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

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE UNITED STATES.

REPORT NO. II-2
July 1, 1934.

WASHINGTON.

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D I R E C T O R Y

REPORT ON
CURRENT HYDRAULIC LABORATORY RESEARCH
IN THE UNITED STATES

Compiled by the National Bureau of
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Volume II, Number 2. July 1, 1934.

INTRODUCTION.

Several hundred copies of Bulletin II-1, January 1, 1934, were sent to the National Committees of the World Power Conference and to hydraulic laboratories and interested individuals abroad. The acknowledgments which have been received as a result of this circulation have shown that a great deal of interest exists abroad in the exchange of information on hydraulic research.

A number of foreign papers on hydraulic and hydrologic subjects have been received and are in the files of the Hydraulic Laboratory Section of the National Bureau of Standards. A list of these accessions is given in this bulletin. The papers will be loaned upon request.

Attention is called to the section of this bulletin relating to the U.S.S.R. Commission for the Exchange of Hydraulic Laboratory Research Results.

An effort is being made to obtain a complete list of hydraulic laboratories abroad. Foreign laboratories are invited to supplement and to correct, if necessary, the information published here.

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:

HARVARD UNIVERSITY.

(106) (a) THE STUDY OF THE FLOW OF WATER THROUGH SAND.
(b) -----
(c) Project conducted as a University research undertaking.
(d) G. M. Fair and L. P. Hatch.
(e) Professor G. M. Fair.
(f) To evaluate the hydraulic characteristics of sands, and to formulate the laws governing the flow of water through sands, both in natural deposits and in artificial structures, such as dams and filters.
(g) Studies in sand measurement and description; studies in frictional resistance of different sands, in streamline and turbulent flow as well as under expansion.

(h) Refinements in procedure and additional experimental data have been obtained in this continuing research during the past year. A preliminary note was published in the Journal of the American Water Works Association, Nov. 1933, and also in Civil Engineering, Feb. 1934.

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IOWA INSTITUTE OF HYDRAULIC RESEARCH.

(107) (a) HYDRAULIC TEST ON MODEL OF MISSISSIPPI RIVER BELOW KEOKUK DAM.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine, (1) remedy for diagonal currents below lock, (2) effect of wing dams and old cofferdam on tailwater of Keokuk plant, and (3) to determine possible power benefits of excavation in powerplant tailrace.
(g) Investigation on fixed-bed model of river built to scale of 125 to 1.
(h) Report being prepared.

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(108) (a) HYDRAULIC INVESTIGATION OF GENERAL MODEL OF LOCK AND DAM NO. 4, MISSISSIPPI RIVER AT ALMA, WISCONSIN.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine hydraulic characteristics of the proposed structure and navigation conditions near the locks.
(g) Investigation on fixed-bed model of river to horizontal scale of 300 to 1 and vertical scale of 100 to 1.
(h) Investigations will be completed about July 15th, 1934.

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(109) (a) HYDRAULIC STUDIES TO IMPROVE FILLING AND EMPTYING SYSTEM FOR RIVER NAVIGATION LOCKS.
(b) U. S. Engineer Department.
(c) Institute Project and Graduate Thesis.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To increase the efficiency of filling and emptying systems and to eliminate disturbances in the lock chamber during lockage.
(g) Investigation on lock model on scale of 15 to 1 with many adjustable and variable features undercontrol.
(h) Improvements in the design of culvert systems have been developed which increase the speed of lockage and effect a more uniform distribution of flow into and out from the lock chamber. Investigations will continue indefinitely. See also following project. (217)

(213) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 26, MISSISSIPPI RIVER AT ALTON, ILLINOIS. (Site 800 feet upstream from R. R. bridge.)
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To design control works necessary to maintain satisfactory navigation channel from the dam to mouth of Missouri river and to study effect of spillway discharge on erosion around piers of railroad and highway bridges. (See also following project.)
(g) Investigation on movable bed model of river on a horizontal scale of 400 to 1 and vertical scale of 60 to 1.
(h) Preliminary report submitted in May, 1934. Investigations will be continued to determine the best location for a battery of roller gates in the spillway and to further study protective measures to prevent erosion at the bridge piers.

(214) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 26, MISSISSIPPI RIVER AT ALTON, ILLINOIS. (Site 800 feet upstream from R. R. bridge.)
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To study effect of spillway discharge on erosion around piers of railroad and highway bridges and to design protection if necessary.
(g) Investigation on movable-bed model representing 400feet of spillway and bridge section on scale of 25 to 1. Model includes 8 tainter gates.
(h) Preliminary report submitted in May, 1934. Tests will be continued to develop protective measures to prevent erosion at the bridge piers. Data will also be secured in this model to determine discharge coefficients for tainter gates.

(215) (a) HYDRAULIC STUDY OF MODEL OF LOCK AND DAM NO. 20, MISSISSIPPI RIVER AT CANTON, MISSOURI.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine (1) principles and rules to follow in design of stilling basin for dam No. 20, and for other dams to be built on erodible foundations, (2) to determine discharge coefficients for tainter gates, and (3) to determine schedule of tainter gate operation to maintain required pool levels at Dam No. 20, and at other similar dams on Mississippi river.
(g) Investigation on a model of a single tainter gate on a scale of 20 to 1 built in a glass-sides flume.
(h) Tests were completed in March, 1934. Report is being prepared. The tests indicate that the length of stilling basin required to prevent erosion along the toe of a spillway, provided the basin is of sufficient depth to develop a stable hydraulic jump, can be determined from an empirical relationship of D_2/H_o and L/V_2^2, in which,

D_2 = Depth of water on the apron downstream from the jump.
H_o = Energy head above the apron floor upstream from the jump.
L = Length of apron.
and V_2 = Mean velocity in the stilling basin downstream from the jump.

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(216) (a) HYDRAULIC INVESTIGATION OF GENERAL MODEL OF LOCK AND DAM NO. 5, MISSISSIPPI RIVER AT FOUNTAIN CITY, WISCONSIN.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine hydraulic characteristics of the structure, its effect on flood stages and to study navigation conditions near the locks.
(g) Model is constructed on a horizontal scale of 500 to 1 and a vertical scale of 100 to 1 and includes a section of the Mississippi river about 9.5 miles long near Fountain City, Wis.
(h) Construction of the model is completed. Calibration of the unobstructed channel will be completed about July 15th, 1934.

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(217) (a) THE EFFECT OF TRANSFACIAL VELOCITY ON DISCHARGE COEFFICIENTS OF ORIFICES AND SHORT TUBES.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To determine the effect of flow across the faces of orifices and across to entrances to short tubes on their discharge coefficients with particular reference to such conditions as apply to the filling systems of navigation locks.

(g) Apparatus consists of a rectangular galvanized iron pipe 6 by 8 inches by 30 feet long, with a mid-section of pyrolin 4 feet long. Standard orifices or short tubes can be inserted in the side of the pyrolin section of pipe. Velocities across the orifice section can be varied from 0 to 9 feet per second. Orifices can be given a downstream submergence of from 0 to 3.5 feet. Equipped to measure accurately the hydraulic gradient and velocity in the pipe, submergence of orifice and discharge through the orifice.

(h) Tests on a standard 2" orifice are in progress.

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(218) (a) DESIGN OF STILLING BASIN FOR MISSISSIPPI RIVER DAM NO. 4.

(b) U. S. Engineer Department.

(c) Institute Project.

(d) U. S. Engineer Department Staff.

(e) Martin E. Nelson, Associate Engineer.

(f) To determine whether stilling basin as designed for roller gate and tainter gate spillways are adequate protection against erosion at the toe of the dam.

(g) A tainter gate model, scale 15 to 1, and a roller gate model, scale 30 to 1, with corresponding sections of stilling basin were tested in a glass-sided flume.

(h) Tests are completed, and manuscript of report has been prepared.

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(219) (a) CALIBRATION OF ROLLER GATE DAMS.

(b) U. S. Engineer Department.

(c) Institute Project.

(d) U. S. Engineer Department Staff.

(e) Martin E. Nelson, Associate Engineer.

(f) To obtain data for determining discharge coefficients for roller gates.

(g) Tests are made on a model of a roller gate, scale 30 to 1, in a glass-walled flume, under wide range in discharge, gate opening and downstream submergence.

(h) Tests will be completed about July 1st, 1934.

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(220) (a) HYDROSTATIC PRESSURES ON ROLLER GATES.

(b) U. S. Engineer Department.

(c) Institute Project.

(d) U. S. Engineer Department Staff.

(e) Martin E. Nelson, Associate Engineer.

(f) To determine variations in hydrostatic pressure on the outside of roller gates under various conditions of operation.

(g) Tests have been completed on a model, scale 22.53 to 1, and full-scale tests are being made when desired conditions exist at the Rock Island dam.

(h) Report is being prepared covering data obtained to date, and additional tests will be made on the full-scale roller gate.

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(221) (a) DISCHARGE OVER SUBMERGED SAND DAMS.
(b) U. S. Engineer Department.
(c) Institute Project.
(d) U. S. Engineer Department Staff.
(e) Martin E. Nelson, Associate Engineer.
(f) To design crests of sand dams to permit discharge of flood waters and to study seepage and capillary flow through sand dams under various degrees of submergence.
(g) Tests will be made on a 1/5-scale model in a glass-walled flume and on a 1/2-scale model in the river canal of the laboratory.
(h) Construction of 1/5-scale model will be completed about July 1st, 1934.

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(112) (a) FLOW OF WATER AROUND BENDS IN OPEN AND CLOSED CHANNELS.
(b) Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Cooperative Government and Iowa Institute of Hydraulic Research Project.
(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) Investigations have been made on 6-inch transparent Pyralin pipe bend, standard curvature, for four angles of 45, 90, 180, and 270 degrees and for four bends of irregular section.
(h) General study in progress since 1926; report completed on transparent conduits of square and rectangular section. Tests made on nine pipe bends.
(i) The tests show that pipe bends may be used as flow meters; merely measuring the difference in pressure between the inside and outside of the bend, preferably at a point 22 1/2° from the beginning of the bend. The experiments revealed that it is possible to have conditions of flow such that the resistance to flow may be very small or unusually large in the same bend, carrying identical quantities of water; the loss in one case being several times that with a different velocity distribution approaching the bend. The amount and distribution of the loss within the bend and on the discharge tangent was also determined for each bend. Usually in pipe bends of circular cross-section the pressure on the inside of the bend is less than on the outside. It is possible to change the shape of the bend so that the pressure on the <u>inside</u> of the bend is greater than on either of the two tangents adjacent to the bend. The report is complete and has been submitted for publication.

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(117) (a) SEDIMENT TRANSPORTING POWER IN OPEN CHANNELS.
(c) Graduate thesis.
(d) Yun-Chang Tu.
(e) Professors S. M. Woodward and F. T. Mavis.
(h) Dissertation complete and ready for publication.
(i) Abstract:

(119) (a) THE HYDRAULICS OF THE MIXTURE OF STREAMS OF WATER AND ITS APPLICATION TO HEAD INCREASERS.
(c) Graduate thesis.
(d) J. Stuart Meyers.
(e) Professor F. T. Mavis.
(f) To investigate phenomenon of pressure recovery and loss attendant upon alteration of velocity distribution in conduits.
(h) Experimental work is complete and a preliminary draft of a dissertation has been prepared.

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(159) (a) TAINTER GATE COEFFICIENTS.
(c) Graduate thesis.
(d) Ross N. Brudenell.
(e) Professors F. T. Mavis and J. W. Howe.
(f) To determine discharge coefficients for various model Tainter gate installations.
(h) Tests have been conducted on a gate closing on a sill. Studies of model dam and tainter gate in progress.

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(207) (a) INVESTIGATION OF EARTH DAMS.
(c) Graduate thesis.
(d) O. J. Baldwin.
(e) Professors F. T. Mavis and C. J. Posey.
(g) An historical study of the art of building earth dams.
(h) Dissertation complete.
(i) Abstract.

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(208) (a) A STUDY OF VORTEX MOTION.
(c) Graduate thesis.
(d) D. F. Djang.
(e) Professor F. T. Mavis.
(f) To determine the effect of vortices on the sediment carrying power of streams.
(g) Problem approached from both mathematical and experimental standpoints.
(h) Exhaustive library study of the hydrodynamics of related problems is essentially complete. Experimental work to be undertaken soon.

.....

(209) (a) A STUDY OF THE MORE RECENT DEVELOPMENTS IN LOCKS.
(c) Graduate thesis.
(d) Arthur Th. Ippen.
(e) Professor F. T. Mavis.
(f) Critical comparison of American and foreign practice in the hydraulic design of locks.

.....

(210) (a) SEEPAGE FLOW THROUGH SAND DAMS.
(c) Graduate thesis.
(d) Lieut. R. L. Jewett.
(e) Professor F. T. Mavis.
(f) To determine the effect of changes in design upon seepage and capillary flow.

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(211) (a) RELATION OF TAIL RACE FLOOR TO BOTTOM OF DRAFT TUBES.
(c) Graduate thesis.
(d) Andreas Luksch.
(e) Professor F. T. Mavis.
(f) To determine effect of location of tail race floor upon draft tube efficiency with and without spiral flow.
(h) This apparatus has been reassembled and equipped with a model draft tube of clear glass. Flow patterns are brought out in cross sections by light reflected from particles of aluminum powder mixed in the water supply.

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(222) (a) TEST OF NEW CREOSOTED WOOD BOX CULVERT 2' x 2' x 32.5'.
(b) Wheeler Lumber Co., Des Moines.
(c) Institute project.
(d) Institute staff.
(e) Professor F. T. Mavis.
(f) To determine (1) roughness factor for culvert; (2) relation between head and discharge for culvert (a) with square entrance, and (b) with entrance rounded to 1 ft. radius on all sides.
(h) Completed.
(i) The discharge through the culvert in the several tests ranged from 4.9 sec.-ft. to 31.2 sec.-ft. The discharge varied as the 0.54 power of the total head. The mean velocity varied as the 0.54 power of the hydraulic gradient. Manning's "n" ranged from 0.0114 to 0.0094; the mean value being 0.0105 with an average error of ± 4%. Hazen-Williams' coefficient C had a mean value of 136 with an average error of ± 1.5%. For the particular culvert with square entrance $Q = 25.5\ h^{0.54}$; with rounded entrance $Q = 29.0\ h^{0.54}$ (14% increased capacity due to rounding entrance). (Q = discharge through culvert, sec.-ft., h = difference between head-water and tail-water elevations, ft.)

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(223) (a) A STUDY OF THE PERFORMANCE OF MODEL RIVER TOWS IN RIVER CURRENTS.
(c) Graduate thesis.
(d) Lieut. William Cassidy.
(e) Professor F. T. Mavis.
(f) To study the performance of a model river towboat (stern-wheeler) in ~~fi~~ moving water and to study the behavior of different barge tows in river currents.

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, La. State Univ.
(c) General scientific research.
(d) T. Smart and assistants.
(e) Dr. Glen N. Cox.
(f) Study of rainfall, runoff and evaporation.
(g) The rainfallis measured in five standard rain 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, La. State Univ.
(c) General scientific research.
(d) Q. A. Hester 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 Dept. 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, La. State Univ.
(c) General scientific research.
(d) E. L. Green.
(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 will soon be installed, as it has been found that the difference between the air and lake temperatures has considerable effect on the evaporation.
(h) Records have been taken since October 1933.

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(226) (a) TILE AND OPEN DITCH DRAINAGE.
(b) Cooperative between the U. S. Dept. of Agriculture and the College of Engineering, La. State Univ.
(c) General scientific research.
(d) B. O. Childs and Glen N. Cox.
(e) B. O. Childs, Houma, La. or Dr. Glen N. Cox.
(f) Study of rainfall, runoff, effectiveness, water-holding power, etc.
(g) Records of rainfall have been kept on a tiled and on an open ditch area for about three years. All runoff is pumped and measured. Watertable readings have been taken at a large number of places daily.

(h) A paper is planned for publication late this year.

(227) (a) FLOW PAST SQUARE CORNERED CONTRACTIONS IN AN OPEN CHANNEL.
(b) Thesis for Master's degree.
(c) General scientific research.
(d) W. L. Daniel, Jr.
(e) Dr. Glen N. Cox.
(f) Study of the coefficient of loss to be used for the above type contraction.
(g) Contractions of different amounts placed in a wood flume and losses measured. Only small velocities possible with the available equipment.
(h) Observations made and thesis presented May, 1934.

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) A plunger at one end of a concrete basin 6 ft. x 20 ft. creates waves which run the length of the basin, break on a sandy beach and strike a vertical sea wall.
(h) Preliminary observations of the sand and water carried over the wall indicate that a possible criterion of the relative effectiveness of various types of sea walls may be judged by measuring the amount of sand carried over the wall in a minute. The effect of the height of wall, and of the height and slope of beach on this amount is now under investigation to determine the conditions for maximum sand movement. Paper entitled "Investigations of Wave Action on Sea Walls by the Use of Models" published in Transactions of the American Geophysical Union, National Research Council, Washington, D. C., June, 1933, pp. 512-516.

(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) Paper to be published by U. S. Waterways Experiment Station as Appendix to collection of papers on bed sediment movement. In hands of printer.

(36) (a) EXPERIMENTAL INVESTIGATION OF THE CAVITATION PHENOMENON.
(b) Massachusetts Institute of Technology.
(c) General scientific research.
(d) E. W. Spannhake, J. K. Vennard, H. N. Halberg.
(e) Above staff.
(f) To study the cavitation phenomenon in all its details, to determine as far as possible in a quantitative way the factors influencing the phenomenon, and to correlate its effect upon metals and various materials with their physical and chemical properties (mainly microstructive, resistance to fatigue, and resistance to corrosion).
(g) Visual observation, observation with high speed movie camera (1000 pictures per second), record of vibrations with sound and vibration recorder, measurements of pressure distributions and maximum pressures, systematic tests on various materials of varying physical and corrosive properties, the relation of the air content of the water and the temperature to cavitation severity. A smalltest unit has been placed in operation to give better control of conditions for endurance tests.
(h) A complete study of cavitation with several consistently varied profiles has been carried out. High-speed motion pictures have been correlated with oscillograms from shock recording devices placed near the point of pitting. It has been found that for the same cavitation length, frequency of shocks varies linearly with velocity, and that for constant velocity, frequency varies inversely with cavitation length. Preliminary work has been started in using the deformation of tubes as a measure of cavitation severity.

(184) (a) EXPERIMENTAL STUDY OF FLOW OVER DAM WITH PIERS.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Master's thesis.
(d) R. Boucher.
(e) Professor K. C. Reynolds.
(f) To study coefficient of discharge for a dam with and without piers of various designs.
(g) The discharge over a dam will be observed without piers and then the effect of various shapes of piers on the flow and on the discharge coefficient will be observed.
(h) Research still under way. To be completed by October 1, 1934.

(185) (a) EXPERIMENTAL STUDY OF THE FLOW OF WATER THROUGH SLUICE GATES.
(b) River Hydraulic Laboratory, M.I.T.
(c) Graduate research for Master's thesis.
(d) F. W. Blaisdell.
(e) Professor K. C. Reynolds.

(f) To study the flow of water through sluice gates by means of models, observing the flow conditions and determining the discharge coefficients.
(g) A model of a spillway section with several sluice gates will be constructed and the flow through them studied for various conditions of operation.
(h) Research still under way. To be completed by October 1, 1934.

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(186) (a) EXPERIMENTAL INVESTIGATION OF THE FLOW CONDITIONS PAST BAFFLE PLATES.
(c) Graduate research for Master's thesis.
(d) A. T. Dempster.
(e) Professor T. R. Camp.
(f) To observe flow conditions after water has passed through various types of baffle plates.
(g) Various types of baffle plates will be set into the 50-cm. wide glass channel. Flow conditions will be observed by means of dyes. The work will be related to water treatment processes in which baffle plates are used.
(h) Research still under way. To be completed by October 1, 1934.

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(187) (a) EXPERIMENTAL INVESTIGATIONS OF FLOW OVER VARIOUS SHAPED DAM CRESTS AS USED IN EASTERN UNITED STATES.
(b) River Hydraulic Laboratory, M.I.T.
(c) Undergraduate thesis.
(d) D. D. Knox.
(e) Professor K. C. Reynolds.
(f) To study effect of changing shape of dam crests on discharge coefficient and on distribution of pressure on downstream face.
(g) Flow over various typical spillway sections will be studied in a glass channel 1 foot wide.
(h) Research complete. Thesis title: "A Study of Different Shaped Spillways with Reference to Their Effect upon the Coefficient of Discharge and upon the Distribution of Pressure on Their Downstream Faces."

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(188) (a) EXPERIMENTAL INVESTIGATION OF ANCHORS.
(b) Graduate research for Master's thesis.
(d) Lt. W. H. Leahy, U. S. N. and Lt. J. M. Farrin, U. S. N.
(e) Prof. H. E. Rossell, Commander, U. S. N.
(f) To study various types of anchors to determine effect of weight, fluke area, shank angle, etc., on holding ability.
(g) A series of commercial anchors of various weights will be investigated in a glass front channel 2 feet wide and 20 feet long. Also other types of anchors will be studied - some by means of models.
(h) Research complete. Thesis title: "Determination of Anchor Holding Power for Model Test". Paper being prepared for publication.

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NEW YORK UNIVERSITY.

(130) (a) DURATION CURVES OF STREAM FLOW.
(c) General scientific research and in connection with theses for Master's degrees.
(d) Thorndike Saville, graduate students, and assistants.
(e) Professor Thorndike Saville.
(f) To determine regional characteristics of stream flow and the applicability of statistical methods to its analysis.
(g) Construction of duration curves of weekly stream flow in terms of mean flow. Deviations of curves from one another as influenced by drainage area and regional characteristics and length of record. Construction of composite curve applicable to a region. Statistical analysis of curves and data.
(h) Study of five North Carolina streams completed and published: "An investigation of the flow duration curves of North Carolina streams," by Thorndike Saville and John D. Watson, Trans. American Geophysical Union, National Research Council, Washington, D. C., 1933, pp. 406-425. Studies in progress covering streams in New Jersey, New York, Tennessee and North Carolina.
(i) The investigation is intended to cover the entire country, and the results will be presented in a series of papers dealing with different regions.

(131) (a) ESTIMATING FLOOD FLOWS.
(b) General scientific research and in connection with theses for Master's degrees.
(d) Thorndike Saville, graduate students, and assistants.
(e) Professor Thorndike Saville.
(f) (g) To compare all the various methods which have been proposed by applying them to streams having long records of flow, and to develop if found desirable, improved methods.
(h) Comparison of several methods to 57 year daily record of Tennessee River in Master's thesis (1933) by H. Thielhelm. Results indicate marked diversity. Subsequent studies indicate period of record has marked influence upon extrapolated values, and that estimates of extreme floods in terms of the mean flood differ for different stations on same streams even when same (30 year) period is used.

(132) (a) RAINFALL, RUNOFF, EVAPORATION, SILTING ON FLAT RIVER, N.C.
(b) N. C. Department of Conservation and Development and City of Durham, N. C.
(c) Project to improve operation of water supply and water power development of City of Durham, and as general research.
(d) Thorndike Saville and Charles E. Ray, Jr.
(e) Professor Thorndike Saville.
(f) To determine hydrological characteristics of Flat River drainage Basin.
(g) Records collected from numerous stream flow and rainfall stations; floating evaporation pan and meteorological instruments. Measurement of silt deposits in reservoir. Forest and vegetation survey. Analysis of data collected.
(h) Records available since 1929. Preliminary report in 1931.

(133) (a) COASTAL EROSION IN NORTH CAROLINA.
(b) North Carolina Department of Conservation and Development and U. S. Beach Erosion Board.
(c) Research in conservation of natural resources.
(d) Thorndike Saville and Charles E. Ray, Jr.
(e) Professor Thorndike Saville.
(f) To determine nature and extent of coastal erosion at selected points and propose control measures.
(g) Historical study of coast from charts. Annual or more frequent surveys by land and air. Studies of sediments, currents, storms, etc. Plans for protecting beaches and inlets.
(h) Report on Wrightsville Beach, 1930. Report on Fort Fisher Beach by U. S. Beach Erosion Board, H. Doc. 204, 72nd Congress, 1st Session, 1931.

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OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE.

(231) (a) CHEMICAL ANALYSES OF THE WATERS OF OKLAHOMA.
(b) State Board of Health and the Industries of the State.
(c) An Engineering Experiment Station Project No. 24.
(d) Professor O. M. Smith, Oklahoma A. & M. College, and H. J. Dorsey, Sanitary Engineer, State Board of Health, Oklahoma City, Oklahoma.
(e) Professor O. M. Smith.
(f) An accurate survey of the chemical constituents of a sufficient number of water supplies of the state to make the work comprehensive and reliable.
(g) Methods used; Standard Method of Water and Sewage Analysis. Scope; an analysis for each municipal supply; analyses of samples taken weekly for one year's duration of water from each of the major streams in the state. Inclusion and compilation of water analyses made by the International Filter Company, the Dearborn Chemical Company, and the Graver Corporation, only when source is positively identified.
(h) This project is about two-thirds completed, 800 analyses now being tabulated and copy prepared.

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(232) (a) THE NEW THEORY OF A BROAD-CRESTED WEIR.
(b) The Oklahoma Engineering Experiment Station, Stillwater, Okla.
(c) Scientific Research.
(d) Research Professor Nicholas M. Oboukhoff.
(e) Research Professor Nicholas M. Oboukhoff.
(h) Completed and published as: "The New Theory of a Broad-Crested Weir, Part I"; Publication No. 19, September, 1933, Engineering Experiment Station. "The New Theory of a Broad-Crested Weir, Part II"; Publication No. 20, January 1934, Engineering Experiment Station.

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OREGON STATE AGRICULTURAL COLLEGE.

(233) (a) TEST OF MODEL ELBOW DRAFT TUBES.
(b) U. S. Engineers, Portland, Oregon District, Maj. C. F. Williams in charge.
(c) Research to investigate flow conditions in elbow draft tubes.
(d) Professor C. A. Mockmore, Oregon State College.
(e) Professor C. A. Mockmore, Oregon State College, Corvallis, Oregon.
(f) Research to find flow conditions in elbow draft tubes of different types and designs.
(g) The tubes are made on a scale of 6 inches equals 23 feet. The tubes are made entirely of pyralin, a transparent material, so that motion pictures are taken of the flow phenomenon, pitot tube measurements are made, and efficiencies of tubes ascertained. Three tubes have been made to date, and two more are planned. In addition to the complete tubes, there have been made five different 90-degree bends in which the flow conditions have been made the object of study.
(h) The tests will not be completed for another year.
(i) Engineers cooperating in the work are, L. F. Harza, Consulting engineer of Chicago, working as consultant on Bonneville Dam; and Mr. H. L. Cooper, engineer working on the powerhouse equipment of the Bonneville Dam which is being built on the Columbia River in Oregon.

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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 & POWER COMPANY.

(228) (a) RESISTANCE OF WELDING MATERIALS TO CAVITATION, HIGH HEAD TESTS AT HOLTWOOD.
(b) Pennsylvania Water & Power Company and Safe Harbor Water Power Corporation.
(c) Commercial research.
(d) J. M. Mousson and assistants.
(e) C. F. Merriam.
(f) Determination of resistance of welding materials to pitting. Selection of best welding rods for repairs to turbines damaged by action of cavitation. Determination of most suitable material for new turbine installatioms.
(g) Exposure of test plates to cavitation formed by a special weir profile under a head of 1100 feet. Materials to be tested include welded, sprayed, cast, forged, and rolled plates of various steels, bronzes and other alloys. Quantitative measurement of severity of damage is to be made by weighing specimens for amount of material lost. All materials are also to be subjected to erosion by a water jet at the laboratories of Westinghouse Electric & Manufacturing Company. Correlation of results of these tests with analysis of chemical and physical properties will be made.
(h) Preliminary tests of apparatus made and about 25 materials tested.

(229) (a) RESISTANCE OF MATERIALS TO CAVITATION, LOW HEAD TESTS AT SAFE HARBOR.
(b) Pennsylvania Water & Power Company and Safe Harbor Water Power Corporation.
(c) Commercial research.
(d) C. F. Merriam and assistants.
(e) C. F. Merriam.
(f) Determination of resistance to pitting of various metals and protective coatings and study of the possible causes of pitting by microscopic examination of damage.
(g) Exposure of test plates to cavitation formed in a rectangular Venturi passage. Materials tested include various steels, cast iron, copper, lead, aluminum, rubber and rubber paints.
(h) Only qualitative differences have been observed; research is being continued.
(i) It has been found that with the head available (about 40 ft), the damaging action is not sufficiently severe for satisfactory testing of high grade steels. This phase of the study is being carried on at Holtwood.

(230) (a) TURBINE MODEL TESTS.
(b) Safe Harbor Water Power Corporation.
(c) Commercial testing.
(d) L. M. Davis and assistants.

(e) C. F. Merriam.
(f) Determination of proper shape of blades for Kaplan turbine to be installed at Safe Harbor, observation of efficiency and cavitation characteristics of the runner.
(g) Routine efficiency and cavitation tests at Holtwood Hydraulic Laboratory. Slight modifications made in shape of blades.
(h) Tests completed and best shape determined. Complete characteristics of final runner being determined.

PRINCETON UNIVERSITY.

(234) (a) PRESSURE ON SQUARE PLATES MOVED THROUGH STILL WATER.
(b) Graduate thesis.
(c) Laboratory research.
(d) Lt. L. E. Seeman, U. S. A.
(e) Professor L. F. Moody.
(f) To determine the total resistance of square flat plates moved normally to the surface through still water, and the variation of the coefficient with depth of submersion, relation of velocity head to size of plate (the "Froude Number") and velocity head to depth below surface. Considerable variation in coefficients reported by previous experimenters created some doubt as to the proper values.
(g) Three plates of 4 inch x 4 inch, 6 inch x 6 inch and 9 inch x 9 inch were mounted on a swinging bell-crank carried in ball bearings on a motor driven car running over a tank 140 ft. long. The force on the plate was measured by a weighing scale, the speed of the car by chronograph.
(h) Curves of variation of coefficient have been plotted, and the depth of submersion necessary to eliminate the effect of this factor is shown for various velocity head ratios, etc.

(235) (a) RESISTANCE OF CIRCULAR PLATES MOVED THROUGH STILL WATER.
(b) (c) Same as previous project (L. E. Seeman, reported above).
(d) Lt. F. G. Saint, U. S. A.
(e) Professor L. F. Moody.
(f) (g) Same as in previous project, reported above, for round flat plates of 4 inch, 6 inch and 9 inch diameters, moved normally to surface.

(236) (a) INVESTIGATION OF FLOW OF WATER OVER TRIANGULAR WEIRS OF DIFFERENT ANGLES.
(b) Graduate Thesis.
(c) Laboratory research.
(d) Lt. L. R. Virak, U. S. A.
(e) Professor L. F. Moody.
(f) This is a continuation of project (143) of earlier report. Object was to amplify data previously obtained, and to coordinate results and to embody them in a general empirical formula applicable to a range of heads and vertex angles.

(g) Flow was measured volumetrically in a tank calibrated by weighing. Previous calibrations were repeated and verified. Additional vertex angles were tested. Flow was diverted from or admitted to measuring tank by means of a swinging chute. Both sharp-edged weirs and those with edge 1/16 inch thick were tested.

(h) A satisfactory formula of simple form was found, applicable over a useful range.

(237) (a) THE LOSS OF HEAD DUE TO GRADUAL ENLARGEMENT IN AN OPEN CHANNEL.

(b) Graduate thesis.

(c) Laboratory research.

(d) M. deK. T. Kennedy.

(e) Professor L. F. Moody.

(f) To find the amount of head lost in an open channel having diverging side walls, forming a transition from a smaller to a larger straight channel. Corresponding losses for closed conduits are known from work of A. H. Gibson and others, but those for open channel flow do not appear to be known. Two diverging side plates were placed in a portion of a glass-sided flume of 12" x 12" section. Two different angles of divergence were tested, and also a sudden enlargement, equivalent to 90 degree divergence. The flow was measured over a weir, in the end of the flume, which was calibrated volumetrically. Attention was directed principally to velocities below the critical.

(h) Curves of loss coefficients and efficiencies of velocity head conversion were obtained and compared with previous results for closed conduits, and with Ostrand's results (previously reported under Project 138) for sudden enlargement following flow under a sluice gate. The losses are found to be somewhat smaller than those in a closed conduit.

(238) (a) EFFICIENCY OF CONICAL DIFFUSERS.

(b) Graduate thesis.

(c) Laboratory research.

(d) R. E. Knell.

(e) Professor L. F. Moody.

(f) To find the variation of efficiency of conversion of velocity head into pressure head, and coefficients of loss, in several homologous sets of enlarging conical tubes of 2 inch, 4 inch and 6 inch throat diameters. The functional relations of efficiency and loss coefficient and the Froude and Reynolds numbers were desired.

(h) The results were presented in a series of curves. For usual velocities to be expected in large sized apparatus, the Reynolds number is of negligible effect, but the Froude number should be considered. Velocities higher than in previous experiments, made with the same tubes, were obtained; and for higher velocities the efficiency and percentage loss were found to reach stable values.

PURDUE UNIVERSITY.

(47) (a) FLOW OF FLUIDS THROUGH CIRCULAR ORIFICES.
(b) Purdue Engineering Experiment Station.
(c) General Scientific Research.
(d) F. W. Greve and J. A. Oakey.
(e) Professor F. W. Greve, School of Civil Engineering, Purdue University, West Lafayette, Indiana.
(f) To determine experimentally the effects of density, surface tension, viscosity, and temperature upon the rate of discharge through small circular orifices.
(g) The liquids under investigation were water, three sucrose solutions of different densities, furnace oil, engine oil, and a mixture of furnace and engine oil. Flow was maintained by a small pumping unit discharging directly into an open orifice tank that was approximately 15 inches in its three dimensions. The nominal diameters of the thin-edge orifices, cut in 1/4 inch brass plates, were 1/4, 3/8, 1/2, 5/8, 3/4, and 7/8 in. respectively. The discharge from each orifice was directed into either a weighing tank or into the reservoir which supplied the pump. The discharge was weighed to within one ounce. A telescope and micrometer scale attached to a piezometer of 2-inch diameter permitted readings of the head to be noted to within 1/1000 in. Time was indicated on a stopwatch. The tests were made at room temperature. An Engler viscometer, a Genco-de Novay tensiometer, and a Jolly balance were employed to measure the respective viscosities, surface tensions, and densities.
(h) Installation has been completed of the larger and more extensive equipment. The investigation will be resumed in the fall if funds will permit.

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STANFORD UNIVERSITY.

(239) (a) CALIBRATION OF HYDRAULIC ROUGHNESS.
(b) Self.
(c) Research.
(d) John Hedberg.
(e) John Hedberg.
(f) To establish an absolute scale of roughness for use in establishing similarity with models.
(g) Models to various scales are being built of open channel sections which are to be lined with sand paper of various grades and with material of standard smoothnesses. These models will be tested at various slopes and the results correlated with past experiments.
(h) The literature is being searched and the models designed.

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CARNEGIE INSTITUTE OF TECHNOLOGY.

(240) (a) EXPERIMENTAL AND ANALYTICAL STUDY OF THE HYDRAULICS OF FLOOD-WAVE MOVEMENTS IN RIVERS.
(b) Carnegie Institute of Technology.
(c) Thesis for Master's degree.
(d) I. L. Wissmiller and M. Sky, with cooperation of Prof. H. A. Thomas and engineers furnished by the Civil Works Administration.
(e) Prof. H. A. Thomas.
(f) Pure research.
(g) Measurement of hydrographs of flood waves at successive sections in a laboratory channel, and comparison with hydrographs computed by analytical methods.
(h) Thesis completed June, 1934. Project to be continued next year.
(i) Data from this project are being published in an Engineering Bulletin of Carnegie Institute of Technology on, "The Hydraulics of Flood-Wave Movements in Rivers" by H. A. Thomas. This bulletin is now in the hands of the printer.

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(241) (a) EXPERIMENTAL STUDY OF THE HYDRAULICS OF CUSHION POOLS FOR FREE-OVERFALL DAMS.
(b) Carnegie Institute of Technology.
(c) Thesis for Master's Degree.
(d) W. S. Walker, and W. R. Vivien.
(e) Prof. H. A. Thomas.
(f) Pure research.
(g) Laboratory investigation of effect of cushion pools of various depths in dissipating the energy of a jet of water from a weir.
(h) Experimental work completed June, 1934.
(i) Special form of Pitot tube devised to register maximum velocities in turbulent water of cushion pool.

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(242) (a) INVESTIGATION OF METHODS OF MINIMIZING THE CROSS CURRENTS AT THE UPSTREAM ENTRANCE OF LOCKS IN NAVIGABLE RIVERS. (Work done in connection with a model study to determine methods of eliminating dangerous cross currents in the Monongahela River at Lock and Dam No. 4, near Charleroi, Pa.)
(b) U. S. War Department.
(c) Laboratory investigation on a river model.
(d) E. P. Shuleen and H. A. Thomas.
(e) Prof. H. A. Thomas.
(f) Improvement of navigation on rivers.
(g) Effects of various structures and dredging projects in modifying direction and strength of river currents were studied in model by photographing surface floats and model barges.
(h) Investigation completed May, 1934.
(i) Research features of project included: (1) a study of methods of using model barges to show effect of river currents on moving vessels

(242) (i) - continued -
(2) an experimental correlation between actual velocities of surface floats in model and prototype, and (3) development of methods of current control applicable for general use in the design of navigation structures on rivers.

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(243) (a) MODEL STUDY OF SPILLWAY ACTION AT PROPOSED DAM ON TYGART RIVER AT GRAFTON, W. VA.
(b) U. S. War Department.
(c) Laboratory investigation on a model dam.
(d) E. P. Schuleen and H. A. Thomas.
(e) Prof. H. A. Thomas.
(f) Improvement of design of structure for river regulation and flood control.
(g) Model studies of energy dissipation of discharge from flood gates, to obtain best design for deflecting apron at foot of this spillway and similar spillways.
(h) Model now under construction.
(i) Height of free fall in prototype is 215 feet. Investigation includes study of the effects of large conduits discharging through dam near toe of spillway.

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(244) (a) MODEL STUDY TO DETERMINE METHODS OF CONTROLLING CURRENTS IN ALLEGHENY RIVER NEAR PROPOSED LOCK AND DAM NO. 9, NEAR EAST BRADY, PA.
(b) U. S. War Department.
(c) Laboratory investigation on a river model.
(d) E. P. Schuleen and H. A. Thomas.
(e) Prof. H. A. Thomas.
(f) Improvement of river navigation.
(g) Investigation will study effect of various structures and dredging operation intended to control the direction and strength of the river currents in the vicinity of the proposed lock.
(h) Model now under construction.
(i) This is a fixed-bed model, having a natural scale of 1:180.

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AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

(245) (a) INVESTIGATION OF RAINFALL AND RUNOFF ON VARIOUS WATERSHEDS IN TEXAS.
(b) General information through scientific research and thesis for Master's degree.
(d) T. A. Munson and graduate students.
(e) Professor T. A. Munson.
(f) To determine hydrological characteristics of individual streams, and to determine the effects of seasonal conditions and geographical location on these characteristics. Runoff relations to be determined for individual storms and for longer periods.
(g) Rainfall and stream flow records used where these have been kept for a reasonably long time.
(h) Investigation partially completed on several watersheds. Preliminary report in progress.

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(246) (a) INVESTIGATION OF FLOOD CONTROL PLANS FOR TEXAS STREAMS.
(b) General information through scientific research and thesis for Master's degree.
(d) T. A. Munson and graduate students.
(e) Professor T. A. Munson.
(f) To determine the apparent effect of several methods on the control and regulation of the flow of various streams in Texas.
(g) Stream flow records and topography used where these data are available.
(h) Collection of data now in progress.

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(247) (a) INVESTIGATION OF METHODS IN GENERAL USE TO DETERMINE RUNOFF FROM WATERSHED AREAS.
(b) Committee on Runoff Formulae, Texas Section, American Society of Civil Engineers.
(c) Scientific research investigation.
(d) T. A. Munson.
(f) To determine formulae and methods now in use for determining flood flow as to amount and intensities as a preliminary step to further research and outside fieldwork by the committee.
(g) Research into literature and correspondence.
(h) Reported May 1933, and published April, 1934, in The Texas Engineer.

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U. S. GEOLOGICAL SURVEY.

(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 material 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 water through a given porous material varies directly as the hydraulic gradient.
(g) The present investigation was conducted with a U-shaped non-discharging type of apparatus having a column of material two meters in length. An initial hydraulic gradient is established by adjusting the water levels so that the level in one column is slightly higher than in the other. Observations are then made on the rate of change of the water levels.
(h) The results obtained in these tests confirm Darcy's law for hydraulic gradients of one foot per mile and indicate that the law probably holds to at least half a foot per mile. There was a definite movement of water for gradients as low as 0.05 foot per mile. These results were presented in a paper at the fifteenth annual meeting of the American Geophysical Union, Section of Hydrology, 1934, and will be published in the reports and papers of the Section of Hydrology.

(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) 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 as a part of a cooperative investigation of the ground-water resources of the Platte Valley to determine the practicability of Thiem's method for determining permeability of water-bearing materials. Two additional pumping tests were made during 1933, one at Gothenburg and the other at Kearney, using a modified method of procedure that was determined by the test near Grand Island to give the most accurate results. See Bulletin II-1 for further details.
(i) The results of the pumping tests near Grand Island will be published by the United States Geological Survey as Contribution to the Hydrology of the United States and the results of the other two tests will be published ultimately in a report on the ground-water resources of the Platte Valley.

(245) (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 this study is to determine the effect of the size of intake openings of well screens upon 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, Nebraska. 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 observations 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) Preliminary work necessary for selecting a suitable site for the tests has been done but actual tests have not been made.

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U. S. BUREAU OF AGRICULTURAL ENGINEERING.

(192) (a) FLOW OF WATER IN IRRIGATION CHANNELS.
(b) Division of Irrigation, Bureau of Agricultural Engineering, U. S. Department of Agriculture.
(c) Conducted as a major project of Division of Irrigation with informal cooperation with U. S. Bureau of Reclamation, irrigation enterprises, hydro-electric companies and municipal water departments.
(d) Fred C. Scobey, Assistance as needed.
(e) Fred C. Scobey, Senior Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering, Berkeley, California.
(f) Revision, U.S.D.A. Bull. 194, "The Flow of Water in Irrigation Channels." (Experimental determinations of the value of 'n' for different kinds of channels and the preparation of estimation charts; originally published in 1915). Corresponding with interested engineers all over the world; receive contributions in the way of capacity tests as made by their organizations.

All elements of hydraulic design of open channels are matters of office and field dimensions except the element evaluating the retardation of flow due to the hydraulic friction between the moving prism of water and the surface of the containing channel

plus the internal friction set up by undulations of surface, constructional irregularities and so on, over and above the asperity of local surface. This element is wholly empirical. It has a direct influence on the carrying capacity and hence on the size and the cost of any water conduit. For the many combinations of original and acquired surfaces and conditions a great many field experiments with precision apparatus are necessary. "Flow of water in Irrigation Channels" was published in 1915. Since then many new tests on other materials of construction and newer variations of old materials of construction have been made and may be assembled and coordinated into related data.

(g) Laboratory tests are believed worthless in comparison with well-conducted field measurements for the reason that similitude of surfaces cannot be expanded from model to prototype. Commercial surfaces ~~cannot be~~ in concrete, enamels and some paints are of such order that no known surface has been developed which will be a MODEL of the original, in terms of asperity of surface.

Complete field tests, developing all the necessary details of local elements to be expanded to average values over a long reach of conduit, are made in channels of all variations of surface that can be located under conditions where experimentation is feasible. These tests are made throughout a wide range of locality, in the whole irrigated West. They are made in all sizes of channel from small lateral ditches to the largest of canals. Farmers are not interested in small ditches alone. Irrigation districts, managed by farmer boards of direction, operate some of the largest canals in the country.

The United States Bureau of Reclamation has agreed to allow access to their files of experimentation made along the lines laid down in our Bulletin 194 and ordered shortly after that publication appeared.

(h) Since the last report much library work has been accomplished and also a field trip that resulted in securing a large amount of data, including tests on the additional capacity developed in Owen River Aqueduct of the City of Los Angeles. At a cost of less than half a million dollars the capacity of a 250 mile aqueduct was increased from about 400 second-feet to 500 second feet (by operative test at this capacity). The original cost of this aqueduct was some $23,000,000 so the 25 percent increase in capacity was attained at a relatively low unit cost. The increase was obtained solely by improvement of the interior surface -- largely that of the invert or bottom. Actually the aqueduct was made smaller in sectional area but with a larger capacity. Photographs of original and attained surfaces over a long reach of channel were obtained.

In Denver, access was allowed to records of the U. S. Bureau of Reclamation, where much information is on file concerning capacity tests by their own organization and also in foreign literature. Some of these foreign data were unknown to the writer.

It is expected that about 500 observations will be used in the revised edition of Bulletin 194, where but 269 were offered in the original edition published 20 years ago.

(246) (a) SAND AND SILT REMOVAL LABORATORY. P.W.A. PROJECT NO. F.P. 99.

(b) This project is conducted for the Bureau of Agricultural Engineering, U. S. Department of Agriculture, and the Bureau of Reclamation, U. S. Department of the Interior.

(c) The investigations are being conducted cooperatively between the two above mentioned bureaus.

(d) R. L. Parshall, Senior Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering, in charge of the investigations; Carl Rohwer, Associate Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering, and E. W. Lane, Research Engineer, Bureau of Reclamation, as collaborators.

(f) The purpose of this work is to test the vortex tube and grating types of sand traps, previously investigated at the Bellvue hydraulic laboratory near Fort Collins, Colorado, with the view of applying these devices on an enlarged scale in the attempt to remove fine sand and silt from Colorado River water.

(g) There has been built at the Rositas Dam, on the Alamo River, Imperial Valley, California, an experimental framed structure 100 feet long, supporting on bents at 4-foot centers, a rectangular flume ~~being~~ section 10 feet wide and 8 feet deep, the floor line of the flume being 8 feet above the foundation sills. Suitably arranged beneath this flume is a hopper section, with 45 degree side slopes, extending the full length of the structure. The capacity of this laboratory is 100 second-feet of water. Three 6-inch constant diameter vortex tubes have been placed in the flume, near the upper end, and outletted in submergence chambers arranged on the outside face of the flume wall. The upstream tube is set with its axis at 60 degrees to the axis of the flume, the middle tube at 45 degrees and the downstream one at 30 degrees. The lip or top edge of the tubes are level transversely and all have the same elevation above the floor line of the structure. The discharge from each tube is delivered through a short 6-inch vertical pipe having a conical reducing section at the lower end forming a jet having a diameter of 3 inches. Sampling apparatus is provided to determine the amount of load extracted and the rate of flow calculated from the pressure head on the jet, these jet flows having been calibrated by means of a 30 degree notch weir. The discharge from the lower end of flume is sampled by special equipment and the rate of flow determined by a calibrated weir having no end contraction.

The grating type of sand trap is relatively new. This device consists of a large number of metal vanes mounted in a convenient sized frame and set in the floor of the channel so that the top edge or lip of the vanes agrees with the floor line of the flume. The top edge of each individual vane is turned downstream on a radius of curvature of about one inch with the parallel vanes set normal to the direction of flow. The space between vanes ranges

from about 1-3/8 to 2-1/2 inches. For the grating installation made at this laboratory the vanes are formed from strips of No. 26 gage galvanized sheet metal 6 inches wide and 28-1/4 inches long. The grating equipment will occupy the full width of the 10-foot flume and a length of 88 feet. Eleven 4-inch outlet tubes from the bottom of the hopper will serve as the means of carrying out the trapped material. Suitable sampling equipment is provided for sampling the effluent at the several points along the axis of this equipment as well as ascertaining the gradation of fineness of the material progressively along the length of the grating. Orifices ranging from 1 to 3 inches in diameter are used to measure the rate of discharge from the hoppers.

(h) Several tests have been made on the vortex tubes for discharge through the flume ranging from 10 to 50 second-feet. The grating type of sand trap will be installed after completing the series of tests on the vortex tubes.

U. S. BUREAU OF RECLAMATION.

(193) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE NORRIS AND WHEELER DAMS, TENNESSEE RIVER.
(b) Tennessee Valley Authority.
(d) U. S. Bureau of Reclamation Staff.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) For design of spillways and related works.
(g) Model 1:72 scale of Norris Dam spillway and 1:36 of Wheeler Dam spillway tested to develop best form of energy dissipation.
(h) Tests under way.

(248) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE SPILLWAY OF THE GRAND COULEE DAM, Columbia River.
(b) U. S. Bureau of Reclamation.
(d) U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) To develop best method of preventing scour below dam.
(g) Model of 1:184 scale tested, to be followed by models of 1:120, 1:40 and 1:15 scales.
(h) Tests under way.

(249) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE SPILLWAY OF THE HYRUM DAM.
(b) U. S. Bureau of Reclamation.
(d) U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) To develop best form of spillway applicable to local conditions.
(g) Model of chute type spillway with stilling pool on scale of 1:48 used to develop best form.
(h) Study completed.
(i) Report available for loan.

(250) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE SPILLWAY OF THE AGENCY VALLEY DAM.
(b) U. S. Bureau of Reclamation.
(d) U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) To develop best form of spillway applicable to local conditions.
(g) Model of chute type spillway with stilling pool on scale of 1:30 used to develop best form.
(h) Study completed.
(i) Report available for loan about August 1, 1934.

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(251) (a) HYDRAULIC MODEL EXPERIMENTS FOR THE DESIGN OF THE SPILLWAY OF THE PINE VIEW DAM.
(b) U. S. Bureau of Reclamation.
(d) U. S. Bureau of Reclamation.
(e) U. S. Bureau of Reclamation, Denver, Colorado.
(f) To develop best form of spillway applicable to local conditions.
(g) Model of chute type of spillway with stilling pool on scale of 1:30 used to develop best form.
(h) Study completed.
(i) Report available for loan about August 1, 1934.

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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 Lieut. H. D. Vogel, Director of the Station.
(e) The Director, U. S. Waterways Experiment Station.
(f) Study of suspended load carried by the Mississippi River, Atchafalaya River and their tributaries - silting of reservoirs.
(g) Field and laboratory investigations, analysis of samples, compilation of curves.
(h) Studies for 1930-31 reported on; other studies still in progress.
(i) See list of Publications, U. S. Waterways Experiment Station (Page 46 of this Bulletin.)

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(52) (a) SOIL INVESTIGATIONS.
(b) Navigable Waterways, U. S. A.
(d) (d) and (e) See (51).
(f) Study physical properties of soils, especially as they pertain to levee construction.
(g) Mechanical analyses, Atterberg Limits, microscopic examination, specific gravity determination, 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 levees 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) First phases of experimental work complete. Report being prepared.

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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) Initial phases of experimental work complete. Tests are to be continued using artificial mixtures.
(i) Results will be contained in Paper 17, now being prepared for publication.

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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.
(g) Movable bed model from Mile 181.4 to 204.0 below Cairo. Model scales are 1:600 horizontal and 1:150 vertical.
(h) Experiment completed.
(i) Report included in Technical Memoranda Nos. 29-2, 3, 4, 5, 6, 7.U.S.W.E.

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(91) (a) MISSISSIPPI RIVER MODEL NO. 4 - INCLUDING THE RIVER FROM MILE 560 TO MILE 655 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving the river between the limits specified in (a).
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(92) (a) MISSISSIPPI RIVER MODEL NO. 5 - INCLUDING THE RIVER FROM MILE 650 to MILE 740 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving the river within the limits specified in (a).
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(148) (a) WINYAH BAY, SOUTH CAROLINA COAST.
(b) Division Engineer, South Atlantic Division.
(c) (d) and (e) See (51).
(f) Study means of increasing navigable depths in the harbor.
(g) Tidal Study. Model scales 1 to 500 horizontal and 1 to 100 vertical. Using a reversing flow of water through model to simulate tidal fluctuations, and sawdust moving over a concrete bed to simulate movement of bed material, the effect of different systems of training walls and dredge cuts, is tested.
(h) Completed.
(i) Results of experiment included in Technical Memoranda Nos. 37-1, 2, 3, 4 and final report rendered to the District Engineer, U. S. Engineer Office, Charleston, S. C.

(150) (a) ISLAND NO. 20, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study of effects of regulating works on channel location and depths.
(g) Movable bed model from Mile 118 to Mile 135 below Cairo-Model scales; 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.
(i) Partial report included in Technical Memorandum No. 43-1, U.S.W.E.S.

(151) (a) ATCHAFALAYA RIVER BASIN.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study of the effects of changes in the regimen of the Effluents of the Atchafalaya.
(g) Model scales 1 to 1500 and 1 to 100; fixed bed.
(h) In progress.

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(152) (a) ROBINSON C RUSOE ISLAND, MISSISSIPPI RIVER.
(b) District Engineer, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) Study of proposed regulating works.
(g) Movable bed model from Mile 208 to Mile 250.9 below Cairo. Model scales; 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.
(i) Partial report included in Technical Memoranda Nos. 44-1, 2, 3, U. S. W. E. S.

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(153) (a) ARTICULATED CONCRETE MATTRESS STUDY.
(b) 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) In progress.

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(163) (a) MISSISSIPPI RIVER MODEL NO. 1 - INCLUDING THE RIVER FROM MILE 390 to MILE 810 BELOW CAIRO, AND THE ATCHAFALAYA RIVER TO MILE 35 BELOW BARBRE LANDING.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems affecting water surface elevations within the limits specified in (a).
(g) Model scales 1 to 2400 and 1 to 120; fixed bed.
(h) In progress.

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(165) (a) MISSISSIPPI RIVER BED MATERIAL SURVEY.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Mechanical analyses of samples taken from bed of Mississippi River, half-mile intervals, Cairo to Gulf of Mexico; also includes the Atchafalaya River survey.
(g) Special trap used for procuring samples. Mechanical and Hydrometer analyses were made, also specific gravity tests and microscopic examinations of all samples.
(h) Analyses of samples from Mississippi, Atchafalaya, Red, Black, and Old Rivers completed. Samples now being taken from Arkansas, White, Ouachita, Yazoo, St, Francis, Ohio, Tennessee, Cumberland, Wabash, Missouri, and Illinois Rivers.

(i) Paper 17 (now being prepared) includes results of analyses of Mississippi, Atchafalaya, Red, Black, and Old River Samples.

(166) (a) U. S. INTRA-COASTAL WATERWAYS CROSSING, WITH BRAZOS RIVER, NEAR FREEPORT, TEXAS.
(b) U. S. District Engineer, Galveston, Texas.
(c) (d) and (e) See (51).
(f) Study to eliminate silting of canal by Brazos River.
(g) Scale 1 to 200 horizontal and 1 to 40 vertical. A silt-laden discharge of water will simulate the Brazos River, and different improvement schemes will be tested.
(h) In progress.

(167) (a) ST. JOHNS RIVER, JACKSONVILLE, FLORIDA.
(b) U. S. District Engineer, Jacksonville, Florida.
(c) (d) and (e) See (51).
(f) Study to determine effects of blocking off one entrance to tidal area in order to improve channel conditions in other entrance; also to determine the effect of a cut-off in the main channel.
(g) Tidal Model. Scale of model 1 to 1000 horizontal and 1 to 50. A reversible flow of water simulates tidal fluctuations; a movable bed is employed.
(h) In progress.

(168) (a) HEAD OF PASSES, MISSISSIPPI RIVER.
(b) U. S. District Engineer, 1st New Orleans 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 1:600 and 1:150.
(h) Experiment in progress.
(i) Partial report included in Technical Memorandum No. 46-1 U.S.W.E.S.

(169) (a) SOUTHWEST PASS, MISSISSIPPI RIVER.
(b) District Engineer, 1st New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods of improving channel conditions in Southwest Pass.
(g) Movable bed model from Mile 8.8 below Head of Passes to Gulf of Mexico. Model scales: 1:1000 horizontal and 1:125 vertical.
(h) Experiment completed.
(i) Report included in Technical Memoranda Nos. 45-1, 2, 3, U.S.W.E.S.

(170) (a) MISSISSIPPI RIVER MODEL NO. 2 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 370 TO MILE 445 BELOW CAIRO, AND 60 MILES OF THE ARKANSAS RIVER, AND 20 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 the rivers upstream from mouth.
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(198) (a) FITLER BEND, MISSISSIPPI RIVER.
(b) Mississippi River Commission.
(c) (d) and (e) See (51) Report I-3, Oct. 1, 1933.
(f) Navigation study.
(g) Model scales 1 to 500 and 1 to 150 movable bed.
(h) In progress.

(199) (a) ARANSAS PASS, GULF OF MEXICO.
(b) The Division Engineer, Gulf of Mexico Division.
(c) (d) and (e) See (51).
(f) To determine improvement works for navigation channel through pass.
(g) Tidal study. Scale of model, 1 to 500 horizontal and 1 to 100 vertical. A reversible flow of water simulating tidal action, and a movable sand bed, is used to test proposed improvement works.
(h) In progress.

(200) (a) FORT CHARTRES, MISSISSIPPI RIVER.
(b) District Engineer, St. Louis, Mo.
(c) (d) and (e) See (51).
(f) Develop dike system to improve depths over crossings in vicinity of Ste. Genevieve.
(g) Movable bed model from Mile 137 to Mile 112 above Cairo. Model scales; 1:1000 horizontal and 1:125 vertical.
(h) Experiment in progress.
(i) This experiment supplements previous study of the river between Miles 137 and 120 below Cairo. (See (83) Report No. I-3, Oct. 1, 1933.)

(201) (a) TETRAHEDRAL BLOCK REVETMENT.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Study to determine effect of slope of bank on stability of Tetrahedral Blocks.
(g) Installation of full size tetrahedral blocks on the banks of the creek from which Station water supplies is derived; observation of effects of floods will be made.
(h) In progress.

(202) (a) INVESTIGATION OF MATERIAL FOR CORE OF FORT PECK DAM.
(b) Fort Peck, Missouri District.
(c) (d) and (e) See (51).
(f) Determine physical properties of soil that may be used for core material of hydraulic fill dam.
(g) Separation of coarse and fine particles into groups for special study of such.
1. Removed particles coarser than fine sand (0.20 m.m.)
2. Removed particles coarser than very fine sand (0.10 m.m.)
3. Removed particles coarser than very fine silt (0.01 m.m.)
4. Removed particles coarser than very fine sand and finer than very fine silt and clay.
(h) Completed.
(i) Report rendered to the District Engineer, U. S. Engineer Office, Fort Peck, Montana.

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(252) (a) SOUTH PASS, MISSISSIPPI RIVER.
(b) U. S. District Engineer, 1st New Orleans District, New Orleans, La.
(c) (d) and (e) See (51).
(f) Determine methods for eliminating scour below sill near entrance to pass.
(g) Movable bed model extending from entrance to pass to 1.5 miles below Head of Passes. Model scales: 1:300 horizontal and 1:75 vertical.
(h) Experiment in progress.
(i) This model study is an auxiliary to the Head of Passes study.

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(253) (a) CAT ISLAND, MISSISSIPPI RIVER.
(b) U. S. District Engineer, Memphis, Tenn.
(c) (d) and (e) See (51).
(f) Study of proposed regulating works.
(g) Movable bed model from Mile 241.2 to Mile 275.0 below Cairo. Model scales; 1:1000 horizontal and 1:125 vertical.
(h) Experiment in initial stage.

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(254) (a) SAVANNAH RIVER, GEORGIA.
(b) U. S. District Engineer, Savannah, Ga.
(c) (d) and (e) See (51).
(f) Determine methods of improving navigation conditions in Savannah River.
(g) Movable bed model from Mile 188 to Mile 178.5 above Savannah. Model scales; 1:200 horizontal and 1:30 vertical.
(h) Experiment in progress.

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(255) (a) CONEY ISLAND DIKE MODEL.
(b) District Engineer, Cincinnati, Ohio.
(c) (d) and (e) See (51).
(f) Determine method of improving the navigability of the Ohio River below Dam 36.
(g) Model scales; 1:250 and 1 to ____; movable bed.
(h) Model being designed.

(256) (a) MISSISSIPPI RIVER MODEL NO. 3 - INCLUDING THE MISSISSIPPI RIVER FROM MILE 486 TO MILE 518 BELOW CAIRO.
(b) Mississippi River Commission.
(c) (d) and (e) See (51).
(f) Miscellaneous problems involving the river within the limits specified in (a).
(g) Model scales 1 to 1000 and 1 to 100; movable bed.
(h) In progress.

(257) (a) DIRECTIONAL 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.
(g) Outdoor flume 50 feet x 15 feet, with movable bed, being used.
(h) In progress.

U. S. - NATIONAL BUREAU OF STANDARDS.

(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, National 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

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) An installation of 6" pipe, which for a part of the work will be of glass, has been made for continuing the study, and several runs have been made. Work has been suspended temporarily on this project.

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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, G. E. Golden.
(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 will be made on pipe of various materials and various degrees of roughness; on sizes up to 20 inch diameter if funds permit; on bends of various central angles and on miter bends and cast fittings. Transparent pipes and bends will be used to investigate the nature of flow.
(h) Preliminary tests have been made on a line of 4 inch steel tubing with special joints and a commercial, seamless, 90-degree bend. Changes in the apparatus were found necessary. These have been completed and experiments resumed. It is planned to test 9 commercial 90-degree bends with radii varying from 6 inches to 16 feet. Tests have been completed on bends of 3/8 inch brass tubing having 5, 10, 20, 30, 45, 60, 90 and 120-degree central angles and constant arc length of 2 meters. Tests on bends of 150 and 180 degree central angles are in progress.

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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, National 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 cfs giving a head of 47 feet on two venturi meters (one 4-inch and one 8-inch) installed in parallel was provided for the work. From the venturi meters a 12-inch pipe extended downward vertically to a depth of 28 feet and connected through a return bend with the well casings in which the calibrations were made.

(h) The experimental work was completed in January, 1934, and the report was submitted to the U. S. Geological Survey in June, 1934. One 15-inch meter was calibrated in 2 and 3-inch casings. The characteristics of three 3-inch meters in 3-inch casings were investigated, and these meters were calibrated against the mean velocity in 4, 6, 8 and 12-inch casings for velocities ranging from 0.1 to 12.5 fps. It was discovered that the calibration of these meters could be interpolated and extrapolated for other sizes of casings, up to 15-inch diameters, from the data obtained in 3, 4, 6, 8 and 12-inch casings with approximately the same accuracy as was obtained by direct calibration in the casings.

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(129) (a) TRANSPORTATION OF SEDIMENT, COLORADO RIVER.
(b) U. S. Bureau of Reclamation.
(c) General research.
(d) C. A. Wright, B. H. Monish and C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) To determine the relative scouring action on a bed of fine sand of clear water and of water containing a considerable amount of fine silt and clay.
(g) A tilting flume 40 ft. long, 20 inches wide and 17 inches high has been built for this work. The circulatory system is entirely independent of the other systems in the laboratory, so that muddy water can be used without requiring too large quantities of clay and silt. A sand trap which will catch all but the finest sand will be mounted at the lower end of the flume. The return channel is designed to act as a settling basin, so that the fine sand will be removed from the water, while the clay will remain in suspension and pass over the weir at the exit end. Water profiles will be measured with a bank of manometers, and hook gage wells will be connected to the ends of the test section for more accurate measurements. Determinations of critical tractive force and amount of material scoured will be made, first with clear water, then with clay-laden water. The sands used for the bed will be relatively fine, and the final tests will be made with bed sand from the Colorado River. In some of the tests the sand bed will be laid down in water containing a considerable amount of silt or clay. A supply of five grades of fine sand, including a quantity from the Colorado River at Yuma, and three grades of clay have been obtained. A mechanical sieving machine with 10 sieves, a gas-fired sand-dryer of seven cubic feet capacity and a large electric oven have also been obtained. For reading the elevations of the water surface, a point gage has been mounted to slide upon brass rails on top of the flume.

A sediment laboratory room has been built and is being equipped with apparatus for determining particle sizes for the clays and sands, as well as for measurements of concentration, specific gravity and grain shapes. A balance, a set of 3 inch sieves/have been obtained as well as an elutriator to separate particles 5 microns and smaller in size. It is planned later to obtain drying apparatus for samples, a turbidimeter and a microscope. A viscometer for

determining the kinematic viscosity of the water has been constructed.

(h) The measuring weir has been calibrated, and experiments have been made upon a smooth sand bed laid down in water in the flume without adding material during the experiments. The flume was set to a given slope and the slope of the water surface maintained parallel to the bed for various depths. The type of movement of the bed sand, and the occurrence of riffles were observed, and the sand caught in the trap was measured. Slopes of 0.0002, 0.0004 and 0.001 were used, and the depths were varied from 0.05 to 0.5 feet. The results are being studied to show relations between the tractive force and bed load discharged, the mean velocity and bed load, critical tractive force and type of bed movement, tractive force and riffle formation in order to determine a criterion for the amount of scouring. No conclusive results are yet available.

(258) (a) STUDY OF DIVISORS FOR SOIL EROSION INVESTIGATION.
(b) U. S. Soil Erosion Service.
(c) Data for calibration and for design.
(d) H. L. Cook, D. A. Parsons.
(e) The Director, U. S. Department of the Interior, Soil Erosion Service.
(f) To determine the relative accuracy of divisors now in use; and to develop improved form of divisor, if necessary.
(g) Tests will be made with clear water and water containing various concentrations of soil and debris to determine accuracy and relative advantages of divisors now in use. If these tests demonstrate the necessity, an attempt will be made to develop an improved divisor.
(h) Most of the experimental apparatus has been procured and erected. Tests will be started shortly. The sediment laboratory referred to under (129).(g), will be used in connection with this project also.

(National Bureau of Standards projects continued to page 43.)

U. S. CORPS OF ENGINEERS.

(259) (a) MODEL STUDIES OF BONNEVILLE DAM, A NAVIGATION AND POWER PROJECT ON COLUMBIA RIVER.
(b) U. S. Engineer Corps, Portland District - Major C. F. Williams, District Engineer.
(c) A research problem to furnish data for design and subsequent operation of the Bonneville Project.
(d) J. C. Stevens, Consulting Engineer, A. J. Gilardi, Engineer in direct charge of laboratory work, C. I. Grimm, Head Engineer in charge of Bonneville Dam Project.
(e) U. S. District Engineer, Portland, Oregon.
(f) To determine (1) the best profile of the dam, aprons and baffles to hold the head water at predetermined levels for power and navigation purposes and also to safely pass floods of over a million cfs, and (2) the best method of operating the structures

so as to give the maximum power output while maintaining adequate navigation conditions and preventing damage to upstream property.

(g) An outdoor laboratory has been constructed at Government Moorings in the City of Portland. Water is pumoed from Willamette River and circulated through the models.
Three models are being used -
No. 1. A 1:36 scale model of 180 feet of 900 feet of crest length of the dam. Model is of 3 of the 18 gates to be installed.
No. 2. A 1:100 scale model of the entire dam with its 18 crest gates, the power house, ship locks, fishways, and approach and retreat channels. Object to determine the behavior of entire assembly.
No. 3. A 1:100 scale model of 4-3/4 miles of Columbia River, including the model No. 2 above and extending upstream to the head of Cascade Rapids. Object to check calculated backwater conditions above the dam and also to forecast the effect of certain channel improvements in reducing flood heights.

(h) Model No. 1 is completed and tests are under way. Model No. 2 is under construction.

(i) The work is being paid from the PWA appropriation for the Bonneville Dam.

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THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA.

(260) (a) PUMP TESTING LABORATORY FOR THE METROPOLITAN WATER DISTRICT AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY.

(b) The Metropolitan Water District of Southern California.

(c) Conducted as part of the engineering research and design of the pumping plants for the Colorado River aqueduct.

(d) Dr. Th. von Karman, assisted by members of the staff of the California Institute of Technology, and engineers of the Metropolitan Water District.

(e) General Manager and Chief Engineer of The Metropolitan Water District of Southern California.

(f) To assist in determining the selection of pumping equipment for the pumping plants of the Colorado River aqueduct.

(g) Tests are to be conducted on model pumps of various characteristics to determine their efficiency and the various factors affecting performance. Investigation will be made of the internal velocity conditions in the pumps. The performance of pumps will be investigated during transient conditions of starting and stopping.

(h) It is expected that actual testing of pumps will commence about August 1, 1934.

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WEST VIRGINIA UNIVERSITY.

(49) (a) SEDIMENTATION OF SMALL PARTICLES SUSPENDED IN WATER.
(b) West Virginia University.
(c) Graduate work for advanced degree.
(d) H. W. Speiden and L. V. Carpenter.
(e) L. F. Carpenter, College of Engineering, West Virginia University.
(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.
(i) Thesis available for loan. See Bulletin II-1, page 51, for progress report. A paper entitled "Notes on Sedimentation" will be published sometime during the summer.

(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, West Virginia.
(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) This investigation is being continued.
(i) A progress report will be available in the autumn.

WORCESTER POLYTECHNIC INSTITUTE.

(203) (a) HOW WATER FLOWS IN A PIPE LINE.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. M. Allen and L. J. Hooper.
(e) C. M. Allen.
(f) General information.
(g) By injecting a small jet of salt solution in various points in the line and by a system of individual electrodes for determining the dispersion or spread due to turbulence.
(h) Presented at A. S. M. E. meeting in New York, December 5, 1933. To appear in A. S. M. E. Journal, January, 1934.

(204) (a) TRAVELLING SCREEN METHOD OF WATER MEASUREMENT.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. W. Hubbard.
(e) C. M. Allen.
(f) General information.
(g) To compare the accuracy of Travelling Screen Method with weirs calibrated by Weighing Tank Method.
(h) In Progress.

(205) (a) SALT VELOCITY METHOD OF WATER MEASUREMENT.
(b) Alden Hydraulic Laboratory.
(c) Research.
(d) C. M. Allen, and L. J. Hooper, and C. W. Hubbard.
(e) C. M. Allen.
(f) To establish limits of accuracy in short test sections.
(g) By comparing the discharges as determined by the Salt Velocity Method for varying flows directly by the Weighing Tank Method or weirs calibrated by the Weighing Tank Method.
(h) In progress.

(206) (a) PITOMETER SHIP LOG.
(b) The Pitometer Ship Log Corporation, New York City.
(c) Commercial research.
(d) L. J. Hooper and Shaw Cole.
(e) E. S. Cole.
(f) To determine the coefficient of the pitometer log and effect of angularity.
(g) Stillwater tests made on revolving boom, moving water tests made in throat of venturi meters.

UNIVERSITY OF MINNESOTA.

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

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

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

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

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

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

(189) (a) VISCOUS FLOW THROUGH PIPE LINES.
(e) Professor Lorenz G. Straub.
(f) To check experimental data previously presented on limits of laminar and turbulent flow.
(g) Flow through glass tubes is observed, the condition of flow noted by means of dye lines, head loss recorded.
(h) In progress.

(190) (a) FLOW CONDITIONS IN OPEN CHANNELS.
(e) Professor Lorenz G. Straub.
(f) To determine the conditions of laminar and turbulent flow in open channels.
(g) Flow conditions are observed in a small tiltable flume.
(h) In progress.

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(261) (a) FLOW OVER SPILLWAYS.
(b) Northern States Power Company.
(d) Lorenz G. Straub and George E. Loughland.
(e) Professor Lorenz G. Straub.
(f) Determination of spillway capacity and coefficients of discharge for flood relief on hydroelectric development.
(g) Experiments conducted on small-scale wooden models built into glass flume.
(h) In progress.

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(262) (a) LAMINAR FLOW THROUGH ORIFICES.
(e) Professor Loreng G. Straub.
(f) To determine the effect of the variation in coefficient of discharge for low velocities through orifices in pipe lines.
(h) In progress.

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NATIONAL BUREAU OF STANDARDS (Continued from Page 38)

(171) (a) INVESTIGATION OF THE PRESSURE VARIATION IN 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, E. Buckingham, C. D. Shepard.
(e) The Director, U. S. Bureau of Standards.
(f) To obtain more complete data than is now at hand on the variations of pressure in the vicinity of an orifice plate, which will assist in better 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 calicrated 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 a 1 to 10 range for each orifice.
(h) Set-up in progress of erection.
(i) It is possible the same set-up will be used later for similar tests using air in place of water.

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(195) (a) LAWS OF SEDIMENT TRANSPORTATION.
(b) Proposed by U. S. Corps of Engineers and U. S. Bureau of Reclamation.
(c) General research.
(d) C. A. Wright, H. N. Eaton, B. H. Monish, C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) Study of the laws of transportation of bed load by flowing water.
(g) The following studies are planned: validity of Du Boys' law of tractive force as a criterion for the movement of bed load, taking account of the wall effect and the vertical velocity distribution curve; relation of bed load movement to mean and bottom velocities of water; critical tractive force for spheres of different sizes and specific gravities, for sand grains of uniform size, for various sand mixtures and different degrees of sharpness; effect on critical tractive force of fine silt or clay particles mixed with the sand; comparison of values of critical tractive force as determined by different criteria; tests of Kramer's sand uniformity factor; range of tractive force over which various sand mixtures are suitable for use in models, roughness coefficients for flume with sand bed; with non-movement of sand and with various degrees of sand movement and riffling.
(h) The flume described in 129 (g), together with a glass-walled flume 40 ft. long and 18 inches wide, will be used for these tests. (See 129 (h).

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(196) (a) MODES OF TRANSPORTATION OF SAND BY FLOWING WATER.
(b) Proposed by U. S. Geological Survey.
(c) General research.
(d) C. A. Wright, H. N. Eaton, B. H. Monish, C. W. Elliot.
(e) The Director, National Bureau of Standards.
(f) Study of the various modes of transportation of bed and suspended load by flowing water.
(g) Study of the formation, dimensions and motion of riffles and traveling banks under different conditions; quantity of bed load as related to depth, slope, velocity, etc.; velocity of travel of uniform sand grains and sand mixtures using colored grains; mechanism of suspension and laws of suspended load.
(h) The flumes described in 129(g) and 195(h) will be used for these tests, together with other special equipment which will be built as required. See 129 (h).

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CURRENT HYDRAULIC RESEARCH IN FOREIGN LABORATORIES.

"DIRECCION DE IRRIGACION" OF ARGENTINA.

(263F) a. APRON OF THE NEUQUEN DIVERSION DAM OF ARGENTINA.
(b) Research made by the Karlsruhe Flussbaulaboratorium (Dr. Rehbock) for the Direccion de Irrigacion of Argentina. Conclusions and local researches made at works for modification of plans are described on report cited under (i).
(d) Dr. Rehbock and staff of Obras Dique Neuquen.
(e) Ing. R. E. Ballester, Inspecting Engineer, Direccion de Irrigacion.
(f) To determine the best form for reconstruction of apron of Neuquen Diversion Dam, damaged by scouring.
(g) Models of two spans with movable sand bed.
(h) Completed. Reconstruction of apron started on 1933 according to results given by models.
(i) General report published on "La Ingenieria", Buenos Aires, December, 1933, pp. 505-513 under title: La Correccion de la Platea del Dique del Neuquen, by R. E. Ballester.

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(264F) (a) MODIFICATION OF A FALL (3,75m.; 37,0 m^3/sec) OF THE RIO NEGRO IRRIGATION WORKS. ARGENTINA.
(b) Direccion de Irrigacion of Argentina. Buenos Aires.
(d) Ing. R. E. Ballester, Inspecting Eng., Direccion de Irrigacion.
(e) " " " " " " "
(f) Concrete of fall was very damaged by alkali waters. Reconstruction of fall was not possible in short time and under such conditions as to obtain good concrete. The purpose was to modify the fall utilizing to the greatest extent the existing structure.
(g) Models at 1:10 scale made at the campment works of different plans of modifications. The fall was transformed into a rapid utilizing the hydraulic jump for the dissipation of energy.
(h) Completed. Fall transformed into a rapid according to the model results. The modification has proved successful after three years of working of rapid.
(i) General report published on "La Ingenieria", Buenos Aires, December 1933, pp. 513-519, under title: La Modificacion de un Salto del Canal Principal de Riego del Rio Negro Superior by R. E. Ballester.

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COMPLETED PROJECTS
Abstracts and References.

Iowa Institute of Hydraulic Research.

(117) Sediment Transporting Power in Open Channels.

The dissertation presents the results of tests conducted in the Hydraulics Laboratory of the State University of Iowa during the academic year 1933-1934. The object of the tests was to study the phenomena of bed load movement and to determine the critical velocity at which granular materials of different sizes and densities start to move under controlled conditions. Tests were made in a glass-walled flume with a smooth floor and with a floor roughened by fixing wooden strips diagonally across the flume above and below the pit which held the granular materials being studied.

The following conclusions are drawn from this investigation: (1) the transporting power of flowing water varies with the 6.75th power of the critical velocity; (2) if there are no obstructions which change the normal velocity-depth curves, there is virtually a constant relation between the critical bottom velocity and the critical mean velocity; (3) if two granular materials have the same diameter and different densities, the critical velocity varies as the square root of (S - 1), in which S is the specific gravity of material; (4) within reasonable limits, the shape of the particles of bed load material does not affect the transporting power appreciably; and (5) disturbances created by obstacles decrease the critical velocity.

U. S. Waterways Experiment Station.

First Series (Limited Printed Edition).

Paper H - Sediment Investigations on the Mississippi River and its Tributaries Prior to 1930. July, 1930. (Out of Print)

Paper Y - Experiment to Determine the Limit of Backwater Influence in the Illinois River, February, 1931. (Out of Print.)

Paper D - Hydraulic Studies of Proposed Dam No. 37, Ohio River, May, 1931. (Out of Print.)

Paper R - Experiments to Determine the Erosive Effects of Floodwaters on Railroad Embankments. May, 1931. (Out of Print).

Paper A - Effects of the Several Proposed Levee Extensions, South of Eagle Lake, Miss. December, 1931. (Out of Print.)

Paper U - Sediment Investigations on the Mississippi River and Its Tributaries 1930-31. December, 1931.

Paper L - Model Study of Effects of Dikes on the River Bed at Walkers Bar, Ohio River, January, 1932.

Paper I - Experiment to Determine the Effects of Proposed Dredged Cut-offs in the Mississippi River. April 15, 1932. (Out of Print.)

Paper C - Model Study of Effects of Operating Birds Point-New Madrid Floodway. December, 1932.

U.S.W.E.S. (continued.)
Second Series (Printed Edition)

Paper 10 - Experiment to Determine the Effects of Mississippi River Backwater on the Red River. January, 1933.
Paper 11 - Model Studies of Dike Location. June, 1933.
Paper 12 - Investigations of Certain Proposed Methods of Bank and Embankment Protection. July, 1933.
Paper 13 - Model Study of Shoaling below Starved Rock Lock and Dam, Illinois River, August, 1933.
Paper 14 - Model Studies of Spillway for St. Lucie Canal, Martin County, Florida, September, 1933.
Paper 15 - Model Studies for Channel Stabilization, Mississippi River. January, 1934.
Paper 16 - Experiment to Determine the Backwater Effects of Submerged Sills in the St. Clair River. April, 1934.

First Series (Limited Mimeograph Edition)

Paper H S - Head Losses in Various Types of Pipe Bends.

Papers to be printed in Near Future.

Paper 17 - Studies of River Bed Materials and Their Movement with Special Reference to Mississippi River System.

Note: 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, Vicksvurg, Miss.

National Bureau of Standards.

(7) Flow in Roof Gutters.

"Flow in Roof Gutters", by K. Hilding Beij.
National Bureau of Standards Journal of Research, Vol. 12, February, 1934, Research Paper RP644. Obtainable from Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents per copy.

Abstract:

The design of roof gutters, heretofore, has been solely a matter of judgment based on experience. In order to provide a more rational method, an experimental study of the basic problem of roof gutters was undertaken. This problem may be stated as follows; What is the capacity of a straight open trough of uniform cross section, one end closed and the

other end discharging freely, when the quantity of water flowing past a given cross section is directly proportional to the distance of the cross section from the closed end of the trough? Tests were made on rectangular and semicircular gutters of various lengths and widths, both level and sloping, and on one gutter of irregular cross section. Level gutters only are discussed in this paper.

Empirical formulas are given for determining capacity of level rectangular and semicircular gutters, and graphs for rapid solution are presented. An approximate method for gutters of irregular cross section, based on the tests of one such gutter, is also given.

Theoretical formulas for level gutters or channels of rectangular, triangular, trapezoidal, and semicircular cross sections are derived. The formulas for rectangular channels are compared with the results of the tests. (Continued on Page 63)

TRANSLATIONS.

Completed: New York University.

L. Oexle. Die Hochwasser des Rheins bei Basel in der zeit von 1808 bis 1930. Bautechnik, Vol. 11, No. 34, August 11, 1934.

Pennsylvania Water and Power Co.

H. SCHROETER.- "Pitting From Cavitation In A Diffuser." (German) (Korrosion durch Kavitation in einem Diffuser, V.D.I., Vol. 76, No. 21, May 21, 1932) Translated by: J. M. Mousson.

This report deals with preliminary experiments regarding the destruction of material by cavitation in a diffuser. The experimental apparatus is essentially a pressure pump which circulates water through a throat and diffuser, located immediately downstream. The beginning of pitting on bakelite "C", zinc, and gray iron were investigated. The location of the pitted area is also referred to.

Copies may be borrowed from the Pennsylvania Water & Power Co.

H. Schroeter.- "Pitting and Cavitation." (German) Korrosion bei Kavitation, Bericht über Versuche am Walchenseekraftwerk, V.D.I., Vol. 77, No. 32, August 12, 1933) Translated by: J. M. Mousson.

Translations (Cont'd) - "Pitting and Cavitation" (cont'd).

There are described in this paper experiments regarding the destruction of materials by cavitation in a diffuser. The experiments deal with the start of the destruction of material easily to be attacked under various flow conditions, especially at various water velocities. The term "Speed of Pitting Progress" is derived, and furthermore, there are described the influences of the rough surfaces on the pitting under cavitation conditions.

Copies may be borrowed from the Pennsylvania Water & Power Company.

H. SCHROTTER - "Destruction of Materials by Cavitation." (German) Werkstoffzerstörung bei Kavitation, V.D.I., Vol. 78, No. 11, March 17, 1934) Translated by: J. M. Mousson.

The earlier experiments with the cavitation test stand at the Walchensee development were continued; for this new stand the intensity of the pitting was more than ten times the value of the old stand. Aside from the Brinell Hardness of the alloys another characteristic of the specimens was found to be of importance regarding the resistance against pitting due to cavitation. This paper discusses the tests and results.

Copies may be borrowed from the Pennsylvania Water & Power Company.

Bureau of Reclamation.

"Some results gained during investigation of the Loess Dam of Boz - Sic." Translation from Russian by M. B. Karelitz. Available for loan.

"The percolation of water through earth dams," by N. N. Pavlovsky. Translation from the Russian by Andreas Luksch, Dipl.-Ing. M. S. University of Iowa, Wm. F. Bingham, U. S. Bureau of Reclamation Technical Memorandum No. 383. Denver, Colorado, June 1, 1934. 212 pages.

Translations (Cont'd) -

National Advisory Committee for Aeronautics, Washington, D. C.

"Energieumsetzung in Querschnittserweiterungen bei verschiedenen Zulaufbedingungen", Ingenieur-Archiv Vol. II, 1931, pp. 92-107. - Technical Memorandum No. 737, N.A.C.A. (Conversion of energy in diverging cross-sections under different conditions of inflow.) by H. Peters.

This investigation treats of the conversion of energy in conically divergent channels with constant opening ratio and half included angle of from 2.6 to 90 degrees, the velocity distribution in the entrance section being varied from rectangular distribution to fully developed turbulence by changing the length of the approach.

Foreign Pamphlets received by the National Bureau of Standards and in files of Hydraulic Laboratory Section.

CZECHOSLOVAKIA.

Jan Smetana.

The T. G. Masaryk National Institute of Hydrotechnical Research. (In Czech, summaries in French and German). 56 pages and numerous illustrations.

Jan Smetana.

Organization and work of the National Hydrological Service in Czechoslovakia. (In French.) 8 pages.

Jan Smetana.

Etude experimentale du ressaut d'exhaussement. (in Czech, with summary in French). 32 pages.

Jan Smetana.

Study of hydrotechnical questions by means of laboratory researches on reduced scale models. (in English.)
Reprint from XVth International Congress of Navigation, Venice, 1931. 19 pages.

Jan Smetana.

Utilization of waterways for the production of power, its consequences and applications. (in English.) Reprint from XIIIth International Congress of Navigation, London, 1923. 31 pages.

Jan Smetana.

The stilling basin of the dam on a tributary of the Ultava near Husinec. (In Czech with summary in French). 17 pages. 1934.

Jan Smetana.

The form of the stilling pool at the Karlovy Vary dam on the Tepla River. (In Czech, with summary in French) 22 pages. 1932.

Antonin Smrček.

Study of hydrotechnical questions by means of laboratory research on reduced scale models. (in English.)
XVth International Navigation Congress, Venice, 1931. 29 pages.

THE FREE CITY OF DANZIG.

R. Winkel.

Die Bedeutung von Temperatur-Messungen in Flüssen für die Auswertung von hydrometrischen Arbeiten. (in German).

Reprint from IV Hydrologische Konferenz der Baltischen Staaten, Leningrad, 1933, 3 pages.

GERMANY.

Mitteilungen der Hannoverschen Hochschulgemeinschaft, Vol. 14, 1933. (in German).

Albert Hinderks.

Strömungsuntersuchungen an selbsttätigen Saugüberfällen. (Saughebern). (In German).

Reprint from "Die Bautechnik", 1929. 8 pages.

Th. Rehbock.

Sickerwasserbewegung im Erdreich. (In German). Ier Congrès des Grandes Barrages, Stockholm, 1933. 4 pages.

Th. Rehbock.

Die Ausbildung der Sturzbetten bei Überfallwehren und Talsperren. (In German). Ier Congrès des Grandes Barrages, Stockholm, 1933. 5 pages.

G. de Thierry.

Die Trockenlegung der Pontinischen Sümpfe. (in German).
Reprint from Zeitschrift d. V.D.I., Band 78, No. 6, February 10, 1934.
4 pages.

GREAT BRITAIN.

F. J. Richards.

The salt marshes of the Dovey Estuary. IV. The rates of vertical accretion, horizontal extension, and scarp erosion. (in English).
Reprint from "Annals of Botany, Vol. XLVIII, No. CLXXXIX, January, 1934 (Great Britain) 34 pages.

ITALY.

Giulio de Marchi.

Temperature, contrazioni e dilatazioni longitudinali, e pressioni interstiziali in una grande diga massiccia, Parts I and II. (in Italian).

Memorie e Studi dell'Istituto di Idraulica e Construzioni Idrauliche del R. Istituto di Idraulica Superiore d'Ingegneria (R. Politecnico) di Milano. Nos. 8 and 9, 1934. 22 and 23 pages, respectively.

Francesco Marzolo.

I serbatoi di piena. (Flood reservoir) (in Italian).

Reprint from "L'Energia Elettrica", Fascicolo IV, Volume X, April, 1933 - XI. 47 pages.

Francesco Marzolo.

Un 'osservazione elementare nel calcolo dei canali. Sezioni di minimo scavo. (Elementary observations on the calculation of flow in canals. Minimum excavation). (In Italian).

Reprint from "L'Energia Elettrica", Fascicolo I, Volume X, January, 1932-X. 4 pages.

Francesco Marzolo.

Il concetto di probabilita nelle expressioni delle portate caratteristiche e di piena. (The concept of probability in the expression of discharge characteristics and of floods.) (In Italian). 1933. 27 pages.

Ettore Scimemi.

Il laboratorio e le ricerche di idraulica nella R. Scuola di Ingegneria di Padova. (The laboratory and hydraulic research at the Royal Engineering School at Padua.) (In Italian.)

Reprint from Primo Congresso Interregionale degli Ingegneri delle Tre Venezie. 3 pages.

Ettore Scimemi.

Rilievi sperimentali sul funzionamento idraulico dei grandi impianti industriali. (Experimental work on the functioning of the hydraulic portions of large industrial works.) (in Italian.)

Reprint from "L'Energia Elettrica", Fascicoli IXe XI, Volume X, September and November, 1933-XII. 47 pages.

JAPAN.

Shizuo Abe.

On hydrology of Japan. 70 pages. (In Japanese.)

Shizuo Abe.

Hydrology of the Tanna Basin as affected by the tunnel. 160 pages. (In Japanese.)

Shizuo Abe.

An experiment for determining the nature of the ground for the passage of ground water. 38 pages. (In Japanese.)

S. Kambara and S. Abe.

Study of physical laws governing infiltration of water through the dam and the subjacent soil. (in English) Ier Congrès des Grand Barrages, Stockholm, 1933. Question 2b, Rapport No. 33, 25 pages.

MEXICO.

F. F. Smith.

Study of the Nazas River. (In Spanish.)
Publication of the Comision Nacional de Irrigacion, Mexico.
91 pages. 1932.

Hector A. Tellez.

Gauging by the section and velocity method, Parts I and II. (In Spanish)
Publication of the Comision Nacional de Irrigacion, Mexico.
Part I, 40 pages. Part II, 31 pages, 1933.

NORWAY.

Hydrographic investigations in Norway. (in Norwegian, with summaries in English, German and French.

Abstract of hydrographical data for the 30-year period 1900-1930. Includes (a) list of water-gauges, (b) characteristic water levels in storage lakes, (c) characteristic spring floods, (d) characteristic monthly and yearly run-offs, (e) normal run-off and normal net precipitation, (f) regulation curves, (g) flood culminations, (h) summation curves, and (i) hydrographical map.

Norges Vassdrags - og Elektrisitetsvesen, Oslo, 1934. 197 pages with numerous charts.

RUSSIA.

- W. Bowin and L. Pashewsky.

Experimental conditions governing the navigation in the lower pool approaches in the Dnepostroy lock. (in Russian with summary in English).

Trans. of the Central Aero-Hydrodynamical Institute, No. 52, 1929, Moscow. 16 pages.

- W. Bowin and L. Pashewsky.

Investigation of the conditions influencing the flow in the lower approach to the lock in the Dneper hydro-electric plant. In Russian, with summary in English).

Trans. of the Central Aero-Hydrodynamical Institute, No. 53, 1929. Moscow, 11 pages.

- P. Walther.

Fundamentals of the hydrodynamical theory of hydraulic turbine spiral cases, Parts I, II and III. (In Russian, with summaries in English.)

Trans. of the Central Aero-Hydrodynamical Institute, No. 44, 1929.
" " " " " " " " 50, 1930.
" " " " " " " " 68, 1931.

Moscow, 111, 144 and 132 pages respectively.

- V. E. Timonoff.

Schematic project of a permanent regional Ice Engineering Institute for the Neva River Basin. (In Russian, with summary in English.)

Reprint from the Transactions of the Scientific Research Institute of Hydrotechnics, Vol. IX, 1933, Leningrad. 12 pages.

SWEDEN.

Erik Lindquist.

On velocity formulas for open channels and pipes. (in English). Special report, World Power Conference Sectional Meeting, Stockholm, 1933, 52 pages.

Erik Lindquist.

On the flow of water through porous soil. (in English). Ier Congrès des Grandes Barrages. World Power Conference, Stockholm, 1933. 21 pages.

Erik Lindquist.

Die Energieumwandlung an Wehren. (in German.) Ier Congrès des Grandes Barrages. World Power Conference, Stockholm, 1933. 11 pages.

SPAIN.

Sociedad Hispano Portuguesa de Transportes Electricos, Saltos del Duero S. A. Zamora, Spain.

Proyecto de Aliviadero y Posible Ampliacion del Embalse del Aprovechamiento de Aguas del Rio Esla en Ricobayo. Anejo N.° 1. Ensayos de Aliviadero en Modelo Reducido . (Model tests of spillway at reduced scale.) (in Spanish) 9 pages with figures.

LIST OF PRINCIPAL HYDRAULIC LABORATORIES IN FRANCE.

I- Le Laboratoire hydrotechnique de France à Beauvert près Grenoble - (Subventionné par l'Etat et par l'Industrie privée).

II- Le Laboratoire des Ateliers Neyret Beylier et P.B. à Grenoble.

III- Faculté des Sciences de Toulouse. - Le Laboratoire d'hydraulique fluviale de M.M. Camichel et Escande a Toulouse. Etude de l'écoulement des fluides et recherches d'ordre général.

IV- Faculté des Sciences de Grenoble.- Le laboratoire de l'Institut Electrotechnique de Grenoble (en cours de construction) - Recherches sur la cavitation "statique".

de M.Kampe

V- Faculte des Sciences de Lille. - Le Laboratoire de Mécanique des Fluides de Fériet à Lille - en cours de construction.

VI- Faculté des Sciences de Paris.- Le Laboratoire de mécaniques des fluides - Prof. M. Foch.

VII- Le Laboratoire d'hydraulique de Riabouchinsky (Ministère de l'Air) - près de l'Ecole Supérieure d'Aéronautique.

VIII- Faculté des Sciences de Marseille. - Le laboratoire de mécanique des fluides (hydrodynamique) - Prof. MM. Marchand, Valensi.

IX- Le Laboratoire de M. Barillon (Bassin des Carênes).

X- Le Laboratoire de machines hydrauliques de l'Ecole de Physique et Chimie - Dr. M. Langevin.

XI- Le Laboratoire d'essai des helices à Brest (Marine militaire) - Prof. M. Legras.

XII- Le Laboratoire de M. Toussaint qui étudie l'hydrodynamique en même temps que l'Aérodynamique.

XIII- M. Thiry, professeur à la Faculté des Sciences de Strasbourg, fait également des études fort interéssantes sur l'hydrodynamique.

XIV- Le Laboratoire d'hydraulique de l'Ecole d'Arts et Métiers de Chalons s/Marne; recherches très poussées sur la cavitation et les roues-hélices, at sur les paliers et pivots à film d'huile.

XV- Le Laboratoire d'Hydraulique du Saulcy (a Metz) de la Societe Hydrotechnique de France, Metz, France. Director M. Hegly.

XVI- Le Laboratoire Mechanique (et Hydraulique) de l'Institute Electrotechnique de l'Universite de Nancy. 2 Rue de la Citadelle. Prof. Hahn, Director.

U. S. S. R. Commission for Exchange of Hydraulic Laboratory Research Results.

The following is an extract from a letter dated June 6, 1934, from Professor I. B. Egiazaroff, President of the Commission:

" Our Commission for exchange of hydraulic laboratory research results was organized the 4 March 1933 after the receipt of Professor W. Fellenius' proposal to participate in the organization of an International Commission during the World Power Conference in Stockholm.

"Our Commission, during the first year of its existence has begun the exchange with about 20 hydraulic hydrotechnic and hydroelectric laboratories of USSR and with about 40 laboratories abroad; an exchange of publications has begun with very good results, and now the Commission is on the way to organize a system of reports, of the same kind you have

so successfully organized in your country.

"To make the exchange still more efficient we intend to visit, during the autumn of 1934 the laboratories of United States and Europe.

"We hope to have the possibility of becoming acquainted with the work and the methods that are used now in your leading laboratories, and would be very thankful to you for help, advice and recommendations as to the leading laboratories of the United States. This scientific trip is supposed to be followed by 3 to 4 of our leading scientific men of the Hydrotechnical Research Institute in Leningrad.

"During 1933 our hydrotechnical laboratories have been visited by Mr. Hugh Cooper and about 20 leading scientific men from Germany, Norway, Italy, Sweden, Finland and other countries.

"We hope that your leaders in hydraulic laboratory research will pay us the honour of visiting our laboratories and our country."

CURRENT PROJECTS IN U.S. HYDRAULIC LABORATORIES (Continued.)

CALIFORNIA INSTITUTE OF TECHNOLOGY.

(100) (a) MODEL INVESTIGATIONS OF SILTING PROBLEMS AT SEAL BEACH
(b) The Los Angeles Gas & Electric Corporation and the Los Angeles County Flood Control District jointly.
(c) General scientific research to solve a particular problem.
(d) Dr. Robert T. Knapp and V. A. Vanoni with Major Charles T. Leeds as consultant.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To determine the probable effect of a change in the channel of the San Gabriel River, which now discharges into Alamitos Bay some distance from the point where the bay is connected with the ocean. This causes the bay to silt up. The Flood Control engineers propose to cut a new river channel so that it will discharge into the channel connecting the bay with the ocean. But the Seal Beach steam plant of the Los Angeles Gas & Electric Corporation is located along this channel and draws condensing water from it. It is feared that the change will cause this channel to silt up and thus interfere with the supply of condensing water.
(g) A model basin has been constructed. In it there has been reproduced to scale a portion of the bay, the ocean, the connecting channel and the present outlet of the river. The river will be caused to discharge its various rates of flow while the ocean will reproduce its tide cycles. The effects will be observed both for the present river course and with the proposed new channel.
(h) This work has been completed and a report presented to the Los Angeles Gas & Electric Corp. The full report is not available for general distribution. However, a group of papers is being presented in Berkeley the week of June 18, 1934, under the auspices of the Hydrology Section of the American Geophysical Union and it is probable that these papers will be published in the Transactions of that organization under the following title, "Solving a Flood and Beach Protection Problem with an Hydraulic Model, - A Study of San Gabriel River Mouth at Alamitos Bay Inlet - (a) 'Physical Conditions', by Col. Charles T. Leeds, Consulting Engineer; (b) 'Apparatus and Technique of Model Study" by Vito A. Vanoni, Research Assistant, California Institute of Technology; (c) 'Results of Experiments' by Professor Robert T. Knapp, Assistant Professor of Mechanical Engineering, California Institute of Technology; (d) 'Practical Application of Laboratory Solution' by Col. Charles T. Leeds."
(i) This work has been financed by the Los Angeles Gas & Electric Corporation and the Los Angeles County Flood Control District. H. L. Masser and J. G. Rollow of the former and E. C. Eaton, Chief Engineer of the latter together with Major C. T. Leeds have made the work possible.

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(105) (a) INVESTIGATION OF TRANSPORTING VELOCITIES OF SAND FOR USE IN MODELS.
(b) to (f) See Report II-1.
(h) Project completed.

(101) (a) THE CHARACTERISTICS OF A CENTRIFUGAL PUMP WHEN OPERATED UNDER ABNORMAL CONDITIONS.
(b) Laboratory problem only.
(c) General scientific research.
(d) Dr. R. T. Knapp and Dr. George F. Wislicenus.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To investigate characteristics when a centrifugal runs in both directions, with water being pumped and also with water flowing down backwards through the pump. This study is of interest for cases where the power suddenly fails for acentrifugal pump with a high lift and a long discharge line in which the flow will reverse.
(g) The method is the usual one of testing a pump, save for the new conditions, which are brought about in the laboratory by a second pump which can pump water into the discharge line of the first pump.
(h) A report of this work is being presented at the Aeronautics-Hydraulics meeting of the American Society of Mechanical Engineers June 20 at Berkeley by Professor Robert T. Knapp under the title, "Complete Characteristics of Centrifugal Pumps and Their Use in the Prediction of Transient Behavior".

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(102) (a) INVESTIGATION OF VELOCITY DISTRIBUTION IN THE VOLUTE OF A CENTRIFUGAL PUMP IN THE NEIGHBORHOOD OF THE IMPELLER.
(b) Laboratory problem.
(c) General research for thesis for M. S. degree.
(d) R. C. Binder.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) By a special instrument the magnitude and direction of the velocity of the water is measured at a number of points within the volute, thus supplying experimental information that has long been desired.
(g) As in (f)
(h) Continued. A preliminary report has been presented by Mr. R. C. Binder and information concerning it can be obtained from him or from Professor Knapp.

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(104) (a) FURTHER MODIFICATION OF THE THEORY OF CENTRIFUGAL PUMP DESIGN.
(b) Scientific Research.
(c) Theoretical investigation.
(d) Dr. George F. Wislicenus.
(e) Professor R. L. Daugherty, or Professor Robert T. Knapp.
(f) To place the method of design on a sounder basis.
(g) Theoretical studies based on actual test data.
(h) Work has been under way for some time and is continuing. Dr. George F. Wislicenus has presented a thesis with the title, "Cavitation and Separation in Pumps and Turbines", copies of which are in the Institute Library. He is presenting an abstract of this work at the Joint Aeronautics-Hydraulics meeting of the A.S.M.E. at Berkeley, June 20, 1934, under the title, "Separation in Pumps and Turbines".

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(267) (a) A STUDY OF THE BALLONA CREEK OUTLET.
(b) The Los Angeles County Flood Control District.
(c) Model study to solve a particular problem.
(d) Professor Robert T. Knapp with Vito A. Vanoni and Warren E. Wilson as assistants.
(e) Professor Robert T. Knapp and Professor R. L. Daugherty.
(f) To determine the most advantageous construction of the new flood control channel of the Ballona Creek to discharge into the Pacific Ocean, together with the length and form of jetties if any prove necessary.

This small creek is the outlet of a densely populated drainage area which has an extremely high percentage of the surface composed of roofs, paved streets and other non-porous covering. The creek is, therefore, subject to sudden floods of much larger magnitude than the area would normally indicate. The new channel is being constructed to straighten the course, increase the hydraulic gradient, and protect the lowlands adjacent to the ocean from flood damage. The beaches in the neighborhood of the outlet are heavily used for recreational purposes and, therefore, these changes must be so made as to protect and if possible help build up these beaches.

(g) Model is being constructed in the basin used for Project 100. The general technique is to be the same as for the older project.
(h) Project commenced June, 1934.
(i) This work is being done under a cooperative arrangement with the Los Angeles County Flood Control District through the Chief Engineer, Mr. E. C. Eaton. Col. Charles T. Leeds, Consulting Engineer, is also actively cooperating.

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UNIVERSITY OF CALIFORNIA.

(12) (a) JET PUMPS.
(c) Laboratory project.
(d) Ledgett.
(e) Professor M. P. O'Brien.
(h) Studies on the mixing length of an air jet in air have been made and will be reported on in a paper by L. A. Ledgett to be presented at the meeting of the Hydraulics Section, American Society of Mechanical Engineers at Berkeley, June, 1934.

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(13) (a) AIR LIFT.
(c) Laboratory project.
(d) O'Brien and Gosline.
(e) Professor M. P. O'Brien.
(h) Additional research on the motion of bubbles in tubes resulted in paper by M. P. O'Brien and J. E. Gosline, "Velocity of Large Bubbles in Vertical Tubes" presented at the annual meeting of the Society of Rheology at Pittsburgh, December, 1933.

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(14) (a) STREAMLINE AND TURBULENT FLOW THROUGH GRANULAR MATERIALS.
(c) Laboratory project.
(d) Hickox.
(e) Professor M. P. O'Brien.
(h) Correlation of test data on flow through lead shot and sands by means of a rational formula is reported in a paper presented to the Section of Hydrology, American Geophysical Union, at Berkeley, June, 1934.

(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) Laboratory project.
(d) Rindlaub and O'Brien.
(e) Professor M. P. O'Brien.
(h) Analysis of available data on friction coefficients, critical tractive force and relation between tractive force and rate of bed-movement. Strickler's equation for friction factor as a function of size of material found to apply reasonably well to small channels. The equation of Krey for the critical tractive force agrees fairly well with the data and is much simpler than the equation of Schoklitsch and Kramer. The rate of movement can be represented by the equation of Du Boys, but the coefficient ψ is not a constant for quartz sand in water.
(i) Paper by M. P. O'Brien and B. D. Rindlaub, "Transportation of Bed Load" presented to Section of Hydrology, American Geophysical Union at Berkeley, June, 1934.

(172) (a) HYDRAULIC JUMP.
(c) Laboratory project.
(d) Hickox and Rose.
(e) Professor M. P. O'Brien.
(h) Experiments in a trapezoidal channel verify the momentum theory. Chart for rapid calculation of the jump in a trapezoidal channel published by G. H. Hockox in Civil Engineering for May, 1934.

(173) (a) RATING A MODIFIED PARSHALL FLUME.
(c) Undergraduate thesis.
(d) Gildea and Taylor.
(e) Professor M. P. O'Brien.
(h) Study complete. Summary included.
(i) Thesis may be borrowed from laboratory.

(174) (a) AERATION OF SHARP-CRESTED WEIRS.
(c) Graduate thesis.
(d) Johnson.
(e) Professor M. P. O'Brien.
(h) Study complete. Summary included.
(i) Thesis may be borrowed from laboratory.

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(175) (a) COMPARISON OF MODELS AND PROTOTYPES.
(c) Laboratory project.
(d) 1. Jameson. (e) Professor M. P. O'Brien.
2. Kidder.
(g) 1. Studies of scour at river beds in models with ratios of 1:24 horizontally and same size vertically.
2. Tests on 1:36, 1:108, and 1:216 scale models of Keokuk dam. Comparisons will be made with prototype and 1:11 scale model tested at University of Iowa.

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(268) (a) WATER HAMMER.
(c) Laboratory project.
(d) LeConte, O'Brien.
(e) Professor M. P. O'Brien.
(g) Tests made on a 2-inch line 278 ft. long with velocities to 5.12 feet per second, using telemeter pressure element and oscillograph.
(h) Theory developed for recoil phase found to agree with experiment. Reported in paper "Some Experiments and Calculations on the Resurge Phase of Water Hammer" by J. N. LeConte, presented to Hydraulic Division, A. S. M. E., at Berkeley, June, 1934.

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(269) (a) PROPELLER PUMPS.
(c) Laboratory project.
(d) Miller and Folsom.
(e) Professor M. P. O'Brien.
(h) Method of calculation developed which checks performance test of 20 inch commercial unit. Reported in paper by M. P. O'Brien and R. G. Folsom, "Propeller Pumps" presented to Hydraulics Division, A. S. M. E. at Berkeley, June, 1934.
Design of small test pump for laboratory experimentation is complete.

COMPLETED PROJECTS
Abstracts and References.
(Continued from Page 48.)

CALIFORNIA, UNIVERSITY OF

(173)
The Calibration of six-inch standard and modified Parshall Flumes.
(Summary of Report.)

1. Object of the Experiment.

At the present time the California Forest Experiment Station is carrying on investigations in various parts of the State in which the measurement of surface run-off water is necessary. To accomplish this measurement, the persons in charge of the work have used the Parshall Flume. The standard Parshall Flume is of such shape as to render it unfit for the measurement of flow under the conditions which obtain at many of the sites of the California Forest Experiment Station investigations. The streams carry a considerable bed load which is deposited in the depressed section filling that section to an extent sufficient to invalidate the relations of measured head to corresponding values of discharge as given by the available rating tables. To obviate this difficulty, the flumes were modified by eliminating the upward rise in the divergent section. The floor in that section was given a slope equal to that in the standard flumes but in the opposite direction, that is, downward.

The purpose of this experiment was therefore to determine the effect of reversing the slope of the floor in the outlet of the flumes. Six-inch flumes were used because of the limitations in the water supply available at the University of California Hydraulic Laboratory.

2. Theory.

The Parshall flume is essentially a critical depth meter. According to the well-known theory of critical depth, (see "Hydraulics of Open Channels" by B. A. Bakhmeteff) the critical depth is a definite parameter of the flow, and if that depth occurs in some section of the flume, the relation of depth of flow to discharge at any point above the critical section should be independent of the downstream conditions. While this theory may be adequate for sensibly parallel flow, Professor B. A. Bakhmeteff has pointed out the difficulties of applying it to flow in which the stream lines are curved. (See discussion by Bakhmeteff on "Tests on Broad Crested Weirs" by Woodburn and Webb, Transactions, American Society of Civil Engineers, 1932). Flow through Parshall flumes is not parallel flow and it is reasonable to suppose that the ordinary theory of critical flow is not directly applicable to this type of device.

3. Apparatus and Procedure.

The experimental flumes were placed in the lower end of a three foot channel which was about 16 feet long. Water was supplied by an 8 inch DeLaval centrifugal pump with a capacity of 1800 gallons per minute. Free water was pumped into a thirty-foot stand pipe from which it was carried in a five-inch pipe to a forebay at the upper end of the channel. The flow was measured by a previously calibrated venturi meter placed in the supply line. Due to the

shape of the flumes, it was necessary to have a four-inch step or contraction from the floor of the channel to the floor of the inlet to the flume. The depth of flow at the proper section was obtained by hook gage and stilling well. A one-eighth inch diameter pressure tap was employed in most of the runs.

In outline, the procedure was as follows:

(a). Calibration of the venturi meter.

(b) Calibration of the Standard Parshall flume.

(c) Determination of the effect of different tap locations on the rating of the Standard flume.

(d). Determination of the effect of a 3/4 inch diameter pressure connection.

(e) Calibration of the modified Parshall flume.

(f) Determination of the effect of a false bottom in the modified flume. Since the experimental flumes were slightly different in size and shape, a false bottom was placed in the outlet of the modified flume to cause it to operate as a standard flume.

4. Summary of the Results and Conclusions.

(a) The calibration of the Standard Parshall flume resulted in finding an average difference of seven percent between the determination of this test and the standard rating tables. The experimental flume measured 6-1/4 inches at the throat. This difference in size and the fact that a bottom contraction existed at the entrance to the experimental flumes are responsible for the difference in rating.

(b) Varying the size of the pressure hole, at least up to 3/4 inches has no effect upon the relation between head and quantity.

(c) It is important to locate the pressure tap at the specified section; failure to do so results in disturbing the standard relation between head and quantity. In this test, the location of the tap was varied two inches upstream and downstream from the standard location. The results indicate that if the tap is located too far (up to 2 inches) there will be little error in measuring flows higher than about 0.75 second feet. If the tap is located slightly downstream from the standard point, there will be small error involved in measuring flows lower than about 0.3 second feet.

(d) Reversing the slope of the floor in the outlet results in increasing the discharge for any given head by two percent.

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(174) Aeration of Sharp-crested Weirs. (Summary of Report.)

Theoretical considerations demand that a weir to be used as an accurate measuring device should be completely aerated; that is, the air pressures above and below the nappe should be equal. The purpose of this study was to determine (1) the effect of not aerating the nappe and (2) the amount of air necessary for complete aeration.

Apparatus:

The apparatus consisted of a sharp crested suppressed weir 1 foot in length in a glass-sided channel 16 feet long. The weir plate was hollow with openings under the nappe to permit access of air. Its height above the bottom of the channel could be varied. Immediately below the weir was a glass-sided afterbay whose bottom could be raised or lowered as desired. Rate of flow of air was measured by means of an orifice or a capillary tube.

Conclusions:

Within the limits of the experiments the following statements may be made.

(1) Under the same head the effect of cutting the air off from free entrance to the underside of the nappe is to give a discharge greater than that obtained by complete aeration. A maximum difference in discharge of 23 per cent was produced by the "adhering" nappe while the "wetted underneath" and "depressed" conditions give differences of 18 per cent and 6 per cent respectively.

(2) The quantity of air withdrawn by the falling sheet of water depends only on the quantity of water flowing and is independent of the position of the downstream channel bottom and the downstream depth.

(3) The only effect of the position of the downstream channel bottom and pool depth is to influence the amount of air that is circulated back after it has once been started to be withdrawn.

(4) For any particular position of the downstream channel bottom the amount of air drawn in through the inlets increases as the depth is decreased in the downstream pool, which is the same as stating that the amount of air deflected and circulated backward increases as the depth in the pool increases.

(5) For a constant position of the downstream water level with respect to the crest level the amount of air drawn in through the inlets increases with the lowering of the channel bottom. This is similar to stating that the amount of air deflected and circulated backward increases as the depth of pool is decreased.

(6) The ability of a falling sheet to withdraw air depends to a great extent on the roughness of the water surface in the downstream pool. Such a conclusion is logical because the rougher a surface the greater is the frictional drag along it.

(7) Within the limits of the experiments the absolute reduction in head is directly proportional to the absolute differential pressure.

Publications of Aeronautic and Hydraulic Divisions, A. S. M. E.

Approximately 38 papers presented at the meetings of the Aeronautic and Hydraulic Divisions of the American Society of Mechanical Engineers held at Berkeley, California, June 19-21, 1934, have been published in the form of a volume and can be obtained from the George Reproduction Company, 500 Sansome St., San Francisco, at a cost of $1.50 per copy.

Transactions of the Section of Hydrology, American Geophysical Union.

The 1933 Transactions of the Section of Hydrology of the American ~~Geophysical~~ Geophysical Union (183 pages), containing the reports of the Permanent Research Committees of the Section and papers on hydrology and the transportation of sediment can be obtained from the Secretary of the Section, Mr. K. H. Beij, National Bureau of Standards, Washington, D.C. $1.00

The 1934 Transactions of the Section of Hydrology, (about 300 pages) containing the reports of the Permanent Research Committees of the Section and papers on hydrology, soil erosion and the transportation of sediment are in process of publication and should be available about August 1, 1934. Copies can be obtained through Mr. Beij. The cost ~~of each volume~~ is $1.00 $1.5 per copy for the United States and Canada and $1.20 for other countries.

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Model tests of hydraulic structures.