U. S. Department of Commerce
BUREAU OF STANDARDS
~~GEORGE K. BURGESS, DIRECTOR~~

REPORT No. I-1

APRIL 1, 1933.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES.

WASHINGTON

DEPARTMENT OF COMMERCE
Bureau of Standards
Washington, D. C.

April 1, 1933.

DESCRIPTIONS OF HYDRAULIC LABORATORIES.

The following institutions and individuals have furnished descriptions of their hydraulic laboratories. (See Page 7 of the report.)

1. Aluminum Company of America.
2. Arkansas, University of
3. California, University of
4. Colorado, University of
5. Florida, University of
6. George Washington University.
7. Robert E. Horton Hydrological Laboratory.
8. Johns Hopkins University.
9. Lafayette College.
10. Louisiana State University.
11. Maine, University of
12. Massachusetts Institute of Technology.
13. Michigan State College.
14. Minnesota, University of
15. Oregon State Agricultural College.
16. Pacific Hydrological Laboratory.
17. Pennsylvania, University of
18. Princeton University.
19. Purdue University.
20. Rensselaer Polytechnic Institute.
21. S. Morgan Smith Company.
22. Texas Engineering Experiment Station.
23. U. S. Bureau of Reclamation, Montrose Laboratory.
24. U. S. Bureau of Standards.
25. U. S. Geological Survey, Hydrological Laboratory.
26. U. S. Waterways Experiment Station.
27. The Tulane University of Louisiana.
28. Valparaiso University.
29. Virginia, University of
30. West Virginia University.
31. Worcester Polytechnic Institute.

REPORT ON
CURRENT HYDRAULIC LABORATORY RESEARCH
IN THE UNITED STATES

Compiled by the Bureau of Standards
U. S. Department of Commerce
Washington, D. C.

Vol. I, No. 1. April 1, 1933.

Purpose and History.

The compilation and distribution of the information contained in this report represents a cooperative attempt on the part of the hydraulic laboratories in the United States to bring about the effective interchange of information relating to research projects which are being carried out in these laboratories. In the past, hydraulic investigations have been conducted independently in the various hydraulic laboratories, for the most part without any one laboratory having any detailed knowledge of what the others were doing. In many instances the results of the investigations have not been published, so that the engineering profession as a whole has been denied the benefit of the work. Even if the results are published, experimenters in other laboratories seldom learn of the investigation until the report appears, so that duplication of effort without the benefit of cooperation may take place, and advances in technique may not become known until some time later.

The events which led the Bureau of Standards to agree to serve as a central agency to compile, publish and distribute information relating to current hydraulic laboratory research and the scope of the undertaking are set forth in a letter circular sent out by the American Committee of the World Power Conference on January 21, 1933, to a large number of hydraulic laboratories in this country. The following is quoted from that circular:

> "At the meeting of the World Power Conference in Berlin in 1930 a proposal was made by Dr. Schaffernak of Austria that 'an organization be established for the purpose of interchanging, in the field of hydraulic engineering, the results of laboratory research and of observations of natural conditions corresponding thereto'. The purpose of this proposal was to develop means whereby laboratory workers in one country might be kept currently informed of the research activities of similar workers in other countries. Such information can now be had only as the results of research are published in the technical press, or are printed and distributed by the institution performing the research. For only a minor part, therefore, of the great volume of hydraulic research is information available even in the country of origin. Still less is available concerning research in foreign countries.

"The proposal of Dr. Schaffernak was referred by the International Executive Council of the World Power Conference to the Swedish National Committee for a report and recommendations to the Sectional Meeting to be held in Stockholm in July. A preliminary report of the Swedish National Committee indicates that there will be recommendations for some form of international commission or for a 'clearing house' of current information on hydraulic laboratory research.

"To the American Committee of the World Power Conference it has seemed evident that there can be no effective international interchange of information on the research work of the different countries unless there has first been established an effective means of exchange of such information within each country, and until some agency within each country has assumed the responsibility of collecting and distributing such information nationally and internationally. While the approach to this matter on the part of the American Committee of the World Power Conference has, naturally, been primarily from the international standpoint, it has realized the value within this country of establishing a means for current exchange of information on research performed by the various hydraulic laboratories in the United States. Accordingly, discussions were started several months ago with institutions in the Eastern part of the United States on a proposal that the U. S. Bureau of Standards be asked to act as a clearing house of information on the activities of American hydraulic laboratories and as the American agency for contact with similar agencies in other countries. This proposal has met with universal approval.

"At about the same time the Department of Mechanical Engineering of the University of California, acting without knowledge of the proposals of the World Power Conference or of the American Committee, made independent proposals to some twenty hydraulic laboratories offering to act as a clearing house of hydraulic research information in the United States. The differences between the two proposals have been adjusted by correspondence. The Bureau of Standards has definitely agreed to act as a national and international exchange agency, if such action on its part meets with the approval and cooperation of other laboratories. The American Committee, World Power Conference, and the University of California now join, therefore, in submitting the following revised proposals for the organization of a national and international exchange of information on

current hydraulic laboratory research. Since the value of such an exchange will largely depend on its completeness, you are urged to cooperate fully in the undertaking.

"The following are the proposals now submitted:
(1) That each cooperating laboratory shall submit quarterly to the Hydraulic Laboratory Section of the U. S. Bureau of Standards, Washington, D. C., a report on all hydraulic research in progress, and on proposed research for which definite plans have been made.
(2) That on the completion of any such research and of the report thereon, the laboratory performing the research shall submit one copy of the report and of the supporting data, together with a brief abstract of such report, to the Bureau of Standards.
(3) That each cooperating laboratory shall submit as early as practicable to the Bureau of Standards a report on the facilities for hydraulic research which it has and on the type of research which it is equipped to conduct, and shall annually thereafter, on a date to be specified, report any essential changes in such facilities.
(4) That the Bureau of Standards shall compile quarterly the reports from cooperating laboratories submitted as provided in paragraph (1), and shall mimeograph and distribute such compilations to all cooperating laboratories.
(5) That the Bureau of Standards shall catalog and file all reports of research submitted as provided in paragraph (2), shall provide means for access to and examination of such reports, shall provide for the loan of such reports under conditions which it may prescribe, and shall in its quarterly compilations include abstracts of all research reports received during the preceding quarter.
(6) That the Bureau of Standards shall prepare annually and submit to the cooperating laboratories a report on Hydraulic Laboratories in the United States, on the facilities for research which each has, and on the type of research which each is equipped to conduct.
(7) That if and when arrangements are made for international exchange of information on hydraulic laboratory research, the Bureau of Standards shall undertake to act as the medium for such exchange between the United States and other countries and shall periodically compile such information and distribute it to cooperating laboratories."

The proposals listed above, if adhered to, are considered adequate to accomplish the purpose of this undertaking. The effectiveness of the service will depend on the cooperation of the contributing laboratories.

Obviously, the cooperation of laboratories will be purely voluntary, and the furnishing of reports to any laboratory is in no way conditioned on its cooperating in this undertaking.

Nature of Investigations which will be reported.

The following is quoted from the letter circular already mentioned:

"The investigations reported may be either theoretical or experimental. The great majority of the experimental investigations reported will be those carried out in a laboratory under controlled conditions, but it is possible that some field investigations may properly be included. If a field study is simply a statistical compilation of data, for example, a record of stream flow on a certain stream or streams for a period of time, such study would not fall within the scope of the present undertaking. However, if such data were used to determine a general law of stream flow, the investigation might then be properly reported.

"A number of laboratory studies are being made by hydrologists which relate to the flow of water and hence naturally fall within the scope of this undertaking, for example, the flow of water through granular materials. Such projects should be reported and the investigators should furnish the necessary information.

"An investigation of the flow of any fluid, for example, water, oil, steam, air, etc., as studied in the hydraulic laboratory properly comes within the scope of the undertaking. However, the purpose of the investigation should be concentrated on the motion of the fluid rather than its effect on the properties of a structure. For example, a project involving the percolation of water through concrete may be reported if the emphasis is on the flow of water, while if the primary object of the investigation is the effect of this percolation on the concrete, it should not be reported."

Form for reporting current research.

"In order that all projects may be reported in a uniform manner it is requested that, until further notice, the following form, prepared from a study of the form used in the Engineering Experiment Station Record, and that used by Professors Woods and O'Brien at the University of California be used:

(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:

"Under (b) is desired a statement as to the organization for which the investigation is being conducted; under (c) a statement as to whether the investigation is undergraduate work for a thesis, graduate work for an advanced degree, or general scientific research; and under (e) the name of the person to whom any interested party should write for information. The meaning of the other headings should be obvious."

Each project reported will be given a number for reference purposes and to prevent confusion when it is listed in several consecutive reports.

Other Attempts to Exchange Information on Hydraulic Research.

In 1923 a Special Committee on Hydraulic Phenomena was appointed by the American Society of Civil Engineers. This committee, consisting of five prominent hydraulic engineers, made several reports, which included a list of engineers who were working on various hydraulic problems, undertook to compile a bibliography covering printed works on hydraulic subjects published before 1860 and now existing in this country. made recommendations as to hydraulic subjects in which further experimental research was needed and encouraged cooperative work in different laboratories. This committee was discharged in 1929. Reference to its work and several brief reports have been published in Proceedings A.S.C.E., Vol. 50, 1924, Vol. 54, 1928, and Vol. 55, 1929, also in Transactions A.S.C.E., 1925, Vol. 88. The Bureau of Standards does not have at this time detailed information as to the extent of the work accomplished by this committee.

The action of the College of Engineering of the University of California in compiling and issuing on December 8, 1932, a report on current hydraulic research has already been referred to. They would have continued to issue these reports if arrangements had not been made for the Bureau of Standards to take over and to expand this service.

General Information.

At the present time, the general listing of investigations which have been completed in the past is not contemplated, although this may be undertaken later. A few investigations which have just been completed are abstracted in this report, however.

Arrangements for the international exchange of information are being given active consideration by the World Power Conference. Definite action will probably be taken at the meetings which are to be held in Stockholm this summer.

It is probable that the letter circular sent out by the American Committee of the World Power Conference did not reach all of the hydraulic laboratories in the United States. Laboratories which have not already been in communication with the American Committee of the World Power Conference or the Bureau of Standards in this connection are requested to notify the latter and to furnish any of the desired information which they can. The next progress reports should be submitted to the Bureau of Standards not later than June 15.

The second report will be issued on July 1, 1933. That report will probably include a list of hydraulic researches which are in progress in Europe. This list was published in the Zeitschrift des Verein deutscher Ingenieure, Band 76, Nr. 42, October 15, 1933, but there has not been time to translate this list for inclusion in the present report.

Form for Reporting Laboratory Facilities.

"A list of hydraulic laboratories in the United States, together with a description of the facilities for research which they possessed and the type of investigation which they are fitted to conduct was first compiled in 1922 by Engineering Foundation and was published as Engineering Foundation Bulletin No. 5. Ten years have elapsed since this publication appeared, new laboratories have been built, and many laboratories have extended their facilities. To bring this information up to date, it is requested that answers be given to the following list of questions which are identical with those asked by Engineering Foundation and which seem to be adequate for the purpose.

1. Name of laboratory;
2. Year established;
3. Kinds of work for which the laboratory is especially fitted;
4. Head and quantity of water available for tests;
   (a) By gravity.
   (b) By pumping.
5. Principal pieces of equipment, with brief notes on size, capacity, precision or other features of interest;
6. Very unusual equipment or facilities, if any;
7. Possibilities for work, for or by outside persons or companies, and terms therefor;
8. Distance from railroad station or siding;
9. Name and title of person in charge of laboratory;
10. Number of persons on regular staff;
11. Brief general description of laboratory;
12. Research or other work of unusual importance which has been done."

A list of hydraulic laboratories in the United States, with their descriptions, will be issued in mimeographed form in the near future. Up to the present time nearly thirty laboratories have sent descriptions of their facilities and equipment. However, since this list will be published annually instead of quarterly, it is desired to have the list as complete as possible before it is issued; consequently it will not be included in the first report on research. Any laboratory which has not already furnished the Bureau of Standards with such a description is urged to do so at once, even if the laboratory is used only for student instruction.

CURRENT PROJECTS IN HYDRAULIC LABORATORIES.

(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:

UNIVERSITY OF CALIFORNIA.

(11) (a) MODEL STUDY OF BALLARD LOCK, LAKE WASHINGTON SHIP CANAL.
(b) Laboratory project.
(d) Viney and Fries.
(e) Professor M. P. O'Brien.
(h) To be completed in May, 1933.
(i) Thesis can be borrowed from director of laboratory when completed.

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(12) (a) JET PUMPS.
(c) Laboratory project.
(d) Ledgett.
(e) Professor M. P. O'Brien.
(f) Continuation of project on water jet pumps by O'Brien and Gosline reported at Pacific Coast Applied Mechanics meeting of the A.S.M.E., January 20-21, 1933.

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(13) (a) AIR-LIFT AND GAS-LIFT.
(c) Laboratory project.
(d) O'Brien and Gosline.
(e) Professor M. P. O'Brien.
(f) Velocity of rise of bubbles as a function of viscosity and surface tension; theoretical and experimental investigation of lifts for water and oil.
(i) Cooperative project with Department of Petroleum Engineering.

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(14) (a) STREAMLINE AND TURBULENT FLOW THROUGH GRANULAR MATERIALS.
(c) Laboratory project.
(d) Givan and Hickox.
(e) Professor M. P. O'Brien.
(i) Cooperative project with University of California Division of Irrigation Investigation and Practice.

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(15) (a) REVERSED FLOW IN CENTRIFUGAL PUMPS.
(c) Laboratory project.
(d) O'Brien and Gosline.
(e) Professor M. P. O'Brien.
(i) Thesis may be borrowed from director of laboratory.

(16) (a) EFFECT ON EVAPORATION FROM STANDARD PANS DUE TO CHARACTER OF SURFACE OF PAN.
(c) Laboratory project.
(d) Hickox.
(e) Professor M. P. O'Brien.

(17) (a) TRANSPORTATION OF BED LOAD BY STREAMS.
(c) Graduate project.
(d) Cothran, Rindlaub, Wilson, Kurilow.
(e) Professor M. P. O'Brien.
(f) Determination of the minimum velocity required to start motion of five harbor sands.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(18) (a) CHARACTERISTICS OF SIPHON SPILLWAYS.
(c) Graduate project.
(d) Saylor and Anderson.
(e) Professor M. P. O'Brien.
(f) Comparison of models with prototypes and determination of effect of air leakage on coefficient of discharge.
(i) Thesis may be borrowed from director of laboratory.

(19) (a) BROADCRESTED WEIRS.
(c) Graduate project.
(d) Bartlett and Carter.
(e) Professor M. P. O'Brien.
(f) Comparison of model and prototype.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(20) (a) VORTEX MOTION ON THE SURFACE OF FLUIDS.
(c) Graduate project.
(d) Carter.
(e) Professor M. P. O'Brien.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(21) (a) CAPILLARY POTENTIAL AND CAPILLARY FLOW IN SOILS.
(c) Graduate project.
(d) Colby.
(e) Professor M. P. O'Brien.
(i) Thesis may be borrowed from director of laboratory.

(22) (a) DISCHARGE COEFFICIENTS OF SHORT TUBES.
(c) Undergraduate project.
(d) Jones and Twigg.
(e) Professor M. P. O'Brien.
(f) Comparison of results with experiments of M. J. Zucrow on carburetor jets (Bull. No. 31, Eng. Exp. Sta., Purdue University.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(23) (a) STIRRING CHEMICALS FOR WATER TREATMENT BY DISC FRICTION.
(c) Undergraduate project.
(d) Gayner.
(e) Professor M. P. O'Brien.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(24) (a) TRAJECTORY OF JET FROM SUPPRESSED SHARP-CRESTED WEIR AND PRESSURE ON FACE OF WEIR.
(c) Undergraduate project.
(d) O'Shaughnessy and Petersen.
(e) Professor M. P. O'Brien.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

(25) (a) EFFECT OF RADIAL RIBS ON END THRUST OF CENTRIFUGAL PUMPS.
(c) Undergraduate project.
(d) Nelson.
(e) Professor M. P. O'Brien.
(h) To be completed in May, 1933.
(i) Thesis may be borrowed from director of laboratory.

U. S. GEOLOGICAL SURVEY HYDROLOGICAL LABORATORY, WATER RESOURCES BRANCH.

(26) (a) PERMEABILITY TESTS CONDUCTED UNDER VERY LOW HYDRAULIC GRADIENTS.
(b) United States Geological Survey, Water Resources Branch.
(c) General scientific research.
(d) O. E. Meinzer, V. C. Fishel.
(e) O. E. Meinzer.

(f) The purpose of this experiment is to find out if there is a flow of liquids through porous materials with hydraulic gradients as low as one foot per mile or less, and if there is a flow at such low gradients, to ascertain if it follows Darcy's law which states that the flow of ground water through a given material varies directly as the hydraulic gradient.

(g) The permeability tests have been made with a simple apparatus which permits an inflow of water at the bottom of a column of material of known height and outflow at the top. The difference in head of water at the top and bottom is regulated by an adjustable supply tank and is indicated by two pressure gages. Observations are made on the rate of discharge and the temperature of the water. Satisfactory results have been obtained for gradients as low as 5 feet per mile by using a column of sand one meter in length. A new U-shaped apparatus has been designed having a column of sand two meters in length. A hydraulic gradient is set up by having the water level in one column slightly higher than in the other. Observations are made on the rate of change of the water levels and the temperature.

(h) The results of the tests with the former apparatus are given in U. S. Geological Survey Water-Supply Paper 596 by N. D. Stearns. The new apparatus has just recently been started and no satisfactory results can yet be given out.

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(27) (a) THIEM'S METHOD FOR DETERMINING PERMEABILITY OF WATER-BEARING MATERIALS.

(b) The U. S. Geological Survey in cooperation with the Conservation and Survey Department of the University of Nebraska.

(c) General scientific research.

(d) Under the supervision of L. K. Wenzel.

(e) L. K. Wenzel, U. S. Geological Survey, Washington, D. C.

(f) Pumping tests were conducted near Grand Island, Nebraska, during the summer of 1931, to attempt to determine the practicability of Thiem's method for determining permeability of water-bearing materials as a part of a cooperative investigation of the ground-water resources of the Platte Valley, Nebraska.

About 80 small observation wells were driven into the saturated sands and gravels of the valley on lines radiating from the pumped wells. The depths to water in these wells were measured at frequent intervals before pumping started, during pumping, and after pumping stopped. The distances of the observation wells from the pumped wells were carefully measured and the altitudes of the measuring points were obtained by instrumental levels. The discharge of the pumped well and the drawdown in it were measured every 30 minutes. The well was pumped continuously at nearly a constant rate for 48 hours and measurements of the depths to water in the observation wells were continued for an additional 24 hours after pumping stopped.

Darcy's law essentially states that the quantity of water discharged through any water-bearing material is equivalent to the product of the cross-sectional area through which movement takes place multiplied by the hydraulic gradient and a constant. This constant is called the coefficient of permeability. The cross-sectional area and hydraulic gradient usually can be obtained in the field but the coefficient of permeability is more difficult to ascertain. Thiem, a German hydrologist, developed a formula for obtaining this coefficient from measuring the drawdowns in two observation wells located at different distances from a pumped well. His formula, however, strictly applies only to a region where there is no hydraulic gradient before pumping begins and it was to determine the effect of an initial hydraulic gradient that this investigation was made.

It has been possible to plot the drawdown and recovery curves of each observation wall from the measurements made of the depths to water in the wells. The initial hydraulic gradient has been determined from a contour map of the water table before pumping started. The cone of depression has been determined for several time intervals and sections have been drawn across the cone. Many coefficients of permeability have been computed because the drawdowns in only two observation wells are needed in Thiem's equation. The coefficients thus computed have varied through a wide range depending upon where the two observation wells used in Thiem's formula were located in reference to the pumped well. This variation in the coefficient is probably due to an initial hydraulic gradient, too short a pumping period, and local variations in the permeability of the formation. Before conclusive results can be obtained, additional tests and a further study of the data already collected will have to be made.

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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) Graduate work for advanced degree as well as general scientific research.
(d) T. Smart and A. Lambert.
(e) Dr. Glen N. Cox, Assoc. Prof. of Mech. & Hydr.
(f) Study of rainfall, runoff, and evaporation.
(g) The rainfall will be measured at a number of different points in standard rainfall cans and in one Weighing Recording Gage. The discharge will be measured over a concrete spillway by means of a Stevens automatic water level recorder. The evaporation will be measured in both a land and a water pan. Wind velocities, humidity and temperature to be taken at a nearby University Weather Station. An attempt will be made to determine the effect of these different variables upon the evaporation and run-off from the area.

(h) The gage house is under construction at the present time.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

(29) (a) EXPERIMENTAL STUDY OF SEA WALL DESIGN.
(b) River Hydraulic Laboratory, M. I. T.
(c) Graduate research for Doctor's degree.
(d) Professor K. C. Reynolds.
(e) Professor K. C. Reynolds.
(f) Improvement of sea wall design.
(g) Models of several types of sea walls will be exposed to various wave conditions and their behavior observed.
(h) Apparatus complete. Actual investigations started.

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(30) (a) EXPERIMENTAL INVESTIGATION OF THE TRANSPORTATION OF SAND BY RUNNING WATER.
(b) River Hydraulic Laboratory, M. I. T.
(c) General scientific research.
(d) C. H. MacDougall of laboratory staff.
(e) C. H. MacDougall.
(f) To investigate the factors which influence the movement of sand and the attendant phenomena.
(g) Very flexible and complete apparatus will permit accurate measurements of the quantity of sand moved at various conditions of slope and depth in a channel 32 feet long, 2 feet wide and having a maximum discharge of 3 sec. feet. Arbitrarily graded sands will be used.
(h) Apparatus complete and research well under way.

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(31) (a) INVESTIGATION OF WAVE PHENOMENA IN CHANNELS.
(b) River Hydraulic Laboratory, M. I. T.
(c) General scientific research.
(d) J. B. Drisko of laboratory staff.
(e) J. B. Drisko.
(f) To determine characteristics of wave phenomena in channels. This includes tidal waves, waves of translation and flood waves.
(g) Simultaneous chronographic recording of the motion of four floats placed along a 42-foot channel enables studies of wave characteristics. Tides can be produced by a mechanism in the tail bay of the channel.
(h) A few runs have been made, dealing with simple waves of translation.

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(32) (a) DYNAMICS OF SUPPRESSED WEIR DISCHARGE.
(b) River Hydraulic Laboratory, M. I. T.
(c) General scientific research.
(d) Hunter Rouse, of laboratory staff.
(e) Hunter Rouse.
(f) To show relation between pressure distribution in nappe and (a) shape of nappe; (b) ratio of head on crest to depth of

approach. To determine progression of contraction and velocity-of-approach coefficients as height of weir decreases to zero.

(g) Pressure and velocity measurements in nappe and upstream from weir crest will be made for six weir heights, varying from 40 cm. to zero, in each case for heads from 2 cm. to 18 cm. Investigations made in glass channel 51 feet long with crest length for weir of 50 cm. Vortex motion upstream from weirs will be investigated. Weirs sloping upstream and downstream will be studied.

(h) Work complete for weir height of 40 cm.

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(33) (a) EFFECT OF ANGULARITY AND DEPTH OF APPROACH ON SPILLWAY DISCHARGE.

(b) River Hydraulic Laboratory, M. I. T.

(c) Graduate work for Master's thesis.

(d) R. Eliassen and H. Farney.

(e) Professor K. C. Reynolds.

(f) To determine variation in spillway coefficient as angle of approach and depth of approach are varied.

(g) Four approach channels of rectangular cross-section have been constructed to bring water to a spillway at angles of 30°, 45°, 60° and 90° from the spillway axis. The channels may be raised or lowered to give varying depths of approach.

(h) Angles of 30°, 60° and 90° investigated as a Master's thesis 1931-1932 by G. R. Lord and T. A. Fearnside. "An Experimental Investigation to Determine the Effect of Angularity and Depth of Approach on the Discharge over spillways". Experimentation is now in progress, using a sharp-crested weir.

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(34) (a) EXPERIMENTAL INVESTIGATION OF THE HOLDING ABILITY OF ANCHORS.

(b), (c) Graduate research for Master's thesis.

(d) Lieut. R. K. James, U.S.N., and Lieut. W. E. Howard, U.S.N.

(e) Professor H. E. Rossell, Commander, U. S. N.

(f) To determine the variation in holding ability of an anchor as the angle of pull varies. To investigate the effect of changes in design.

(g) A model of a standard U.S.N. 11,000-pound anchor was pulled at various angles and the maximum pull observed. Changes in design were also investigated.

(h) Experimental work completed.

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(35) (a) EXPERIMENTAL STUDY OF FLOW OVER TYPICAL SPILLWAY SECTIONS.

(b) River Hydraulic Laboratory, M. I. T.

(c) Graduate research for Master's thesis.

(d) L. Reid.

(e) Professor K. C. Reynolds and Mr. H. Rouse.

(f) To improve spillway design and put it on an analytical rather than empirical basis.

(g) Measurements of pressure distribution, nappe profile and discharge will be made for models of various spillway crests in a glass channel 1 foot wide.
(h) Apparatus under construction.

.....

(36)(a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENA.
(b) Safe Harbor Water Power Corporation.
(c) General scientific research.
(d) Hydraulic Machinery Laboratory, under direction of Professor W. Spannhake.
(e) Professor W. Spannhake, Professor of Hydraulics and Visiting Professor of Hydraulics from Technische Hochschule, Karlsruhe, Germany.
(f) An experimental study in a systematic way of the fundamental theory of cavitation and the pitting caused by cavitation.
(g) A closed system in which a test section allows observation through glass has been set up with flow produced by two centrifugal pumps arranged in series or parallel. Cavitation is produced at the observation section by sharply converging and gradually diverging profiles of the side walls where a maximum velocity of 100 ft. per sec. can be obtained.
(h) The unit is now complete in every detail, having connections to both a steam and a refrigeration unit for regulation of temperature, an air compressor for pressure regulation, and an analyzer to determine air content in the water. Many different profile shapes have been used and the pressure distribution measured along them. Motion pictures at a speed of 1000 per sec. have allowed a better study of the phenomena. Systematic endurance tests have been made in varying types of material under carefully regulated cavitation conditions, thus rating the ability of different materials to withstand the pitting effect. Work will commence shortly to determine the effect of the air content of the water upon cavitation pressures and pitting effects.

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(37) (a) MODEL STUDIES OF PUMPS AND TURBINES BY USE OF ROTOSCOPE.
(b) Hydraulic Machinery Laboratory.
(c) General scientific research.
(d) Above-named staff of Hydraulic Machinery Laboratory.
(e) Professor W. Spannhake.
(f) Observe the flow conditions and hence study the pressure and velocity distribution within a model turbine in operation.
(g) The casing on the front face of a horizontal turbine or pump is replaced by a disk of plate glass. By the use of the rotoscope, the turbine, although in rotation, appears to stand still. By introducing dyes from definite point of the plate, it is possible to observe the flow conditions.
(h) Rotoscope constructed under the direction of Professor D. Thoma of the Hydraulic Machinery Laboratory at München, Germany, and is now being installed.

(38) (a) LATERAL SPILLWAY CHANNELS.
(c) Conducted as graduate and undergraduate theses.
(d) D. M. Stewart and H. W. Taul.
(e) Professor T. R. Camp.
(f) The purpose of these experimental studies is to determine the hydraulic conditions of flow in rectangular channels such as are used for the effluent flumes of settling tanks, to develop the theory from the fundamental differential equations, and to correlate the theoretical results with experimental measurements.
(g) The experimental work is being done upon a 20-foot flume with level bottom having a constant cross-section 9 inches wide and 2 feet deep. It is hoped to complete the work for flat-bottom flumes and also for flumes with sloping bottoms.
(h) The work now being done is a continuation of the work started by Engler and LaPointe in 1930 and carried on by Hunter and Hough in 1932. Some results worthy of publication should be obtained this year.

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(39) (a) HYDRAULICS OF OPEN CHANNEL TRANSITIONS.
(c) Conducted as graduate and undergraduate theses.
(d) No experimental work now in progress.
(e) Professor T. R. Camp.
(f) The purpose of these studies is to determine the magnitude of the lost head and the conditions of flow through open channel transitions of various types for design purposes.
(g) Experimental measurements have been made upon velocity and pressure distributions on a small open channel transition with rectangular cross-section. It is expected to continue such measurements with transitions of other sizes and shapes and to attempt a correlation of the lost head with the conditions of flow.
(h) The previous experimental work was done by Muir and Miller in 1930 and by Silva in 1931. A reference to Silva's results is contained in a paper, "Hydraulics of Sewer Transitions", by T. R. Camp, published in the Journal of the Boston Society of Civil Engineers, June, 1932.

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(40) (a) STUDY OF HYDRAULICS OF SEDIMENTATION BASINS.
(c) Conducted as undergraduate and graduate theses.
(d) Work now in progress by Chayabongse and Miller.
(e) Professor T. R. Camp.
(f) The purpose of this work is to develop as result of experimental measurements a rational theory for estimating the removal by sedimentation of suspended solids.
(g) The method of study is to measure the distribution of velocities in settling tanks as to direction and magnitude, and to correlate these velocities with the settling velocities of suspended particles in order to estimate the path taken by the particles and hence the proportion of particles removed.

(h) The work now in progress is confined to the measurement of the distribution of velocities in a model settling tank, 2 feet wide, 1 1/2 feet deep, and about 10 feet long. It is a continuation of work done upon the same subject in 1932 by Parker and Velez. Preliminary studies are now in progress upon the settling values of floc particles. Experimental studies relating to this subject were made in 1932 by Wagner in the sedimentation basin of the Cambridge Filter Plant.

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(41) (a) FLOW OF WATER THROUGH SAND FILTERS.
(c) Conducted as fundamental research by staff member and collaborators.
(d) Professor T. R. Camp, and E. L. Bean, Chemist of the Providence Water Treatment Plant.
(e) Professor T. R. Camp.
(f) Purpose of these studies is to develop fundamental hydraulic theory of the flow of clean water through sand filters and to use this theory in the development of the theory of deposit of suspended matter in sand filters.
(g) A rational mathematical theory of flow of clean water through sand has been developed and the valuation of coefficients is now being undertaken by experimental work at the Providence Water Treatment Plant, and also by the study of experimental work done elsewhere upon the same subject, notably by Hulbert and Feben at Detroit.
(h) The work now being carried on at the Providence Water Treatment Plant has for its specific purpose the study of the relation of flow through a homogeneous sand bed to flow through the same sand bed when stratified after back washing.

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NATIONAL HYDRAULIC LABORATORY.

(42) (a) INVESTIGATION OF THE PHYSICS OF PLUMBING.
(b) The Subcommittee on Plumbing of the U. S. Department of Commerce Building and Code Committee.
(c) General research.
(d) R. B. Hunter.
(e) The Director, U. S. Bureau of Standards.
(f) To obtain data on which to base logical estimates of the capacities of various sizes of drain pipes, vertical and sloping, in plumbing systems.
(g) It is proposed:- (1) To determine the capacities of various sizes of cast iron drains at slopes from 1/8 inch to 1 inch fall per foot with steady flow and full pipes; (2) To study the flow in the same drains or in drains constructed of the same class of pipe with the flow built up to a capacity load by discharges from plumbing fixtures and tanks simulating plumbing fixtures, to obtain an approximate relation between the average capacity load under surging conditions and the capacity load of

the same drain with a full pipe under steady conditions; (3) to study the effect of temporary peaks formed by overlapping of discharges from two or more fixtures and the relation of these peaks to the average flow; and (4) to establish if possible an approximate relation between the number of fixtures and the average and peak loads to be expected in actual service.

(h) Measurements of flow in cast iron soil pipe, 2", 3", 4" and 5" diameters with losses in head corresponding to 1/8", 1/4", 1/2" and 1" fall per foot have been completed and the hydraulic formula determined for this class of pipe. A study of surging flow has been made and a means of detecting the point at which the critical or capacity load is reached for surging conditions has been discovered. An installation of 6" pipe, which for a part of the work will be of glass, is being made for continuing the study.

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(43) (a) INVESTIGATION OF PIPE BENDS.
(b) U. S. Bureau of Reclamation.
(c) General research.
(d) K. H. Beij, G. H. Keulegan.
(e) The Director, U. S. 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) The first work will be on a 4 inch line of steel tubing with special joints to provide accurate alignment. The first bends will be commercial, seamless, 90 degree bends of various radii. Especially long upstream and downstream tangents will be used. Later the work will be extended to smooth (copper and brass) pipe with special bends of accurate dimensions; to sizes up to about 20 inch diameter; to bends of various central angles and radii; to miter bends and cast fittings; and to pipe of various materials and various degrees of roughness. Transparent pipes and bends will be used to investigate the nature of flow.
(h) The installation for tests on 4 inch steel tubing with commercial seamless bends is now being set up, and necessary apparatus is under construction.

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(44) (a) STUDY OF "DEEP WELL" CURRENT METERS.
(b) U. S. Geological Survey.
(c) General research.
(d) R. B. Hunter, W. F. Stutz.
(e) The Director, U. S. Bureau of Standards.
(f) To study the characteristics of current meters developed by the U. S. Geological Survey for explorations in artesian wells; to calibrate these meters in various sizes of well casings from

4" to 15" diameters; and to examine their reliability for detecting the location and extent of leaks in the casing.

(g) An 8-inch supply line fed by a constant level tank with a capacity of 5 c.f.s.and a total head of 47 feet has been provided for the work. The well casings in which the study is to be made will extend vertically from the lower end of the supply line. Two venturi meters, one 4" and one 8", have been installed in parallel in the supply line for measuring the flow and a measuring basin is to be provided for additional measurements. It is proposed to calibrate the meters directly against the mean velocity in the vertical sections of well casing.

(h) The supply line of the installation has been completed and the measuring equipment is under construction.

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PACIFIC HYDROLOGIC LABORATORY.

(45) (a) RELATION OF PERMEABILITY OF GRANULAR MATERIALS TO PARTICLE SIZE.

(b) Water Conservation Committee, Irrigation Division, American Society of Civil Engineers.

(c) General scientific research.

(d) Charles H. Lee.

(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.

(f) To provide a more accurate basis for preliminary classification of soil and earth materials as to permeability.

(g) Permeability coefficient of natural undisturbed material determined by means of permeameter. Also complete mechanical analysis of material made by means of hydrometer (Bouyoucos) method for which improvements have been developed. Mechanical analysis curves plotted by groups within fixed limits of permeability, data being obtained for as wide a variety of earthy materials as possible.

(h) With data published in W.S.P. 596-F, U.S.G.S., pp. 164-169 as a nucleus, other materials are being tested and results tabulated as rapidly as opportunity affords.

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(46) (a) RELATION OF HEAD TO FLOW OF WATER THROUGH PARTIALLY SATURATED GRANULAR MATERIALS.

(c) General scientific research.

(d) Charles H. Lee.

(e) Charles H. Lee, Consulting Engineer, 58 Sutter Street, San Francisco, California.

(f) To ascertain more definitely the relation of flood flow in streams to seepage from their beds.

(g) Loss of head determined under various conditions of partial saturation as well as complete saturation with downward flow through undisturbed columns of various types of natural soils and earthy materials. It is proposed to extend the scope of observations to include capillary back pressure.

(h) Preliminary results obtained on beach sand indicate capillary back pressure is of prime importance in controlling the net head available for percolation through submerged and partially saturated soil columns.

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PURDUE UNIVERSITY ENGINEERING EXPERIMENT STATION.

(47) (a) FLOW OF FLUIDS THROUGH CIRCULAR ORIFICES.
(d) Professor F. W. Greve and graduate students.
(e) Professor F. W. Greve.
(f) To determine experimentally the effects of density, surface tension, viscosity, and temperature upon the rate of discharge through small circular orifices.
(g) The orifices were cut in a solid brass sheet which formed one side of the orifice tank. Flow was maintained by a small pumping unit. The fluids employed were distilled water, oils of different densities and several sugar solutions.
(h) The project was started in December, 1931. The tests have been completed and the computations are in progress.

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U. S. BUREAU OF RECLAMATION.

(48) (a) Hydraulic Model Experiments for the Design of the Hoover Dam.
(b) U. S. Bureau of Reclamation.
(c) General scientific research.
(d) Research Division, U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) These experiments are being carried out for the design of the spillways, gate towers, penstocks and needle valve outlets at the Hoover Dam.
(g) An extensive study was made to develop the best form of spillways to discharge 400,000 sec. ft. with a fall of more than 500 ft., as a result of which two units of the side channel type were adopted, discharging into inclined tunnels which led to the horizontal diversion tunnels. Various forms were tested with models of 1:100, 1:60 and 1:20 scale, involving flows up to 112 sec. ft. and drops up to 30 ft. A great deal of data bearing on the design of side channel spillways was accumulated. An intensive study was made of the hydraulics of ogee weirs, including discharge coefficients, crest shapes as developed from nappe shape studies, vacuum and pressure effects, also coefficients of discharge and pressures on drum gates were determined.

A study was made of the intake losses of the intake gate towers and the losses in the penstocks due to branches, bends, etc. A detailed study was made of the loss of single branches of various forms.

The best arrangement for the battery of needle valves in the tunnels to discharge the waste water after the dam is completed, is being worked out in detail by means of models. A

model study of the river below the dam is under way, to determine the effect of the various streams reentering the river at that point.

Most of these experiments were made at the Hydraulic Laboratory of the Colorado Agricultural College. Others were carried out at the Montrose Laboratory of the Bureau of Reclamation.

(h) The experimental work and preparation of the report on these studies is still under way, and will continue for some time. When the results of these studies are in shape for giving to the public, it is expected that technical reports for general distribution will be issued.

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WEST VIRGINIA UNIVERSITY.

(49) (a) SEDIMENTATION OF SMALL PARTICLES SUSPENDED IN WATER.
(b) West Virginia University.
(c) Graduate work for an advanced degree.
(d) H. W. Speiden and L. V. Carpenter.
(e) L. V. Carpenter, College of Engineering, West Virginia University, Morgantown, W. Va.
(f) To study the laws governing the rate of settling of small particles in model basins.
(g) It is proposed to construct a series of basins making use of the principles of similarity, and investigate the effect of various types of inlet and outlet arrangement; work out the similarity laws governing the flow of water in basins and try to determine some of the theoretical laws governing the rate of settling of small particles.
(h) Experimental work has been started on a basin 4 ft. by 6 ft. in cross-section and 10 ft. long. Other basins will be constructed in the near future.

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(50) (a) DISCHARGE THROUGH THIN PLATE ORIFICES IN PIPE LINES.
(b) West Virginia University.
(c) General scientific research.
(d) L. V. Carpenter, assisted by students.
(e) L. V. Carpenter, College of Engineering, West Virginia University Morgantown, W. Va.
(f) To study coefficients of various sizes of circular thin plate orifices in pipe lines with a view to the determination of the relations existing between the coefficients of large and small orifices by principles of similarity.
(g) A series of six different size circular orifices have been tested in a 2-inch pipe line. The section of pipe line as well as the thin plate orifice are smooth brass. It is proposed to make a number of similar tests on orifices in 3, 4 and 6 inch pipe lines.

(h) Experiments on the 2-inch pipe lines are completed, and preparations are being made to start experimental work on the 3-inch pipe line.

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U. S. WATERWAYS EXPERIMENT STATION.

(51) (a) SEDIMENT 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 Lt. H. D. Vogel, Director of the Station. Further information and data covering any particular experiment may be obtained from the Director, U. S. Waterways Experiment Station.
(e) Movement of sedimentary material through Mississippi River system - silting of reservoirs.
(f) Field and laboratory investigations analysis of samples, compilation of curves.
(g) Studies for 1930-31 reported on; other studies still in progress.

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(52) (a) SOILS INVESTIGATIONS.
(b) Navigable Waterways, U. S. A.
(c) See (51).
(d) See (51)
(e) Physical analyses of soils samples, for levees, hydraulic fills, etc.
(f) All kinds of mechanical analyses.
(g) Studies in progress continually.

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(53) (a) BONNET CARRE FLOODWAY.
(b) Mississippi River Commission.
(c) See (51)
(d) See(51)
(e) Characteristics of flow through floodway.
(f) Model scales 1 to 100.
(g) Completed.

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(54) (a) CUT-OFFS GREENVILLE BENDS.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of various cuts across the Greenville Necks.
(f) Model scales 1 to 4800 and 1 to 360.
(g) Completed.

.....

(55) (a) ILLINOIS BACKWATER STUDY.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Determination of limits of backwater on Illinois River under various conditions of stage in Mississippi and Illinois Rivers.
(f) Model scale 1 to 1200 and 1 to 48.
(g) Completed.

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(56) BIRDS POINT - NEW MADRID FLOODWAY.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) To determine the effects of operating the Birds Point-New Madrid Floodway.
(f) Model scales 1 to 4800 and 1 to 200.
(g) Completed.

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(57) (a) DAM NO. 37, OHIO RIVER.
(b) District Engineer, Cincinnati, Ohio.
(c) See (51)
(d) See (51)
(e) Design of dam to insure navigable conditions.
(f) Model scales 1 to 120 undistorted.
(g) Completed.

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(58) (a) RELIEF MAP ALLUVIAL VALLEY, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Provide graphic and animated picture of the flood control plans.
(f) Model scales 1 to 250,000 and 1 to 250.
(g) Completed.

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(59) (a) LEVEE SEEPAGE.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Locate hydraulic gradient and seepage lines in levees of standard section and of varying materials.
(f) Loop of levees, standard section, 10 feet high, of various materials and placed in various ways, kept full; measurements taken.
(g) Loop levee built, observations now in progress.

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(60) (a) CUT-OFF STUDIES, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of twelve proposed cut-offs in various combinations.
(f) Model scales 1 to 2400 and 1 to 120.
(g) Completed.

.....

(61) (a) BRUNSWICK LEVEE EXTENSION.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of extending the east bank levee, Miss. River, south from Brunswick in various ways.
(f) Model scales 1 to 2400 and 1 to 120.
(g) Completed.

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(62) (a) WALKER BAR, OHIO RIVER.
(b) District Engineer, Louisville, Kentucky.
(c) See (51)
(d) See (51)
(e) Develop dike system to improve navigation conditions vicinity of Walkers Bar, Ohio River.
(f) Model scales 1 to 720 and 1 to 72, movable bed.
(g) Completed.

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(63) (a) BOEUF FLOODWAY.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effect of pilot channels in proposed floodways.
(f)
(g) Completed.

.....

(64) (a) PIPE BENDS.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Flow through bends in pipes.
(f) Observations on ordinary pipe fittings.
(g) Completed.

.....

(65) (a) HARBORS FRONT LEVEES.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Methods to decrease sections of protection - Levees.
(f) Models scale 1 to 10.
(g) Completed.

.....

(66) (a) DRAINAGE SPILLWAYS.
(b) District Engineer, Jacksonville, Fla.
(c) See (51)
(d) See (51)
(e) Design of spillway and dam, drainage canals entering navigation canal.
(f) Model scales 1 to 16 undistorted.
(g) Completed.

.....

(67) (a) RED RIVER BACKWATER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Extent of backwater on Red River under worst conditions.
(f) Model scales 1 to 800 and 1 to 80.
(g) Completed.

.....

(68) (a) RAILROAD EMBANKMENT.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Means of preventing erosion of a railroad embankment.
(f) Model scales of 1 to 20, 1 to 5 and full size.
(g) Completed.

.....

(69) (a) MORRISON TOWHEAD.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Means of closing a back channel chute.
(f) Model scales 1 to 700 and 1 to 70, both fixed and movable beds.
(g) Completed.

.....

(70) (a) RALEIGH BAR.
(b) District Engineer, Louisville, Ky.
(c) See (51)
(d) See (51)
(e) Development system to improve navigability of Raleigh Bar (and other bars) Ohio River.
(f) Model scales of 1 to 720 and 1 to 72, with movable bed.
(g) Study complete; report about to be rendered.

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(71) (a) STEWARTS BAR.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Means of closing a chute and improving navigable depths.
(f) Model scales 1 to 1000 and 1 to 100 movable bed.
(g) Completed.

.....

(72) (a) DIAMOND POINT CUT-OFF.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects on bed and water surface of the Diamond Point Cut-Off.
(f) Model scales 1 to 2400 and 1 to 120 fixed and movable beds.
(g) Completed.

.....

(73) (a) CONCRETE AND GRAVEL REVETMENTS.
(b) Mississippi River Commission. (c) and (d), See (51)
(e) Possibilities and characteristics of proposed new revetments.
(f) Flume tests under high velocities.
(g) Completed.

.....

(74) (a) TRACTIVE FORCE.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Critical depths and slopes to cause movement of any given bed load.
(f) Flume tests in special tilting flume.
(g) In progress.

.....

(75) (a) ISLAND NO. 9, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of dikes, dredge cuts, retards and dams to end of improving navigation and measuring bank attack.
(f) Model scales 1 to 600 and 1 to 150; movable bed.
(g) Completed.

.....

(76) (a) STARVED ROCK LOCK AND DAM.
(b) District Engineer, Chicago, Ill.
(c) See (51)
(d) See (51)
(e) Means of stopping silting of channel; method of operating Tainter gates of dam.
(f) Model scales 1 to 185 and 1 to 50, movable bed.
(g) Completed.

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(77) (a) ISLAND NO. 55, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Develop methods of improving navigation.
(f) Model scale 1 to 600 and 1 to 150, movable bed.
(g) Nearing completion.

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(78) (a) LACONIA BEND MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of dredging on point bar to end of stopping bank attack.
(f) Model scales 1 to 1500 and 1 to 150 movable bed.
(g) Completed.

.....

(79) (a) RACE TRACK TOWHEAD.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Method of closing old back channel by dikes and dredging.
(f) Model scales, 1 to 1000 and 1 to 100; movable bed.
(g) Completed.

.....

(80) (a) HOTCHKISS BEND, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Develop dikes upstream to improve navigation conditions.
(f) Model scales 1 to 600 and 1 to 150; movable bed.
(g) In progress.

.....

(81) (a) ST. CLAIR RIVER COMPENSATING WEIRS.
(b) Great Lakes Division.
(c) See (51)
(d) See (51)
(e) Determine kind, number and placing of weirs to raise level of Lake Huron.

(f) Model scales 1 to 100 undistorted and 1 to 100 against 1 to 30, also flume tests of individual weirs.
(g) In progress.

.....

(82) (a) BED LOAD DIVERSION.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Possibilities of diverting bed load from main channel.
(f) Model scales 1 to 600 and 1 to 150.
(g) Completed.

.....

(83) (a) FORT CHARTRES, MISSISSIPPI RIVER.
(b) District Engineer, St. Louis, Mo. (c) and (d), see (51).
(e) Develop dike system to improve depths over crossings.
(f) Model scales 1 to 1000 and 1 to 100; movable bed.
(g) In progress.

.....

(84) (a) BROOKS POINT, MISSISSIPPI RIVER.
(b) District Engineer, St. Louis, Mo.
(c) See (51)
(d) See (51)
(e) Develop dike system to improve depths over crossings.
(f) Model scales 1 to 1000 and 1 to 100; movable bed.
(g) In progress.

.....

(85) (a) ACTION OF BED LOAD AT A STREAM FORK.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Characteristics of a Bifurcated Flume.
(f) Flumes with divided channels movable beds.
(g) 1st and 2nd phases complete, more to come.

.....

(86) (a) ST. ANDREWS BAY GULF OF MEXICO
(b) Gulf of Mexico Division.
(c) See (51)
(d) See (51)
(e) Effects of jetties and possibilities of new channels.
(f) Model scales 1 to 2000 and 1 to 100; tides, littoral drift, winds to simulate.
(g) Complete.

.....

(87) (a) BRAZOS SANTIAGO PASS, GULF OF MEXICO.
(b) Gulf of Mexico Division.
(c) See (51)
(d) See (51)
(e) Effects of jetties on present channel.
(f) Model scales 1 to 300 and 1 to 150.
(g) In progress.

.....

(88) (a) FITLER BEND MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Effects of Point Bar Dredging.
(f) Model scales 1 to 800 and 1 to 125; movable bed.
(g) In progress.

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(89) (a) RELIEF MAP, BIRD'S POINT-NEW MADRID FLOODWAY.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Court Exhibit of floodway (see experiment No. 56)
(f) Scales 1 to 20,000 and 1 to 500; not built for operation as a model.
(g) Complete.

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(90) (a) TONEY'S TOWHEAD MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Develop dike system to improve conditions for navigation.
(f) Model scale 1 to 1000 and 1 to 100; movable bed.
(g) In progress.

.....

(91) (a) MILLIKENS AND PAW PAW BEND MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Cut-offs divisions, and other problems, Mississippi River from Mile 560 to Mile 650.
(f) Model scales 1 to 1000 and 1 to 100; movable bed.
(g) In progress.

.....

(92) (a) GLASSCOCK BEND MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Same for Mississippi River from Mile 650 to Mile 740.
(f) Model scales 1 to 1000 and 1 to 100; movable bed.
(g) In progress.

.....

(93) (a) LAKE LONG BIFURCATION, ATCHAFALYA RIVER.
(b) Mississippi River Commission.
(c) See (51)
(d) See (51)
(e) Study of bed load movement at this stream fork.
(f) Model scales 1 to 500 and 1 to 50; movable bed.
(g) In progress.

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UNIVERSITY OF MINNESOTA.

(94) (a) TRANSPORTATION OF SEDIMENT.
(e) Prof. Lorenz G. Straub.
(f) Investigations of the transportation of bed sediment in alluvial rivers and the effect of contraction works on the river channel.
(h) In progress.

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(95) (a) BROAD-CRESTED WEIRS.
(e) Prof. Lorenz G. Straub.
(f) Characteristics of broad-crested weirs, experimentally establishing the pressure-momentum relations.
(h) In progress.

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(96) (a) EXPERIMENTAL DESIGN OF DROP-CULVERT SPILLWAYS.
(e) Prof. Lorenz G. Straub.
(h) In progress.

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(97) (a) MODEL TESTS OF SAND DAMS.
(e) Prof. Lorenz G. Straub.
(h) In progress.

.....

(98) (a) PERMEABILITY OF GRANULAR MATERIALS.
(e) Prof. Lorenz G. Straub.
(f) Investigation of the permeability of granular materials when subjected to high liquid pressures.
(h) In progress.

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(99) (a) LAWS OF HYDRAULIC SIMILITUDE.
(e) Prof. Lorenz G. Straub.
(f) Investigation of the limitations of the laws of hydraulic similitude.
(h) In progress.

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COMPLETED PROJECTS.
Abstracts and References.

UNIVERSITY OF CALIFORNIA.

(1) "Model Law for motion of Salt Water Through Fresh", by M. P. O'Brien and John Cherno.
Proc. Am. Soc. Civil Engineering, Vol. 58, No. 10, December, 1932, pp. 1767-1788.

(2) "Hydraulic Ram", by M. P. O'Brien and J. E. Gosline, University of California Publications in Engineering, Vol. 3, No. 1, 1933, pp. 1-58.

Abstract. (By H. N. Eaton, Bureau of Standards.) The theory of the hydraulic ram is developed with particular reference to the period of retardation and the relation of this to the period of acceleration, and is tested experimentally.

(3) "The Water Jet Pump", by M. P. O'Brien and J. E. Gosline. Paper presented at the Pacific Coast Applied Mechanics Meeting at the California Institute of Technology, Jan. 20-21, 1933. (A.S.M.E.)

(4) "Siphon-Spillway Models Tested against Prototypes", by H. H. Wheaton. Engineering News-Record, Vol. 109, No. 7, August 18, 1932, pp. 187-189.

Abstract. (By H. N. Eaton, Bureau of Standards.) The tests reported in this paper are unusually significant because comprehensive field tests had been made on the full-scale structures which the models duplicated. It is concluded that the coefficient of discharge of a siphon can be determined from a model, but that there is probably a limit to the scale reduction of the model for reliable results. Small models were found to have slightly smaller coefficients of discharge than large models.

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U. S. BUREAU OF RECLAMATION.

(5) "Results of Hydraulic Model Studies of the Cle Elum Dam Spillway", Final report. By E. W. Lane.
U. S. Department of the Interior, Bureau of Reclamation Tech. Memo. No. 290, April 28, 1932, Denver, Colorado.

Abstract. The Cle Elum spillway was designed for a discharge of 40,000 sec. ft. and a fall of 110 ft. It is founded on earth throughout and is of the trough or flume type, discharging into a stilling pool. The report deals with the experiments on the flow in the flume and the development of the best type of stilling pool.

As a result of the experiments, a flume with a narrower section in the middle was developed, in which undesirable wave action did not exist. A study of wave action in steep chutes was made and tentative conclusions on the general principles controlling it were developed.

In the studies for the stilling pool design the following are the principal points covered: The best combination of width, depth and length for the stilling pool; the effect of the slope of the bottom entering the pool; the best shape of the end of the pool and the effect of various still forms; desirability of various forms of pool and walls and scour protection on banks and bed; the magnitude of the unbalanced upward pressure on the pool floor due to the hydraulic jump.

(6) "Model Tests for Design of the Madden Dam Spillway", by R. R. Randolph, Jr., Asst. Engineer. Feb. 1, 1932, Denver, Colorado.

Abstract. The Madden Dam was designed to discharge 260,000 sec. ft. over an ogee spillway, with a total drop of 123 ft. The principal problem to be solved was a determination of the best form of protection against scour at the toe of the dam. The controlling condition was that the depth of tailwater was greater than that required to form the jump on an apron at streambed level. Various forms of level aprons with sills were tested and a sloping apron finally developed, which caused an efficient hydraulic jump to form at all discharges. Several other forms of apron were also investigated. The velocities within the jump for a wide range of conditions were observed.

Observations were also made on the pressures below the nappe flowing over the ogee crest and on the discharge coefficients. The coefficients of flow over the crest drum gates were also determined.

NATIONAL HYDRAULIC LABORATORY.

(7) "Capacity of Level Roof Gutters",
by K. Hilding Beij.

Abstract. Tests were made on rectangular and semi-circular roof gutters, both level and sloping, and on one gutter of irregular cross-section. The paper discusses the results for level gutters only. Emmirical formulas for determining the capacity of level rectangular and semi-circular gutters are derived and graphs for rapid solution are presented. Theoretical formulas are derived for several forms of cross-section. These agree satisfactorily with experimental results. The paper will be published in the near future.

DIRECTORY.

(Laboratories for which projects are listed in this report.)