is used for the pump models. Seven principal models have been built and operated up to date; other models are under construction at the present time.

The lock model, the spillway model and spillway flume, the gate model, the power house diffusion chamber model, the large river model, together with the description of the experimental work carried out to date have been described in Bulletin IV-1, of this series. (See pages 44 and 45). Additional experiments have been carried out in the spillway flume lately, for further study of the fishway problems.

The river model has been used intermittently during the second half of 1936 for studies and demonstrations of the third step closure for a large variety of possible combinations; and the best method of procedure was adopted for construction in the field.

(h) The Bonneville Hydraulic Laboratory has been in operation for about three years. The original experimental program has been completed, but a considerable volume of additional experimental work has developed later.

(i) No detailed reports have been published to date. Information concerning details of the experimental work may be obtained from the District Engineer, U. S. Engineers Office, Second Portland District, Portland, Oregon.

(621) (a) COLUMBIA RIVER NEAR THREEMILE RAPIDS.
(b) (c) (d) (e) See Project 567, above.
(f) To determine the most satisfactory and the most economical method of improving the stretch of the Columbia River located near The Dalles at the head of the future Bonneville reservoir. This section is approximately 4 miles long and includes Threemile Rapids proper; the flow is extremely turbulent and dangerous, and numerous river boats have been lost or damaged. The purpose of the work is to bring about safer navigation conditions.
(g) A model approximately 70 ft long and 35 ft wide representing about 2 miles of the Columbia River, including Threemile Rapids proper, has been built on a scale of 1:100.
(h) Numerous experiments under natural conditions and with the completed Bonneville Project have been carried out for various flows. Experiments with proposed channel improvements are now in progress.

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(622) (a) WALLA WALLA FLOOD CONTROL PROJECT.
(b) (c) (d) (e) See Project 567 above.
(f) To determine a satisfactory cross section for scour prevention and the best layout of the structures for the Mill Creek Diversion Dam for the Walla Walla Flood Control Project.
(g) The models for the Walla Walla Flood Control Project have been described in the preceding issue (See Bulletin IV-2, page 73).
(h) The experiments have been completed and reports have been submitted.

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(623) (a) INVESTIGATION OF 18-INCH DREDGE PUMP.
(b) (c) (d) (e) See Project 567 above.
(f) To determine design improvements, possible wear reduction and other studies of the 18-inch pump for the new Pacific Type Light-Draft Hopper Dredge.
(g) The 1:4 Dredge Pump Model and the first part of the experimental work have been described in Bulletin IV-2, page 74.
(h) The completion of this work has been postponed to carry out the work mentioned in Project 624 below.

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(624) (a) INVESTIGATION OF 28-INCH DREDGE PUMP.
(b) (c) (d) (e) See Project 567 above.
(f) To analyse the flow conditions and possible wear reduction of the Fort Peck Type.
(g) A 1:6 scale model made out of pyralin and aluminum has been constructed and installed with a new pipeline and tank layout. The model is driven by means of a 15 HP Diesel Dynamometer.
(h) The experimental work is in progress at the present time.

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(635) (a) STUDIES OF BEDLOAD MOVEMENT.
(b) (c) (d) (e) See Project 567 above.
(f) To extend the range of the existing information concerning the tractive capacity of water for bedload material similar to that found in the bed of the Columbia River.
(g) A flume 6 ft wide, 5 feet deep and approximately 125 ft long has been designed and practically completed. It will have a maximum water supply of about 45 cfs: it will be provided with a motor-driven sandfeed, weighing apparatus to determine the rate of bedload movement, and mechanical means for returning the sand to the sand-feed.
(h) The experimental work is not expected to start for some time.

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COMPLETED PROJECTS - ABSTRACTS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Dept. of Civil and Sanitary Engineering.

(362) MODEL OF CAPE COD CANAL AND APPROACHES. (Experiment for Corps of Engineers, U. S. Army, Boston.)

The Cape Cod Canal, a sea-level canal 7.7 miles long connecting Cape Cod Bay and Buzzards Bay, is to be widened and deepened. Also a new approach channel is to be dredged in Buzzards Bay.

Since the tides of these two bays have a different range and are several hours out of phase, a tidal flow of varying intensity occurs in the canal, the water flowing twice daily toward each bay. This constantly changing rate of flow makes it practically impossible to determine analytically hydraulic data for the canal as it is widened from its former trapezoidal section of 170 ft bottom width and 25 ft depth at mean low water to its project dimensions of 540 ft by 32 ft or its ultimate dimensions of 500 ft by 40 ft.

A 115-ft fixed bed concrete model, with a horizontal scale of 1 to 600 and a vertical scale of 1 to 60, was first constructed to simulate the 170-ft canal. Tides were automatically created by an electrical water-level control mechanism designed for these tests. Water levels at stations along the model canal were determined by an especially designed electrical water-level indicator. Both devices gave results to 1/100 in. in the model.

High and low water surface profiles of the 170-ft canal model were compared with those based on tide curves observed in nature at seven stations along the canal. The average difference in elevations was 1 in. in nature. The velocities of the model were indirectly checked by studying the rate at which high and low water progressed through the model. Three-quarter inch broken stones were scattered on the model bottom to give proper roughness ($n_m = 0.017$)

The 500-ft and 540-ft models were operated using mean tide curves. High and low water profiles and velocities were observed. The model disclosed serious eddies and cross currents in Buzzards Bay which were corrected by disposing of dredged material in the form of dikes.

CORPS OF ENGINEERS, BOSTON, MASS.

(362) MODEL OF CAPE COD CANAL AND APPROACHES. Reported under Massachusetts Institute of Technology, Dept. of Civil and Sanitary Engineering. (See foregoing.)

CORPS OF ENGINEERS, Eastport, Maine.

(468) THE DETERMINATION OF DISCHARGE COEFFICIENTS FOR VENTURI AND OPEN-TYPE SLUICE GATES FOR THE PASSAMAQUODDY TIDAL POWER PROJECT.

The purpose of the investigation was to determine the most suitable design of filling-gate structure for restoring the operating level of Cobscook Bay, following cycles of generation at the proposed main tidal power station.

Tests were made at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute on 1/30 scale models of submerged Venturi type and open-sluice type filling gates. The throat section of the submerged Venturi tube in the prototype was 30 x 30 ft, the bottom of the gate sill being raised about 10 ft above the bottom excavation of the waterway channels, with the concrete structure extending from gate sill to channel bottom on a slope of 1 to 6 on the intake side and 1 to 10 on the discharge side. The model for the open-type sluice design was constructed by removing the roof section of the submerged Venturi tube, leaving an open-top structure somewhat similar in form to the so-called critical depth or open-Venturi measuring flume.

At very low head differences (below 2 ft in prototype) the open-type sluice was found to be more efficient than the Venturi type. At higher heads, however, the Venturi type showed a superiority over the open type. Inasmuch as the very low head condition is critical for this project, the open type of sluice is considered more applicable, particularly if the cost of an installation affording the required discharge capacity is equal to, or less than, the Venturi type.

The prototype design developed on the basis of the laboratory tests consists of open-type sluice gates.

Further information may be obtained from the District Engineer, United States Engineer Office, 13th floor Customhouse, Boston, Massachusetts.

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(469) MODEL TESTS ON THE NAVIGATION LOCK FOR THE PASSAMAQUODDY TIDAL POWER PROJECT.

A Two-way navigation lock with a usable length of 360 ft, width of 56 ft, minimum depth of 12 ft over the sills and maximum lift of about 25 ft, was planned to afford shipping access to Cobscook Bay, the high-level pool of the proposed tidal power development. Tests were conducted at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute on a 1/30 scale model of this lock for the purpose of obtaining required design data. Comparative measurements were made of hawser stresses on a model of a 4500-ton cargo vessel 300 ft long, 45 ft wide with draft of 11.5 ft

(469) (Continuation of Abstract.)

Two systems of filling and emptying the lock chamber were studied - (1) by operating the main-sector gates at greatly reduced speed against a full head and allowing the discharge to enter the chamber directly through the main gates, (2) by means of loop culverts by-passing the sector gates. Two alternative types of loop-conduits were studied, - (1) culverts of uniform rectangular cross-section controlled by Tainter valves operating about horizontal axes, (2) culverts having the lower half of the vertical sides bevelled, to accelerate the rate of discharge while operating the corresponding rectangular valve leaf at uniform vertical velocity. Provision was made in the model test operating mechanism for imparting either a uniform or an accelerated rate of opening to the Tainter valves and the main-sector gates.

The time required with the filling-systems tested to fill the lock chamber for a lift of 25.5 ft and the maximum unbalanced forward longitudinal force on the vessel are as follows:

Filling System	Time to Fill Lock Chamber (Minutes)	Max. Unbalanced Forward Long'l Forces of Vessel (tons)
Main-sector gates	11.5	10
Main-sector gates with dentated baffles* attached to guard timbers.	7	4
Bevelled type loop culverts controlled by rectangular leaf valves.	6.4	5.7
Rectangular loop culverts controlled by Tainter valves.	6.4	11.6

*To dissipate kinetic energy of jet.

Work on the project was suspended before completion of detailed application of results of model studies to revision of lock design.

Further information may be obtained from the District Engineer, United States Engineer Office, 13th Floor Customhouse, Boston, Massachusetts.

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(470) MODEL TESTS ON ROCKFILL DAMS FOR THE PASSAMAQUODDY TIDAL POWER PROJECT.

Rockfill dams across the present Eastport and Lubec entrances to Cobscook Bay were proposed for effecting closure of the bay as the high-level pool of the tidal power development. The maximum depth of water, below mean sea level, is about 120 ft in the Eastport channel and about 65 ft in the Lubec channel. The proposed method of construction of these dams was by dumping material directly into the tidal flow without cofferdamming. The purpose of the model experiments, undertaken at the Alden Hydraulic

Laboratory of the Worcester Polytechnic Institute was to establish the dimensions of the profile and determine the size and gradation of stones required at various stages of construction to resist displacement by the combined action of percolation through the body of the dam and the impulse of the overflowing discharge.

Tests were conducted for hydraulic conditions corresponding to critical levels of the ocean and Cobscook Bay tides, provision being made for simulating the action of the tide by reversing the direction of flow in the test flume during construction of the 1/50-scale model dam.

Based on the results of the experimental program, the following features are incorporated in the final design of the rockfill dams. Quarry-run material will be deposited by bottom-dump scows from the foundation stratum to Elevation-30 M.S.L., giving a crest width of about 225 ft at that elevation. Between Elevations-30 M.S.L. and -20 M.S.L. a 10-ft layer of 4-ft diameter stones will be deposited for a width of about 60 ft adjacent to the shoulders, and the remaining central gap filled with quarry-run stone. Closure above Elevation -20 M.S.L. will be effected by depositing 4-ft stones (by means of duplex overhead cableways) in two embankments spaced approximately 165 ft center to center and displaced about 15 ft bayward with respect to the longitudinal axis of the quarry-run base. The space between the two embankments will be filled with quarry-run stone, the level of the quarry-run material being kept somewhat lower than the levels of the two outer embankments at all stages of closure. When the rockfill section is finally completed to Elevation+30 M.S.L. a filter of graduated stones, gravel, and sand, and an impervious blanket of random fill will be deposited against the upstream face of the dam to restrict percolation to the economic limit. This sealing blanket will be protected from erosion by riprap.

The tests indicated that it is particularly important to advance the construction by small vertical increments extending uniformly along the entire length of the crest. Any irregularities in crest elevation were found to be conducive to the development of serious and progressive local scouring.

Further information may be obtained from the District Engineer, United States Enginee r Office, 13th Floor Customhouse, Boston, Massachusetts.

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BUREAU OF RECLAMATION.

(48) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE BOULDER DAM - BOOK 5 - MODEL STUDIES OF APPURTENANT STRUCTURES.

As the Boulder Dam far surpassed in magnitude any similar struc ture constructed in the past, careful studies, coupled with laboratory investigations, were made concerning many features of its design. This report, fourth of five technical memorandums to be written on the Boulder Dam hydraulic model studies, describes in detail tests performed on the following:

(1) A model to study the hydraulic losses between the 18-foot branches and the 30-foot main power penstocks.

(2) A model to determine experimentally the losses, flow conditions, and pressures in the intake towers. This model also included a complete assembly of the upper Arizona power penstock with branches to turbines and canyon wall needle valves.

(3) Three models at different scales for studying the flow characteristics of the needle valves in the tunnel plug outlet works. The final setting of the valves was determined from these models.

(4) A model to study future conditions in the river immediately downstream from Boulder Dam.

Tests on these models yielded information concerning eddies, distribution of pressures and hydraulic losses; made possible a material improvement in the flow conditions in the 50-foot tunnel below the tunnel plug outlets, the elimination of unnecessary piping and detail, and the formulation of an operating program for various combinations of flow from the outlet works and spillways.

This report was compiled as a description of the laboratory procedure and an analysis of the results procured.

Technical Memorandum No. 525 by J. N. Bradley and J. E. Warnock on deposit with the Denver Public Library.

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(548) HYDRAULIC MODEL EXPERIMENTS FOR THE IMPERIAL DAM AND DESILTING WORKS - BOOK 1 - STUDIES OF SPILLWAY, SLUICEWAY, AND STILLING POOLS.

The Imperial Dam, a part of the Boulder Canyon project, will be located on the Colorado River about 4.5 miles upstream from the existing Laguna Dam for the purpose of diverting Colorado River water into the All-American canal on the California side and into the Gila Valley canal on the Arizona side. As rock lies at a considerable depth below the river bed at the site, the dam and sluiceway will be of the Amberson type resting directly on the

sand and gravel river bed. Its over-all length will be approximately 7,400 feet, of which 1,200 feet will constitute a free over-fall weir and 240 feet on the California side will serve as a sluiceway controlled by radial gates. A reinforced concrete slab 170 feet in length with three rows of sheet piling will be constructed upstream from both overfall weir and sluiceway to check underseepage, and heavy concrete aprons with sheet piling will be provided downstream from the overflow section to carry the hydraulic jump.

As the tail-water depth was small and somewhat uncertain, careful consideration was given to the stilling pools below the dam and sluiceway to make certain that they would confine the hydraulic jump for all expected conditions of discharge and tail water. This report deals primarily with this phase of the structure, and in it is described in detail the extensive series of tests performed on both the weir and the sluiceway for the purpose of developing satisfactory and dependable stilling pool designs. Numerous sills and stepped aprons were tested, and the results obtained for the majority of layouts are described in this report.

Technical Memorandum No. 516 by J. N. Bradley, on deposit with the Denver Public Library.

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NATIONAL BUREAU OF STANDARDS.

(43) INVESTIGATION OF PIPE BENDS.

A paper entitled, "Pressure losses for fluid flow in curved pipes", by Garbis H. Keulegan and K. Hilding Beij, will be published in the January, 1937, issue of the National Bureau of Standards Journal of Research. A limited number of reprints will be available for free distribution by the Hydraulic Laboratory Section of the Bureau. An abstract of the paper follows:

This paper considers the flow of water in large-radius smooth-walled pipe bends for the viscous and turbulent regimes of flow over a range of Reynolds numbers from 500 to 60,000. The discussion is based on experimental data obtained with 3/8-inch brass tubing. Pressure losses were measured both for the bend itself and for a considerable length of downstream tangent.

The paper is devoted mainly to a discussion of the viscous regime of flow. Empirical formulas are given for the effective resistance coefficients for the bend and for the downstream tangent under conditions of viscous flow.

A method of computing to a first approximation the length of bend required for the transition to the characteristic velocity profile is presented. A brief discussion of the critical Reynolds numbers for bends of different curvature ratios when the entering flow is laminar is given also.

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UNIVERSITY OF CALIFORNIA.

(276) DISCHARGE COEFFICIENTS OF SHARP-CRESTED WEIRS IRREGULAR IN PLAN.

The investigation included a step-down weir and two weirs circular in plan - one convex upstream and the other convex downstream. Heights of 0.375 and 0.75 feet were used for each weir in a one-foot channel in which the rate of flow was varied from 0.1 to 1.0 cubic feet per second. The weirs were fully suppressed and aerated.

For the same head, the weirs in order of decreasing discharge per unit crest length was found to be: standard, stepdown, circular-convex upstream, circular-convex downstream. There was considerable increase in the rate of discharge when the circular weir was changed from convex downstream to convex upstream.

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(633) VELOCITY DISTRIBUTION IN OPEN CHANNELS.

Velocity distributions in vertical sections in the Mississippi River at Burlington were used to compute the trac tive force on the bed, using the equation of von Karman: From the tractive force and the velocity near the bed, the equivalent granular roughness, k, was computed, using the equation of Nikuradse. The mean velocity in the vertical and the tractive force were used to obtain "n" in Manning's equation and the results were correlated with the granular roughness. The correlation confirmed the form of Strickler's equation $n = ck^{1/6}$, but C = 0.049 in place of 0.039. The theoretical form of the velocity curve agreed well with the measured curve. The computed values of n varied from 0.015 to 0.040, which is within the range commonly found for rivers.

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U. S. WATERWAYS EXPERIMENT STATION. (Completed projects.)

Technical Memoranda and Research Memoranda have been prepared for all completed studies, and for all completed phases of any study now listed as "In progress". Loan copies of these papers may be obtained by writing to the Director, U. S. Waterways Experiment Station, Vicksburg, Miss.

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TRANSLATIONS.

UNIVERSITY OF CALIFORNIA.

The following translations have been made at the University of California, Department of Mechanical Engineering. Copies available for loan are in the files of the National Hydraulic Laboratory, National Bureau of Standards, Washington, D.C.

Flamant, A.	Hydraulique. Undulatory Movements, Section 1, Waves of Translation. Chapter VIII, pages 412-501.
Hagen, Poiseuille, Hagenbach.	On the motion of water in narrow cylindrical tubes. Ostwald's Klassiker der Exakten Wissenschaften, Akademische Verlagsgesellschaft, M.B.H., Leipzig, 1933.
Mayer-Schuchard, Clemens	Vibration of air-columns with great amplitude. V.D.I.- Forschungscheft 376, January-February 1936, pages 15-22.
Lauffer, Harald	Influence of the surface tension on the discharge from Poncelet orifices. Forschung, vol. 5, no. 6, November-December, 1934.
Stüper, J.	Comment on the problem of the airfoil placed in the path of a free jet. Luftfahrt - Forschung, vol. 12, no. 8, 1935, page 267.
Prandtl, L.	Report concerning recent research of turbulence. Hydraulische Probleme, VDI - Verlag, G.M.B.H., Berlin, 1926, pages 1-13.
Schlichting, H.	Experimental investigations on the problem of roughness. Ingenieur-Archiv, Verlag von Julius Springer, Berlin, Band VII, Heft 1, Feb. 1936.
Jouget, A., Rateau, A., de Sparre.	Theoretical and experimental study on water hammer, in the forced piping. H. Dunod and E. Pinat, publishers, 47 and 49, Quai des Grands-Augustins, Paris, 1917.
Schaffernak, F. Dachler, R.	Experimental technical solution of underground water problems. Die Wasserwirtschaft, Heft 1 and 3, 1931, pages 1-8.

BUREAU OF RECLAMATION. (Translations.)

The following translations have been prepared at the Bureau of Reclamation since the previous list given in this bulletin for July, 1936. Inquiries should be addressed to the Chief Engineer, U. S. Bureau of Reclamation, Denver, Colorado.

Veronese, Alessandro	Ricerche sulla relazione che intercede tra l'altezza d adescamento dei sifoni autolivellatori spirimentati in modello e quella dell'originale. (A study of the relationship between the priming heads of models and prototypes of automatic siphons.) Translated by F. L. Panuzio from the Italian in L'Energia Elettrica, July, 1934.
Ramponi, Francesco	Sugli stramazzi di misura circolari. (Circular measuring weirs). Translated by F. L. Panuzio from the Italian in L'Energia Elettrica, February, 1936.
Scimemi, Ettore	(The hydraulic laboratory of the Royal Technical University at Padua and the research work there in progress). Translated by F. L. Panuzio from the Italian in L'Energia Elettrica, September, 1935.
Keutner, Chr.	Strömungsvorgänge an Strompfeilern von verschiedenen Grundrissformen und ihre Einwirkung auf die Flussohle. (Flow around piers of various gross sections and its effects on the river bed). Translated by E. F. Wilsey from the German in Die Bautechnik, vol. 10, no. 12, March 15, 1932.
Hasse, Albrecht	Druckmessgerät mit elektrischer Anzeiger (Pressure measuring device with electrical indicator). Translated by E. F. Wilsey from the German in Zeit. d. Verein deutscher Ingenieure, Vol. 80, No. 19, May 19, 1936.
Krisam, F.	Uber die Messung von Geschwindigkeit und Druck in einer Dreidimensionalen Strömung. (Concerning the measurement of velocity and pressure in three-dimensional flow). Translated by E. F. Wilsey from the German in Zeits. f. Flugtechnik und Motorluftschiffahrt, July 14, 1932.
Iterson, F. K.	Cavitation et tension superficielle. (Cavitation and surface tension.) Translated by E. F. Wilsey from the French in Proceedings of the Royal Academy, Amsterdam, vol. XXXIX, No. 2, 1936.

Favre, Henri — Velocity distributions and the hydraulic design of side-channel intakes and spillways and tailraces. (Contribution to the study of flowing water.) Translated from the French by D. C. McConaughy, in Publications du Laboratoire de Recherches Hydrauliques annexe a l'Ecole Polytechnique Federale de Zurich, 1933.

FOREIGN PAMPHLETS RECEIVED BY THE NATIONAL BUREAU OF STANDARDS AND IN FILES OF NATIONAL HYDRAULIC LABORATORY.

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Secções - Tipo de Barragens constantes do Plano de Açudagem em Realisação. In Portuguese.

Canada.

Department of the Interior, Dominion Water Power and Hydrometric Bureau, Water Resources Paper No. 71, Surface Water Supply of Canada, Arctic and Western Hudson Bay Drainage in Alberta, Saskatchewan, Manitoba and Western Ontario. Climatic years 1931-32 and 1932-33.

Finland.

The inland waters of Finland. In English. H. Renqvist. Hydrografisen Toimiston Tiedonatoja. (Communications of the Hydrographic Bureau), IX, 1936. Vth Hydrological Conference of the Baltic States, Finland, 1936.

Vesimääränmittaukset Suomessa Vuoteen 1936. (Stream-flow measurements in Finland up to 1936). F. Lönnfors. In Finnish with Swedish and German abstracts. Hydrografisen Toimiston Tiedonatoja. (Communications of the Hydrographic Bureau), VIII, 1936.

Ergebnisse optischer und chemischer Wasser-analysen, 1911-31. (Results of optical and chemical water analyses from 1911-31). In German. Linda Holmberg. Communications of the Hydrographic Bureau, V, 1935.

Finland (Continued.)

Yearbook of the Hydrographic Bureau of Finland, for 1930-31, 9, 1935. In Finnish and Swedish.

Yearbook of the Hydrographic Bureau of Finland, for 1932-33, 10, 1936. In Finnish and Swedish.

The water districts of Finland and their lakes. T. V. Olin. Communications of the Hydrographic Bureau, VII, 1936. In Finnish and Swedish.

France.

Hydraulique. - Note sur l'écoulement de l'eau dans un canal a profile complexe. (Note on flow in a channel having a compound cross-section. M. Hegly.

Hungary.

Hydraulic Proceedings of the Water Board of the Royal Hungarian Ministry of Agriculture, Vol. 18, No. 1, January-March, 1936. With English summaries.
Contents:

A. Rohringer.	The regulation of embanked rivers.
A. Trummer.	Water economy.
A. Rohringer.	Study of ground water conditions in the Tisza.
J. Einwachter.	The Boulder Dam.
K. Sédi.	The hydrography of the Velence Lake.
L. Vojcsik.	Problems in maintaining water supply systems.

Hydraulic Proceedings of the Water Board of the Royal Hungarian Ministry of Agriculture, Vol. 18, No. 2, April-June, 1936. With English summaries.
Contents:

E. Sajó.	The furtherance of our traffic by water, and the waterways.
A. Réthly.	Has flood control changed our climate?
L. Vas.	The significance of inland navigation routes in the network of communication.
L. Tavy.	Gully stabilization at Nyúlhegy.
Gy. Andor.	Rational water supply of cities.
W. Lászlóffy.	Some new water power plants in France.
S. Horváth.	Surveying of river beds.
L. Filep and S. Horváth.	Examination and correction of the sounding tachygraph.
B. Pataky.	Traffic on the Balaton Lake in 1935.

Supplement to Hydraulic Proceedings of the Water Board of the Royal Hungarian Ministry of Agriculture, "Our irrigation in the years 1932-1934. With English summary.

Pamphlets. (continued.)

Italy.

Prove di controllo sul funzionamento idraulico dei diaframmi e dei boccagli normalizzati I.S.A. (1934). Secondo serie di Esperienze eseguite per bassi numero di Reynolds. (Tests on the I.S.A. (1934) standard nozzles and orifices. Second series of tests at low Reynolds numbers). M. Marchetti. Memorie e Studi, Hydraulic Institute of the Royal School of Engineering at Milan, No. 14, 1936.

Sul Regime delle foci lagunari. (On the hydraulic regime at the mouths of tidal lagoons.) F. Paderi. Publication No.263 of the Royal School of Engineering at Pisa. July, 1935.

Correnti uniformi entro grandi condotte e grandi canali. (Uniform flow in large pipes and open channels.) G. de Marchi. Memorie e Studi, Hydraulic Institute of the Royal School of Engineering at Milan, No. 16, 1936.

Sulla nuova formula del coefficiente udometrico. (On a new formula for the udometric coefficient.) D. Bonvicini. Publication No. 269 of the Royal School of Engineering at Pisa, November, 1935.

Sulla utilizzazione delle linee di possibilitá climatica nel calcolo dei canali di scolo. (Utilization of the lines of climatic possibilities for laying out drainage channels.) U. Todaro. Publication No. 271 of the Royal School of Engineering at Pisa, November, 1936.

Sulla determinazione della portata solida nei corsi d'acqua naturali. (On the determination of the solid material carried in a natural watercourse.) E. Indri. Reprint from the "Atti dell'VIII Congresso Nazionale delle Acque", Padua, 1935.

Di uno speciale dispositivo sperimentale per le ricerche sugli effetti della pioggia (Regarding a special experimental arrangement for the investigation of the effect of rainfall.) M. Velatta. Reprint from "Atti dell'VIII Congresso Nazionale delle Acque", Padua, 1935.

Il regime uniforme idraulico nelle condotto di acciaio senzo saldatura. (The uniform hydraulic regime in steel pipes that are not welded.) E. Scimemi and A. Veronese. Reprint from "Annali dei Lavori Pubblici", 1936, Fasc. 7.

Sull' azione delle onde contro le opera maritime di difesa a parete verticale. (On the action of waves on seawalls with vertical faces.) G. Ferro. Reprint from "Annali dei Lavori Pubblici, 1936.

Pamphlets.

Italy (Continued.)

Prove su boccagli e diaframmi normalizzati inseriti in condotte da 200 mm. (Tests on standard nozzles and orifices inserted in a pipe 200 mm in diameter.) E. Scimemi. Reprint from "L'Energia Elettrica", Fasc. VII, Vol. XIII, July, 1936.

Nuove ricerche sulla forza di trascinamento delle correnti liquide (Recent investigations on the tractive force of liquid currents.) E. Indri. Reprint from "L'Energia Elettrica", Fasc. IV, Vol. XIII, April, 1936.

Sugli stramazzi di misura circolare. (On circular measuring weirs.) F. Ramponi. Reprint from "L'Energia Elettrica", Fasc. II, Vol. XIII, February, 1936.

Contributo sperimentale allo studio delle velocitá e del movimento delle sabbie al fondo di una massa soggetta a moto ondulatorio stazionario. Nota preliminare sulla formazione degli escavi e dei depositi. (Experimental contribution to the study of the velocity and the movement of sands at the bottom of a mass of liquid subjected to stationary wave motion.) In Italian. G. Ferro. Reprint from "Tecnica Italiana", No. 8, September, 1936.

Cenni sul procedimento Italiano per lo studio e la costruzione degli acquedotti. (Remarks on the Italian procedure for the design and construction of aqueducts. G. di Ricco. In Italian. Reprint from Annali dei Lavori Pubblici, 1936, Fasc. 1-2-4.

Japan.

On the hydrodynamic group-waves and the flux of wave-energy. H. Murakami, Tokyo, 1923.

Experiments on a small rectangular weir without side contractions. V. Shimoyama. Reprint from the Memoirs of the Faculty of Engineering, Kyushu Imperial University, Vol. VII, No. 4, 1934. In English.

A contribution to the design of axial-flow propeller-type machines with their housing. V. Shimoyama. Reprint from the Memoirs of the Faculty of Engineering, Kyushu Imperial University, Vol. VIII, No. 2, 1936. In English.

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Latvia.

Beitrag zur Frage des vacuumlosen Dammprofiles. (Contribution to the question of the suction-free dam profile). A.Vitols. Reprint from Wasserkraft und Wasserwirtschaft, Heft 16, 1936, p. 207.

Ein Beitrag zur Frage der universellen Konstanten in der Hydraulik und einer zweckmässigen Fliessformel.(A contribution to the question of the universal constants in hydraulics and a suitable flow formula). A. Vitols. Fifth Hydrological Conference of the Baltic States. June, 1936.

Norway.

Water power in Norway. Norwegian Society of Civil Engineers. In English. (Also see Norwegian publication listed at bottom of page 95.)

Switzerland.

Ueber die Zerstörung von Werkstoffen durch Tropfenschlag und Kavitation. (On the destruction of materials by the impact of drops and by cavitation.) J. Ackeret and P. de Haller. Schweiz. Bauzeitung, Bd. 108, Nr. 10, Sept. 5, 1936.

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Transactions of the Scientific Research Institute of Hydrotechnics, Leningrad, Vol. XVIII, 1936.

Flow of ground water to drainage channels. V. I. Aravin.

Groundwater flow under flat-bottomed structure resting on porous soil underlain by inclined watertight strata. N. T. Meleshenko.

Theory of probability applied to analysis of sedimentation of silt in turbulent streams. M. A. Velikanov.

An attempt at theoretical analysis of temperature changes in masonry of dams and retaining walls of triangular profiles. G. N. Maslov.

Temperature changes in hollow circular cylinders. G. N.Maslov.

New Types of roller and segment gates in the U.S.S.R. V. G. Gebel.

On investigation of stresses in thick cylindrical arches. V. L. Fedorov.

Compound beams with vertical keys. G. A. Arkanghelsky.

Permeability of mortars and concretes mixed with various kinds of cement. I.D.Zaporogez and S. D. Okorokov.

Results of field investigations of silting in upper part and structures of Dzoraghet hydroelectric plant and their comparison with model experiments in Hydroelectric Laboratory. A. F. Burkov.

Approximate methods for computation of general stability of earth dams. R. R. Chugaev.

(In Russian with English summaries.)

Adhesion between mortars and concretes mixed with various kinds of cement. I. D. Zaporogez and S. D. Okorokov.

Pamphlets. (continued)

U.S.S.R. (cont.)

U.S.S.R. Commission for Exchange of Hydraulic Laboratory Research Results. Bulletins Nos. 3(11), 4(12) and 5(13). Exchange of Hydrotechnical Research Results. Description of hydraulic research in the U.S.S.R. laboratories in 1935. In English.

U.S.S.R. Commission for the Exchange of Hydraulic Laboratory Research Results, Bulletins 1(9), 2(10), 3(11), 4(12) and 5(13). In Russian.

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COLUMBIA UNIVERSITY.

"Varied Flow in Channels of Adverse Slope", by Arthur E. Matzke. Published in Feb., 1936, Proceedings, American Society of Civil Engineers.
Abstract. This paper defines a channel of "adverse slope" as one in which the bottom slopes upward in the direction of flow. It presents a method for determining surface curves and delivery curves for such channels. The method is similar to the one developed for "sustaining slopes" by Prof. B. A. Bakhmeteff in his book "Hydraulics of Open Channels", Engineering Societies Monographs, 1932. The paper contains the "Varied Flow Equation" and the "Varied Flow Function" for channels of adverse slopes, a table of values for the "Varied Flow Function" and a simple graphical method for obtaining values of this function. Illustrations are offered in the form of numerical examples.

Closing discussion. (By B. A. Bakhmeteff and A. E. Matzke) published in Feb., 1936 Proceedings, American Society of Civil Engineers, of "The Hydraulic Jump in Terms of Dynamic Similarity."
Abstract. Experimental clarification of several points raised in the discussion of the paper is presented. First, the physical meaning of the maximum height of jump is demonstrated. Also, discussion of the physical nature of the energy losses in a jump led to an investigation of the velocity distribution around the end of the jump. These experiments, in particular, seemed to reveal some interesting features of the jump. The results of some other experiments on a very narrow flume are compared with similar experiments on the original flume in an attempt to clarify a question on dynamic similarity.

See under Norway (page 94) - Vannstandsiakttagelser i Norge 1935. (Stream gage records in Norway for 1935) Norges Vassdrags - og Elektrisitetsvesen, Hydrografiske Avdeling. In Norwegian.

References. (Cont'd.)

HORTON HYDRAULIC AND HYDROLOGIC LABORATORY.

(385) Surface runoff phenomena. Part I of this investigation was issued in 1935 as Publication No. 101 of the Horton Hydrologic Laboratory. (See this Bulletin, III-2, July 1, 1935, p. 40). Part II, treating of the theory of surface runoff and the effect of various factors on surface runoff, is well advanced. It is expected that this paper will be published within a few months.

Maximum ground-water levels. By R. E. Horton. Trans. American Geophysical Union, 1936, Part II, pp. 344-357.

Natural stream channel storage, by R. E. Horton. Trans. American Geophysical Union, 1936, Part II, pp. 406-415.

Surface runoff control, by R. E. Horton. Presented before the Up-stream Engineering Congress, Washington, D. C., September, 1936. To be published in the Transactions of the Congress.

Relation of laboratory research in hydraulics and hydrology to physical and economic geography, by R. E. Horton. Presented at meeting of the International Geophysical Union, Edinburgh, September, 1936. Presumably to be published in Transactions of the Union.

Phenomena of the contact zone between the ground surface and a layer of melting snow, by R. E. Horton. Presented at the meeting of the International Commission on Snow and Ice, International Geophysical Union, Edinburgh, September, 1936. Presumably to be published in Transactions of the Union.

Hydrologic interrelations between soil and water, by R. E. Horton. Presented at meeting of the American Soil Survey Association, Washington, D. C., November, 1936. Presumably to be published in the Proceedings of the Association.

UNIVERSITY OF WISCONSIN.

Bulletin of the University of Wisconsin, Engineering Experiment Station Series No. 80, "Experimental Investigation of the Hydraulics of Drop Inlets and Spillways for Erosion Control Structures", by L. H. Kessler, 1934.

Bulletin of the University of Wisconsin, Engineering Experiment Station Series No. 82, "Experimental Investigation of Friction Losses in Wrought Iron Pipe when installed with Couplings", L.H.Kessler, 1935.

References to Articles.

Latvia.

A contribution to the question of universal constants in hydraulics and a suitable formula.
Professor A. Vitols.
Hydrological Conference of the Baltic States, Finland, June, 1936.
In German. Copy available for loan in files of the National Hydraulic Laboratory.
Abstract. It is a known fact that the present-day form of the flow formula $v = C\sqrt{Ri}$ is too elementary and inadequate, and that the marked variability of the coefficient C is to be attributed to this fact. We must seek to set up a new Bernoulli equation in which, as far as possible all flow conditions and processes shall be represented. If such a formula should be set up, then we may hope that the hydraulic coefficient will prove to be practically constant. The author proposes in this article a method for the solution of this problem.

Contribution to the question of the suction-free dam profile.
A. Vitols.
Zeits. für Wasserkraft und Wasserwirtschaft, 17, August, 1936, pp. 207-213.
In German. Copy available for loan in files of the National Hydraulic Laboratory.
Abstract. The solutions that have been proposed up to now, among them Creager's, are rough, empirical and uncertain. The author proposes a new solution that has a hydraulic basis. The Bernoulli equation is generalized by introducing a term that takes into account the centripetal force which is the cause of the reduced pressure. New coordinates are recommended for dam profiles.

Hydraulic Research at The City and Guilds (Engineering) College of the Imperial College of Science and Technology, London University.

A brief statement regarding the hydraulic research carried out at the City and Guilds College is given in the Journal of the Institution of Civil Engineers, No. 1, 1936-37, November, 1936, pages 149-50. The following studies are mentioned:

Flow past roughened plates. To correlate frictional effects on flat plates with those in pipes. Data from Froude's tests of towed planks have been correlated with Nikuradse's results for pipes. The results have been applied to the computation of coefficients for broad-crested weirs.

Resistance laws for flow in open channels. Artificially roughened beds have been used in these experiments.

Friction losses in pipes. Different types of roughness were simulated by fixing sand grains to the pipe wall in various arrangements. Existing data on the deterioration of pipe lines are being studied, and it appears that the loss of capacity with age because of incrustation can be predicted by a simple method.

Flow through nests of tubes is being studied in an attempt to find the optimum spacing and arrangement of tubes to yield low frictional resistance and high heat transfer.

Electric analogy. An improved technique has been developed, and fluid friction effects have been included in the electrical model. Practical streamline and pressure distributions can be obtained very rapidly.

Cavitation is being studied with an open-jet type of water tunnel.

Scour below dams has been studied with small models, using many types of protective devices.

Transportation of silt and bed scour are being studied using silt particles in a turbulent flow. The results are being compared with those obtained with a model river that has a bed of loose granular alluvium. The erosion of a sand bed by jets of water and air is also being studied.

Wind erosion. Studies are being made of sand storms, the formation of sand dunes, etc. in an investigation of the transportation of sand by wind.

Subcommittee on Velocity Formulas for Open Channels and Pipes, The Institution of Civil Engineers Research Committee.

The Journal of the Institution of Civil Engineers (June, 1936, page 332) states that the above-named subcommittee has been formed to collect information relative to flow in channels, including the effect of silt in suspension, to evolve a basic formula and to suggest needed research, if this appears necessary. The subcommittee is composed of the following:

Mr. W. J. E. Binnie (Chairman),
Mr. William Allard,
Mr. A. A. Barnes,
Mr. B. W. Bryan,
Mr. J. R. Davidson,
Prof. A. H. Jameson,
Mr. J. M. Lacey,
Mr. W. N. McClean,
Mr. R. W. S. Thompson,
Dr. C. M. White.

HYDRAULIC RESEARCH COMMITTEES.

Committee on Dynamics of Streams, Section of Hydrology, American Geophysical Union.

Chairman: Professor Lorenz G. Straub,
University of Minnesota,
Minneapolis, Minnesota.

No report.

Special Research Committee on Fluid Meters, American Society of Mechanical Engineers.

Chairman: R. J. S. Pigott,
Gulf Research & Development Corporation,
Pittsburgh, Pa.

Subcommittee on Flow Nozzle Research.

Chairman: H. S. Bean,
National Bureau of Standards,
Washington, D. C.

Subcommittee on Solicitation of Funds.

Chairman: E.C.M. Stahl,
Brooklyn Edison Co.,
380 Pearl St.,
Brooklyn, N. Y.

This committee is sponsoring and very largely supporting an extensive research program on flow nozzles used in the measurement of fluid flow. Both long-radius and I.S.A., nozzles are being used, but particular attention is being given to the former. Tests are being made and will continue, in pipes ranging from 2 to 24 inches in diameter. The fluids used are oil, water, steam and air.

Since no one laboratory had facilities with which to make tests over the entire range of conditions to be covered by the program, different parts of the work are being assigned to different laboratories which are cooperating in this work. The parts of the program assigned to the different laboratories are listed in the following table. In some of the laboratories the work is well under way; in others it has not yet been started. This is because the nozzles are being sent around to the different laboratories, and as yet not enough have been finished to enable all of the laboratories to start work.

Spec.Res.Com. on Fl.Meters (Cont'd)

Laboratory	Pipe sizes inches	Fluids used	Project No. in this Bulletin
National Bureau of Standards Division II, Section 5.	3,3,4,6,8	water, air	(496)
University of California, Dept. of Mech. Eng.	3,4,6,8	water	(280)
Cornell University, College of Civil Engineering.	3,4,8,16,24	water	(587)
Ohio State University, Dept. of Mech. Eng.	2,3,4,6,8	water, steam	(526)
University of Oklahoma, School of Mech. Eng.	2, 3, 4	oil	(617)
Lehigh University, Dept. of Mech. Eng.	10, 16, 24	air	-
Mass. Inst. of Technology, Dept. of Mech. Eng.	2	steam	-
University of Pennsylvania, College of Civil Eng.	4, 6, 8	water	-

Transportation Subcommittee of the Petroleum Division of the American Society of Mechanical Engineers.

Chairman: W. G. Heltzel,
Stanolind Pipe Line Company,
Philcade Bldg.,
Tulsa, Oklahoma.

This committee has collected additional data, but there has not been time for the members to study it thoroughly.

Special Committee on Hydraulic Research, American Society of Civil Engineers.

This committee was appointed in April, 1934. Its main objective is to encourage hydraulic research by agencies and individuals having the facilities and personnel for such work. In furtherance of this objective the following definite problems are now the subjects of research by directors of hydraulic laboratories:

	Project No. in this Bulletin.
"Traveling Waves on Steep Slopes", by Professor Harold Thomas, Carnegie Institute of Technology.	(490)
"Curves in Open Channels", by Professor C. A. Mockmore, Oregon State College.	-
"Phenomena of Intersecting Streams", by Professor M. P. O'Brien, University of California.	(424)
"The Conversion of Kinetic to Potential Energy", by Professor F. T. Mavis, University of Iowa.	(507)
"Sedimentation at the Confluence of Rivers", by Professor L. G. Straub, University of Minnesota.	-

To define and determine fundamental physical phenomena involved in the problems is the primary object. To further this work the Committee has received an appropriation of $1500.00 from Engineering Foundation.

In addition to the above research program the Committee has under way: The preparation of a manual for hydraulic laboratory practice; The adoption of a set of standard letter symbols for hydraulic laboratory work to be followed later by a glossary of terms; The making of translations and English abstracts of important papers on hydraulics published in other languages.

The Committee is composed of:

J. C. Stevens, Chairman, *
Chilton A. Wright, Secretary,
Herbert D. Vogel,
Clarence E. Bardsley,
E. W. Lane,
Lorenz G. Straub.

Cooperating Members:
Harold A. Thomas,
C. A. Mockmore,
M. P. O'Brien,
F. T. Mavis.

* Spalding Bldg., Portland, Oregon.

Committee for Research on Hydraulic Friction, Division of Engineering and Industrial Research, National Research Council.

Chairman: Th. von Kármán,
Daniel Guggenheim Aeronautical Laboratory,
California Institute of Technology,
Pasadena, California.

No report.

Subcommittee on Absorption and Transpiration, Section of Hydrology, American Geophysical Union.

Chairman: Charles N. Lee,
58 Sutter St.,
San Francisco, California.

No report.

Subcommittee on Hydrodynamics, Committee on Borderland Fields between Geology, Chemistry and Physics, National Research Council.

Chairman of Subcommittee:

W. W. Rubey,
U. S. Geological Survey,
Washington, D. C.

During the early part of 1936, a Committee on Borderland Fields between Geology, Chemistry and Physics was organized under the auspices of the three divisions of Geology and Geography, Chemistry and Chemical Technology, and Physical Sciences of the National Research Council, with Dr. T. S. Lovering of the U. S. Geological Survey as chairman.

The objectives of this committee were expressed as follows: "It is anticipated that this will be a short term committee. Its purpose would be a review or stocktaking of those borderline problems between geology, chemistry and physics whose advancement seems particularly important and timely and can be furthered by some sort of cooperative effort. From such a review it is anticipated that valuable suggestions not only as to objectives, but as to modes of attack as well, would flow. On some problems individual attack might be indicated. On others attack through an institution, such as a university or research laboratory. On others a cooperative attack, as through a committee of the National Research Council."

At its organization meeting of June 5, 1936, the Committee set up subcommittees to deal with the sixteen groups of problems into which it was decided the projects proposed to the Committee should be classified. It was found that a number of problems proposed as being in urgent need of study could be grouped logically under the heading, "Application of hydrodynamics to problems of geology", and hence one of the above-mentioned subcommittees, under the name of Subcommittee on Hydrodynamics, was assigned those proposals falling in this classification. The membership of this subcommittee is as follows:

Mr. W. W. Rubey, U. S. Geological Survey (Chairman),
Prof. R. A. Daly, Geological Museum, Harvard University,
Mr. H. N. Eaton, Hydraulic Laboratory, National Bureau of Standards,
Mr. David T. Griggs, Geological Museum, Harvard University,
Dr. N. C. Grover, U. S. Geological Survey,
Prof. T. S. Lovering, U. S. Geological Survey,
Dr. W. C. Lowdermilk, Soil Conservation Service,
Capt. G. T. Rude, U. S. Coast and Geodetic Survey.

The general problems suggested to the Committee on Borderland Fields and falling within the scope of interest of the Subcommittee on Hydrodynamics are listed below. Further details can be obtained from the Chairman, Mr. W. W. Rubey.

Subcommittee on Hydrodynamics, etc. (Cont'd)

I. Principles of stream work and of wind work, to be studied in hydraulic laboratories and wind tunnels.
   (a) Channel morphology - factors influencing slope, channel cross-section and channel plan of a graded stream.
   (b) Basic cause of stream meandering.
   (c) Mechanism by which sediment is suspended in flowing water.
   (d) Relationship between debris carried per unit volume of flowing water and rate of travel of debris transported.
   (e) Erosion and transportation of soil particles under conditions of so-called sheet flow.
   (f) Effect of cavitation on rocks.
   (g) Problems of rythmic flow - tidal currents, ripples, sand waves.
   (h) Hydrodynamics of glaciers.

II. Bottom currents - submarine and in reservoirs.
   (a) Investigation of possible currents in submarine valleys sloping toward the open sea.
   (b) Mechanism of bottom currents of muddy water in lakes and reservoirs.

III. Settling of particles in a viscous fluid. Departures from Stokes' law of particles falling through water. Analytical and experimental study.

IV. Orientation of disc-shaped and rod-shaped particles through a viscous fluid. This question is important in connection with mineral grains in igneous and metamorphic rocks.

V. Rock permeability under special conditions.
   (a) Permeability of unsaturated rocks and soils.
   (b) Flow of brines through permeable rocks.
   (c) Permeability of limestone at high temperatures and pressures.

One of the objectives of the Committee on Borderland Fields is to stimulate research on the projects that it has listed. It is believed that a number of the problems assigned to the Subcommittee on Hydrodynamics for consideration offer worth-while opportunities for research in hydraulic laboratories. Since all of these problems relate more or less closely to geology, it is felt that, if any research is undertaken on the problems suggested above, it would be desirable for the persons undertaking such research to communicate with the chairman of the Committee on Borderland Fields, Dr. T. S. Lovering, in order that the experimenters might benefit from suggestions that geologists might have to offer.

A proposal to form a permanent committee for the study of bottom currents is now being considered by the National Research Council, but no definite action has been taken as yet.

HYDRAULIC RESEARCH IN THE U. S. S. R.

The following scientific research in the hydraulic laboratories of the U.S.S.R. for 1935 is reported in Bulletins 3(11), 4(12) and 5(13), "Exchange of Hydrotechnical Research Results", issued by the U.S.S.R. Commission for Exchange of Hydraulic Laboratories Research Results under the direction of Professor J. B. Egiazaroff. Many of the projects relating to specific projects on individual structures have been omitted for lack of space.

A. Scientific Research Institute of Hydrotechnics (N.I.I.G.) P. N. Provorov, Director.

I. Division of Engineering Hydraulics. Professor N. N. Pavlovsky, Director.

2. Free flow of ground water. The flow of ground water to construction pits in a deep layer of a homogeneous permeable soil with side walls formed by sheeting.

3. Pressure flow of ground water accompanied by washing out of fine particles of soil.

222. Percolation through earth dams on permeable foundations. Further development of the hydraulic method proposed by N. N. Pavlovsky in 1932, together with development of method proposed by R. R. Chugaev for computing the stability of earth slopes.

223. Percolation forces under hydraulic structures.

224. Approximate methods for computation of amount of ground water flowing to construction pits.

II. Hydroelectric Laboratory. Professor J. D. Egiazaroff.

6. Investigation of negative waves.

10. Experimental investigation of surge tanks.

15. Investigation of vertical components of velocity by statistical method. Observation of paths of balls of emulsion having same density as the water.

19. Continuous and discontinuous motion of bed load.

25. Investigation of the settling basin for the Chirchik Hydroelectric Plant.

226. Analysis of unsteady flow on the basis of field data obtained by expeditions of the Scientific Research Institute of Hydrotechnics in 1934.

227. Kinematics of silt suspension in two-dimensional flow.

231. Experimental study of the Johnson needle valve.

232. Tests of the electromechemical method of measuring water.

233. Registering of foreign hydroelectric plants according to a system proposed by Professor J. B. Egiazaroff.

234. Unsteady flow in natural channels. Development of analysis of unsteady flow in upper and lower pools of hydroelectric plants.

235. Hydraulic regime of power water courses and its connection with the power regime of hydroelectric plants.

III. Hydrotechnical Laboratory (No. 1).
S. V. Isbash, Director.

236. Construction of cofferdams in running water.

237. Investigation of devices for destroying local velocities.

245. Investigation of reverse filters on soils from a site on the Tikhvinka River.

IV. Small Hydrotechnical Laboratory (No. 2).
L. A. Markevich, Director.

40. Study of three-dimensional, non-erodible models in connection with Reynolds number and roughness coefficient.

V. Large Hydrotechnical Laboratory (No. 3).
P. A. Voinovich, Director.

251. Comparison of distorted and undistorted models of structures of the Kama Hydroelectric Plant. Study of a reach of the Kama River with distorted and undistorted cofferdams.

254. Preparation of plans for the hydraulic laboratory of the All-Union Scientific Research Institute of Marsh Lands Reclamation at Minsk.

VI. Hydrotechnical Laboratory for Silt Studies and Head Works Investigations.
Professor J. J. Levy, Director.

50. The study of mixing of two streams at various ratios of discharges and velocities and for various locations of streams.

255. Investigation of canal flushing, erosion below dams and other similar problems.

258. Investigation of types of revetments below dams.

VII. Laboratory of River Hydraulics.
G. J. Shamov, Director.

262. Falling of silt particles in a turbulent stream.

263. Analysis of forces exerted by a stream upon bed-load.

264. Design of transitions in open watercourses.

265. Experimental verification of basic formulas used for plotting stream-line patterns in open channels.

266. Investigation of flow conditions in winding channels with flood plains.

270. Systematization of data on reservoir silting and experimental study of silt deposition in streams.

VIII. Laboratory of Soils and Hydrotechnical Structures. I. E. Kartelev, Director.

55. Investigation of physico-mechanical and structural properties of soils.

272. Professor N. P. Pouzyrevsky's apparatus for determination of angles of internal friction and of permeability coefficients.

273. Compilation of data on fishways.

IX. Laboratory of Soil Mechanics.
Professor N. A. Kandyba.

62. Determination of stability of foundation soils.

277. Investigation of the sliding resistance of dams of the system proposed by Senkov, with determination of soil pressures on inner faces of dam walls.

278. Hydraulic integrator for study of flow through heterogenous materials.

X. Laboratory for Physical and Mechanical Analyses of Soils.
B. V. Arkhanguelsky, Director.

279. Investigations of the accuracy of various methods for determination of moisture content in soils, as dependent upon loading.

280. Investigation of physico-mechanical processes in soils, caused by freezing and thawing.

281. Investigation of the hydrometer method of mechanical analyses of soils.

282. Design of Soil Laboratory at Magnitostroy.

XI. Laboratory of Electro-Dynamical Analogy.
B. F. Reltov, Director.

69. Investigation by method of electrical analogy in three dimensions of percolation at the right bank flank of the Tuloma Dam.

284. Investigation by means of the electrical analogy method of the distribution of ground water pressure on downstream cut-off wall as depending on the dimensions of the various parts of the foundation structure.

285. Investigation by the electric analogy method in three dimensions of percolation around left bank abutment of the dam on the Chirchik River.

286. Investigation by the electric analogy method in three dimensions of percolation at head structures of the Niva I Hydroelectric Plant.

XII. Hydro-Physical Laboratory.
B. F. Reltov, Director.

73. Investigation of the structure and of physical properties of a stream of a liquid.
(1) Ultra-microscopic investigations of the boundary layers of a flow of liquid with a free surface.
(2) Investigation of the structure of flow by means of X-rays.
(3) Investigation of displacements in liquids by means of the optical method.
(4) Investigation of electrical properties of a stream of liquid.

XIII. Hydro-Mechanical Laboratory.
M. A. Dementiev, Director.

74. Investigation of the boundary layer in streams with rough granular channels.

XIV. Hydro-Thermic Laboratory.
B. V. Proscuriakov, Director.

76. Evaporation from open water surfaces. Adjustment of Dalton's formula for variable conditions.

288. Process of heat transfer in turbulent flow and dynamics of heat convection in still bodies of water.

289. Methods of thermo-electric analogy and development of apparatus for investigations of heat losses in closed channels protected with various materials.

290. Hydraulic and thermal regime of trickling cooling stacks.

291. Investigations of sprinkling cooling plants.

XV. Division of Ice Engineering.
Professor V. E. Timonoff (deceased) Director.

292. Flow of liquids in closed conduits in connection with thermal and ice regime.

293. Intake structures on rivers carrying large amounts of frazil ice and silt.

294. Experimental installations for study of thermal and ice regime in water conduits laid in continually frozen ground.

295. Forecast of various elements of the regime of hydro-electric plants.

296. Ice phenomena on mountain and lowland streams.

297. Ice troubles at hydroelectric plants and hypotheses concerning the causes of frazil ice formation.

298. Winter regime of hydraulic structures.

XVI. Division of Statical Methods of Structural Design.
Professor B. G. Galerkin.

300. Reproduction in models of boundary potential distribution.

301. Systematization of data on gates for hydraulic structures.

XVII. Division of Special Field Investigations.
A. T. Potapov, Director.

101. Investigation of wood-stave penstocks of the Niva 2 Hydro-electric Plant.

110. Investigation of temperature conditions of the Svir River.

302. Investigation of unsteady flow in the diversion canal of the Niva 2 Hydroelectric Plant.

303. Determination of the velocity of wave propagation under ice cover.

304. Wind waves in large pools of hydrotechnical structures.

307 Compilation of tables for plotting backwater curves by method of Professor B. A. Bakhmeteff.

310. Summary of results of field investigations of intake structures of hydro-electric plants.

311. Desilting reservoirs, summary of field investigations.

314. Field and laboratory investigations planned in connection with construction of experimental core wall of frozen ground.

315. Field investigations concerning the hydraulics of structures and of water courses.

XVIII. Division of Mechanization and Organization of Construction Works.
Professor V. K. Belilovsky, Director.

317. Device for creating distributed loading upon models of structures.

318. Apparatus for dispersing soil particles.

XIX. Laboratory for Testing Structural Materials.
Professor V. A. Kind, Director.

The work of this division has to do mainly with concretes and mortars.

XXIX. Laboratory for Investigation of Hydraulic Structures.
Professor G. N. Maslov, Director.

The work of this laboratory relates mainly to the design and strength of structures.

XXXI. Division of Apparatus and Instruments Installed in Structures for Field Research Purposes.
N. A. Girillovich, Director.

346. Installation of measuring apparatus on head works structures of the Chirchik Hydro-electric Plant. The following problems are to be studied: percolation, soil pressures, stresses in concrete and reinforcement bars, displacement, temperatures, construction joints.

347. Installation of research apparatus on the Magnitogorsk Dam No. 2 on the Ural River.

348. Working out of field research and control apparatus.

351. Investigation of soil pressures in a Senkov type dam.

XXXII. Laboratory of Bituminous Materials.
P. D. Glebor, Director.

The work of this laboratory relates mainly to asphaltic concretes and mortars and the treatment of surfaces with bituminous materials.

XXXIII. Complex Hydrotechnical Projects.
Professor V. E. Timonoff (deceased), Director.

360. Investigation of methods used in foreign countries for the study and solution of complex hydrotechnical problems pertaining to many sides of national economy.

INDEX TO PROJECTS.

Hydraulics - General.

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Model tests - coasts, harbors, etc.

Model tests - Dams, gates, spillways, locks, etc.

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Weirs.

ADDENDUM
to
National Bureau of Standards
Hydraulic Laboratory Bulletin Series B
- HYDRAULIC LABORATORIES IN THE UNITED STATES -
(First revision, October 1, 1935.)
January, 1937.

NEW YORK UNIVERSITY, UNIVERSITY HEIGHTS, NEW YORK, N.Y.

1. New York University Hydraulic Laboratory.
2. Established 1936.
3. Laboratory designed primarily for student instruction in the basic laws of fluid flow but with facilities for research projects.
4. Head and quantity of water available for tests:
   a. 1000 gpm (2.2 cfs), 26 ft head
   b. 320 gpm (0.71 cfs), 80 ft head
   c. 100 gpm (0.22 cfs), at city pressure (40 lb/in^2)
5. Principal equipment:
   a. Two circulating pumps fitted for student tests; one high pressure low discharge, one low pressure high discharge, capacities as indicated above.
   b. Tank containing skimming weir to maintain a constant head of 26 feet above the laboratory floor. A valve closes this tank into a pressure tank with air cushion for higher pressure work.
   c. Steel flume 3 ft wide, 3 1/2 and 5 ft high, 45 ft long.
   d. A small constant level reservoir supplied with city water used to maintain constant head on pipe friction and orifice apparatus or small research setups.
   e. Two venturi meters.
   f. Two pipe line orifices.
   g. Two Pelton wheels.
   h. Apparatus to demonstrate pipe friction.
   i. Two standard pitometers set on 6" pipe sections
   j. Orifice setup equipped with device for measuring contraction of the jet accurately.
   k. Wooden tank 2' x 2' x 6' equipped with small weirs and glass sides for demonstration purposes.
   l. Miscellaneous hook gages, pressure gages, nozzle stream gages, water meters, manometers, etc.
6. Nothing unusual.
7. Space is available for research and commercial testing projects within the range of heads and discharges given above. Each case will be considered independently.
8. Centrally located.
9. J. K. Vennard and S. F. Yasines, Instructors in Civil Engineering.
10. Four persons on regular staff assisted by mechanic.
11. The laboratory is located on the first floor of the Bliss building. It is 85 ft long by 22 ft wide and has a 16 ft ceiling height. The pumps draw water from a 19,000 gal storage tank in the basement and deliver it to the pressure tank, whence it flows to the various laboratory equipment and returns to the storage tank via the steel flume or via a shallow return channel set in the laboratory floor and covered with grating. The pumps are interconnected, so that high or low pressure water may be delivered to all points in the laboratory.
