

URC 1.1/7

C.1

COLORADO STATE PUBLICATIONS LIBRARY



3 1799 00141 6296

Government Publications Division  
University of Colorado Libraries

JUN 27 1980

# UPPER COLORADO RIVER COMMISSION

=

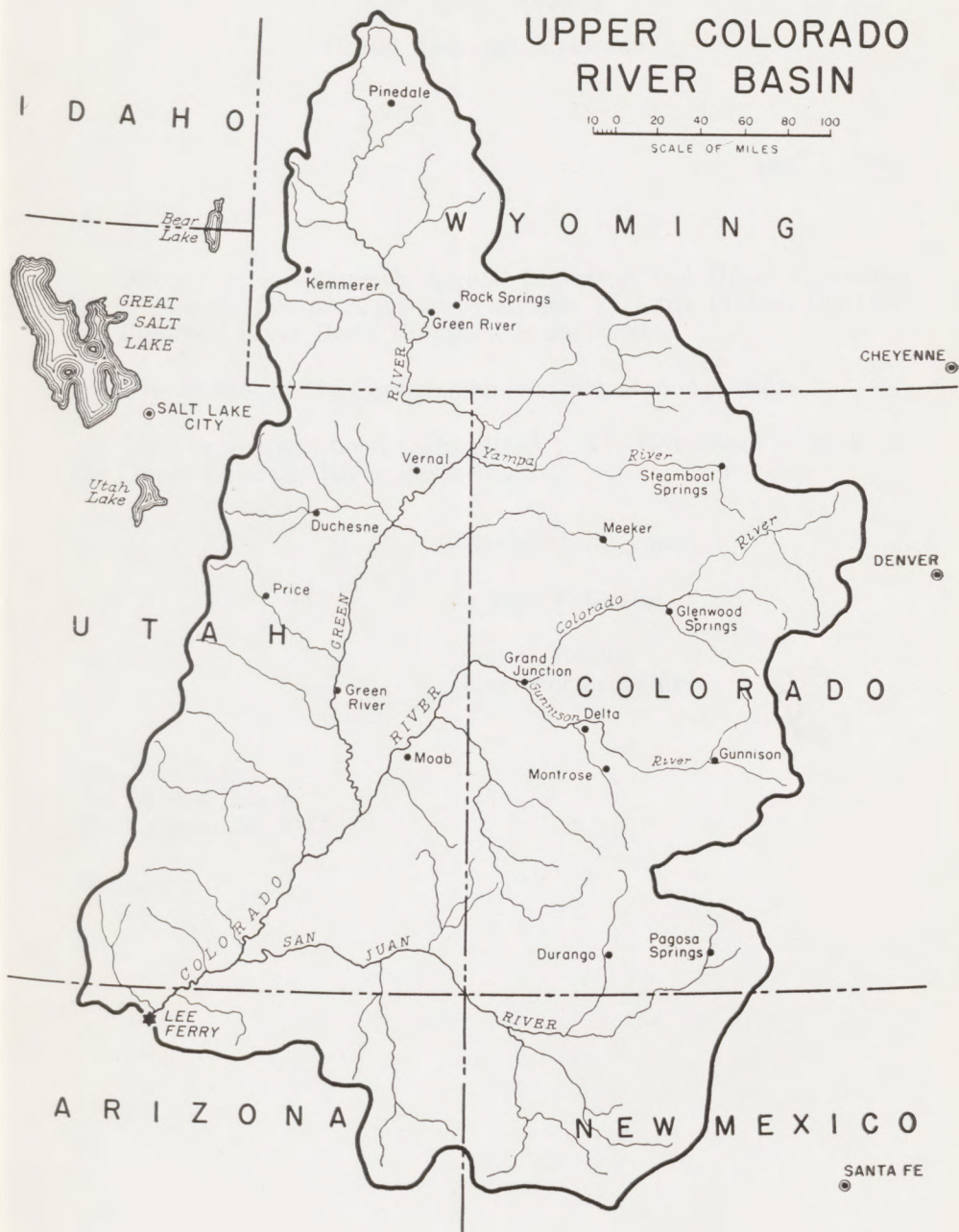
## SEVENTH ANNUAL REPORT

=

APRIL 1, 1956

# UPPER COLORADO RIVER BASIN

10 0 20 40 60 80 100  
SCALE OF MILES





UPPER COLORADO RIVER COMMISSION

Monte Building, Room 5

748 North Avenue

Grand Junction, Colorado

April 1, 1956

Mr. President:

A copy of the Seventh Annual Report of the Upper Colorado River Commission, as required by Article VIII (d) (13) of the Upper Colorado River Basin Compact, is enclosed.

The budget of the Commission is attached as Appendix A.

This report has been transmitted to the Governors of each of the Upper Colorado River Basin States.

Respectfully yours,

|s| Ival V. Goslin

Ival V. Goslin  
Engineer-Secretary

The President  
The White House  
Washington 25, D.C.

Enclosure

d

## FRONTISPIECE

## LETTER OF TRANSMITTAL

### — Table of Contents —

Seventh Annual Report	1
Appendix A—Budget Fiscal Year Ending June 30, 1957	39
Appendix B—Audit as of June 30, 1955	40
Appendix C—Methods of Determining Consumptive Use of Water in Irrigation by R. D. Goodrich	47
Appendix D—Key Gaging Stations	63
Appendix E—Resolution—John Geoffrey Will	75



**SEVENTH ANNUAL REPORT**  
**UPPER COLORADO RIVER COMMISSION**

April 1, 1956

**I. SUMMARY**

This annual report covers the activities of the Commission for the preceding year. It includes, among other things, the following:

Membership of the Commission, its Committees and its staff.

Roster of meetings of the Commission.

Brief discussion of events and activities relating to the passage of legislation by Congress to authorize the development of the water resources of the Upper Colorado River Basin.

Copy of the Conference Report to accompany S. 500 which authorizes the Secretary of the Interior to construct, operate, and maintain the Colorado River Storage Project and participating projects.

A legislative history of the Act passed by the 84th Congress.

Statements pertaining to hydrological research including Inflow-Outflow Studies.

Appendices containing:

Fiscal data, such as: budget, balance sheet, statements of revenue and expense, etc.

Paper on methods of determining consumptive use of water in irrigation.

Lists of gaging stations used by the Commission and trans-mountain diversions from the Upper Colorado River Basin.

For data on the activities of the Commission during that part of the preceding water year to March 21, 1955, the reader is referred to the Commission's Sixth Annual Report. In order that a more nearly recent account of the Commission's activities may be gained, the Commission has included in this report an account of the activities of the Commission through March 31, 1956.

## II. COMMISSION

During the period covered by this report the Commission consisted of the following:

Robert J. Newell	—Commissioner for the United States of America and Chairman of the Commission
George D. Clyde	—Commissioner for the State of Utah and Vice-Chairman of the Commission
John H. Bliss	—Commissioner for the State of New Mexico
Frank Delaney	—Commissioner for the State of Colorado
L. C. Bishop	—Commissioner for the State of Wyoming

The following have acted as advisers to each Commissioner from time to time:

### United States of America:

#### Legal:

J. Stuart McMaster, Regional Counsel, Region 4, Bureau of Reclamation, Salt Lake City, Utah

Laurence Davis, Assistant General Counsel, The Navajo Tribe, Window Rock, Arizona

#### Engineering:

J. R. Riter, Chief Development Engineer, Bureau of Reclamation, Denver, Colorado

G. B. Keesee, Area Irrigation Engineer, Bureau of Indian Affairs, Gallup, New Mexico

### Colorado:

#### Legal:

Hatfield Chilson, Legal Counsel, Colorado Water Conservation Board, Loveland, Colorado

Omer Griffin, Deputy Attorney General, Denver, Colorado

Engineering:

Royce J. Tipton, Consultant, Colorado Water Conservation Board, Denver, Colorado

Ivan C. Crawford, Director, Colorado Water Conservation Board, Denver, Colorado

Frank C. Merriell, Engineer, Colorado River Water Conservation District

New Mexico:

Legal:

Fred E. Wilson, Attorney-at-Law, Albuquerque, New Mexico

Engineering:

John H. Bliss, Engineer, New Mexico Interstate Stream Commission, Santa Fe, New Mexico

David P. Hale, Assistant Engineer, New Mexico Interstate Stream Commission, Santa Fe, New Mexico

Utah:

Legal:

E. R. Callister, Jr., Attorney General, Salt Lake City, Utah

Engineering:

George D. Clyde, Director, Utah Water and Power Board, Salt Lake City, Utah

Jay R. Bingham, Assistant Director, Utah Water and Power Board, Salt Lake City, Utah

Wyoming:

Legal:

George F. Guy, Attorney General, Cheyenne, Wyoming



#### Engineering:

Earl Lloyd, Deputy State Engineer, Cheyenne, Wyoming

H. T. Person, Dean of School of Engineering, University of Wyoming, Laramie, Wyoming

Paul Rechar, Chief of Water Development, Wyoming Natural Resources Board, Cheyenne, Wyoming

#### Alternates in absence of Commissioner:

Joe L. Budd, Big Piney, Wyoming

Norman W. Barlow, Cora, Wyoming

### III. THE STAFF

The staff of the Upper Colorado River Commission, as of the date of this report, consists of:

Ival V. Goslin, Engineer-Secretary

R. D. Goodrich, Engineering Consultant

Barney L. Whatley, Treasurer

Richard T. Counley, Assistant Treasurer

Mrs. Dorothy Dye, Administrative Assistant

Mrs. Adele N. Wilson, Assistant to Engineer-Secretary  
(Washington Office)

Mrs. Lois P. Crowder, Official Reporter

### IV. MEETINGS OF THE COMMISSION

During the period March 22, 1955 to March 19, 1956, the Commission held seven meetings, as follows:

May 23, 1955	Special Meeting Denver, Colorado
August 17-18, 1955	Special Meeting Denver, Colorado
September 19, 1955	Annual Meeting Grand Junction, Colorado
November 2, 1955	Special Meeting Denver, Colorado

December 21, 1955	Special Meeting Cheyenne, Wyoming
January 5, 1956	Special Meeting Santa Fe, New Mexico
March 19, 1956	Regular Meeting Washington, D. C.

During this period there were meetings from time to time of the standing committees. These committees and their membership, as of the date of this report, are as follows: (In accordance with Article V (4) the Chairman and Secretary are ex-officio members of all committees).

#### Engineering Committee:

J. R. Riter, Chairman	David P. Hale
John H. Bliss	H. T. Person
Royce J. Tipton	Paul Rechar
Frank C. Merriell	George D. Clyde
Ivan C. Crawford	Earl Lloyd
Jay R. Bingham	G. B. Keese

#### Legal Committee:

Fred E. Wilson, Chairman	Omer Griffin
E. R. Callister, Jr.	Hatfield Chilson
J. Stuart McMaster	George F. Guy
Laurence Davis	

#### Budget Committee:

John H. Bliss, Chairman	Norman W. Barlow
Ivan C. Crawford	Jay R. Bingham
J. R. Riter	

The following special committee also met during the period of this report:

#### Finance Committee:

Norman W. Barlow, Chairman	George D. Clyde
I. J. Coury	Dan Hunter

### V. SIGNIFICANT EVENTS AND ACTIVITIES OF THE COMMISSION

Within the scope and limitations of Article I (a) of the Upper Colorado River Basin Compact "... to secure the expeditious agricultural and industrial development of the Upper Basin, the storage



of water . . ." and under the powers conferred upon the Commission by Article VIII (d) pertaining to making studies of water supplies of the Colorado River and its tributaries and the power to ". . . do all things necessary, proper or convenient in the performance of its duties . . . , either independently or in cooperation with any state or federal agency" the principal activities of the Commission have consisted of: (A) an educational campaign to aid the Congressional Delegations from the Upper Basin States in securing passage of legislation to authorize the construction of the Colorado River Storage Project and participating projects; and, (B) the continuance of hydrological research on methods for applying the Inflow-Outflow Theory of measuring stream depletions in the Upper Colorado River Basin.

## **A. LEGISLATION—1955-1956**

### **A Year of Achievement**

In recent years several attempts were made to persuade Congress to pass legislation to authorize the construction of an over-all project to be known as the Colorado River Storage Project and participating projects. Such an over-all Project was to consist of two interrelated parts. One part, the storage units, was to consist of several large water-storage dams and reservoirs to be used for regulating the Colorado River, for storing water for future consumptive use by the principle of water exchange, for the generation of hydro-electric energy, and for the creation of revenues from the sales of power to be used for the purpose of defraying the costs of irrigation projects that would be beyond the ability of the irrigators to repay. The other part of the plan was to be made up of irrigation projects which would consumptively use the water apportioned to the Upper Basin and to each State of the Upper Division of the Colorado River Basin by the Colorado River Compact and the Upper Colorado River Basin Compact. Because such consumptive-use projects participated in the use of water and in the use of power revenues to be derived from the Storage units, they were to be known as participating projects. It was not until the 84th Congress, 1955-1956, that such legislation was finally passed by Congress.

### **Grass Roots Organization**

During the Second Session of the 83d Congress it was impossible to obtain a rule for H. R. 4449 from the Rules Committee. S. 1555, after some debate, died on the Senate floor on the last day of the Session without being called up for a vote. See SUMMARY, page 23.

The vast amount of opposition during the 83d Congress to legislation to authorize the development of the water resources of the Upper Colorado River Basin showed the necessity for a comprehensive nation-wide educational campaign to sell the Colorado River Storage Project to the nation and to the Congress. The need for such a program to disseminate information and to counteract the



opposition of Southern California interests who stood to benefit if the enactment of authorizing legislation were prevented prompted the citizens of the four Upper Basin States to organize the Upper Colorado River Grass Roots, Inc. (Aqualantes) with the approval of the Upper Colorado River Commission. This organization (Grass Roots) was incorporated in Colorado and permitted to operate in New Mexico, Wyoming and Utah; it and its officers and personnel were registered under the Federal Regulation of Lobbying Act. Throughout most of the First Session and until March 1, 1956 of the Second Session of the 84th Congress, the Grass Roots organization operated under the general supervision of the Commission in its Washington office. Between Sessions, it carried on the educational campaign from Salt Lake City, Utah.

### **Legislation Introduced—Hearings 84th Congress**

Early in the First Session of the 84th Congress five bills, H. R. 270 (Dawson), H. R. 2836 (Fernandez), H. R. 3383 (Aspinall), H. R. 3384 (Aspinall) and H. R. 4488 (Rogers), were introduced in the House of Representatives to authorize the construction of the Colorado River Storage Project and participating projects. A companion bill, S. 500, was introduced in the Senate by Senator Anderson for himself and Senators Allott, Barrett, Bennett, Chavez, Goldwater, Hayden, Millikin, Watkins and O'Mahoney.

The Subcommittee on Irrigation and Reclamation of the Senate Committee on Interior and Insular Affairs held hearings on S. 500 February 28-March 5, 1955. On March 29, the Subcommittee reported S. 500 favorably to the full Committee which in turn reported it to the Senate by an 11 to 1 vote. On April 20, 1955, S. 500 was passed by the Senate after a roll-call vote, 58 to 23.

Hearings were held on H. R. 3383 by the Subcommittee on Irrigation and Reclamation of the House Interior and Insular Affairs Committee, March 9-28, April 18-22, June 6-13, 1955. On June 14, 1955, the Subcommittee by a vote of 18 to 6 reported favorably H. R. 3383 with amendments to the Committee on Interior and Insular Affairs. On June 28, the full Committee by a vote of 20 to 6 ordered H. R. 3383 with amendments reported favorably to the House of Representatives. On July 6, 1955, the Chairman of the House Interior Committee requested a rule from the Rules Committee. The rule was obtained on July 21, 1955. The First Session of the 84th Congress adjourned with H. R. 3383 as a pending item of business before the House.

### **Echo Park Dam Deleted From House Bill**

H. R. 3383 and S. 500 as originally introduced contained a provision for the authorization of Echo Park Dam in Dinosaur National Monument in northwestern Colorado. Opposition to these bills was bitter and nationwide by officials and members of many organizations devoted to the proposition that no part of our national park system should be utilized for purposes that would materially change natural conditions. In spite of this well-organized opposition, S. 500



was passed by the Senate with Echo Park Dam included. In the House the story was different. By early Spring of 1955 it became apparent that H. R. 3383 could not be reported out of the Interior Committee with an authorization for Echo Park Dam in it. In an executive session held in Denver, Colorado, on May 23d, the Commission agreed to recommend to our Congressional Delegations the acceptance of an amendment deleting Echo Park from the House bill. Therefore, H. R. 3383, as amended, when reported by the Subcommittee on June 14, and by the Committee on Interior and Insular Affairs on June 28, 1955, contained no authorization for Echo Park Dam.

### **Position of State of Colorado**

Immediately prior to the adjournment of the First Session of the 84th Congress, the Governor of Colorado in a public statement revealed that he and the people of his State could not support H. R. 3383, as amended and reported, because it did not provide sufficient assurance for the future development of consumptive-use projects in Colorado.

From an objective analysis of all problems concerned with securing the enactment of authorizing legislation by the Congress, it was ascertained between sessions that steps would have to be taken to secure unanimity of action by the Upper Division States and to eliminate as many of the opposing elements as possible. The problems and difficulties encountered in Congress and relative to the position of the State of Colorado were ably described by Congressman Aspinall (Colorado), Chairman of the Subcommittee on Irrigation and Reclamation of the House Committee on Interior and Insular Affairs in a statement to the Commission at its meeting on September 19, 1955.

### **Sources of Opposition**

The principal opposition to H. R. 3383 came from four rather well-defined sources. These sources were:

- (a) Certain interests in Southern California who objected to the construction of water storage facilities in the Upper Basin States in order to make possible the consumptive use of water there because they felt it would jeopardize the consumptive use of water and the production of extremely cheap electrical energy in the Lower Basin.
- (b) Officials and members of many conservation organizations who adhered to the proposition that no part of the national park system should be used for purposes other than those for which it was originally set aside.
- (c) So-called economy-minded organizations and individuals, especially in certain Eastern, Midwestern and Southern portions of the United States who did not believe in rec-

lamation, did not understand it, or who had been misled by false and misleading propaganda.

- (d) People in Colorado, especially in Western Colorado, who objected to the legislation on the grounds that H. R. 3383, as amended and reported, did not provide for sufficient and adequate benefits for the State of Colorado.

### Denver Conference

Under the auspices of Senator Clinton P. Anderson (New Mexico), Chairman of the Subcommittee on Irrigation and Reclamation of the Senate Committee on Interior and Insular Affairs, a conference of Senators, Congressmen and Governors of the Upper Division States and Members of the Upper Colorado River Commission was held in Denver, Colorado, on November 1, 1955 for the purpose of determining procedures to be followed in obtaining passage of legislation by the Second Session of the 84th Congress. At this meeting the Governor of Colorado forthrightly and ably presented the position of his State, including the recommendation that only Glen Canyon Dam be initially authorized and that the legislation include a formula for the division among the States of the power profits anticipated from the generation of power at Glen Canyon.

The results of the November 1 Conference can best be summarized by quoting the resolutions adopted by those present:

ACTIONS OF CONFERENCE OF  
SENATORS, CONGRESSMEN, GOVERNORS,  
UPPER COLORADO RIVER COMMISSIONERS  
on  
COLORADO RIVER STORAGE PROJECT LEGISLATION

Denver, Colorado

November 1, 1955

I

RESOLVED that we very much appreciate the action of the Governor of Colorado in coming to this meeting and presenting at length his viewpoint. We have appreciated particularly his statement of his desire to see an accomplishment flow from the results of this meeting beneficial to all of the Upper Colorado River Basin, and we all join unanimously in thanking him for his action as host in co-operation with the Senior Senator from Colorado, Mr. Millikin, and the Junior Senator, Mr. Allott.



## II

RESOLVED that it is the sense of this meeting that we do not approve a bill to authorize the Upper Colorado River Storage Project which would include only the Glen Canyon Dam.

## III

RESOLVED that, in the hope of getting action on an Upper Colorado River Storage Project bill in the present Congress, the Senators and Representatives present agree that they will not try to reinsert the Echo Park Dam.

## IV

RESOLVED that it is the sense of this meeting that the dams to be included in pending Upper Colorado River legislation should be Glen Canyon, Flaming Gorge, Curecanti, and Navajo.

In the event Colorado should desire to substitute some other dam for Curecanti, it was agreed that that should be done.

## V

RESOLVED that we favor the preparation of a formula to provide a construction schedule for the participating and contingent projects in the bills now before the Congress.

## VI

RESOLVED that if possible the Navajo Irrigation Project (Shiprock-South San Juan) be developed under the Leavitt Act or similar legislation.

## VII

RESOLVED that a committee be constituted to include one representative of each of the four states and a representative of the Upper Colorado River Commission to put the motions and resolutions in final form; and that upon completion of this task, the actions of the conference shall be presented by the committee to Governor Johnson and Congressman Wayne Aspinall.

And BE IT FURTHER RESOLVED that the committee be authorized to call further meetings to effect the purposes of these resolutions.

The members of the committee subsequently designated are as follows:

New Mexico	Senator Anderson, Chairman
Colorado	Senator Millikin with Senator Allott as his alternate
Utah	Senator Watkins
Wyoming	Senator O'Mahoney
Upper Colorado River Commission	Ival V. Goslin, Engineer- Secretary

### Proposals to Amend H. R. 3383

At Cheyenne, Wyoming, on December 21, 1955, at a special meeting of the Commission, the Colorado Commissioner reiterated the stand of Colorado that authorizing legislation should provide for a percentage division of power revenue credits in the Basin Fund among the States. He also proposed that the revenues from the Central Utah Project should be credited towards the cost of that project for the benefit of the State of Utah. Several other suggestions concerning amendments to H. R. 3383 pending in Congress were made at this meeting including two proposals by the New Mexico Commissioner to make non-reimbursable the costs of the Navajo Indian irrigation project that are beyond the capability of the Indians to repay, and to base percentage allocations of power revenues to the States in general on unused portions of water allocations remaining to each State under the Upper Colorado River Basin Compact. Instructions were given to the Engineering Committee directing it to take the principles agreed to and derive a formula for the apportionment of power revenue credits in the Basin Fund among the States.

### The Santa Fe Accord

The Engineering Committee of the Upper Colorado River Commission met in Salt Lake City, Utah, on December 30, 1955. Its report was made to the Commission at Santa Fe, New Mexico, at a special meeting on January 5, 1956.

Based primarily upon the recommendations of the Engineering Committee, the Commission at Santa Fe recommended certain amendments to H. R. 3383. These amendments were submitted to the Chairman of the Irrigation and Reclamation Subcommittee of the House. After many meetings of the Members of the House from the Upper Basin States to consider final language of the



amendments an agreement on language and intent of the amendments was reached, and the amendments submitted to the House Committee on Interior and Insular Affairs.

### **Supplemental Report—Substitute Bill**

After the Chairman of the House Committee obtained unanimous consent from the House of Representatives to file a supplemental report (Part 2, Report 1087) to H. R. 3383, the Committee on February 8, 1956 by a vote of 13 to 3 amended H. R. 3383 in the form of a Substitute Bill to provide for an apportionment of power revenues among the States, etc., substantially as recommended by the Upper Colorado River Commission. Two other amendments were also included. These pertained to protection of Rainbow Bridge National Monument in the Glen Canyon Reservoir area and to the intent of Congress that no dam or reservoir authorized by H. R. 3383 could be constructed within any national park or monument. These latter provisions were necessary because by the last part of January, 1956, officials of conservation organizations throughout the nation had been assured that the Senators and Representatives from the Upper Basin States would not press for the inclusion of the Echo Park Dam in the joint Senate-House Conference Committee. As a result of this assurance most of these organizations agreed to withdraw their opposition to the passage of H. R. 3383 providing the bill would contain these amendments.

### **H. R. 3383 Passed by House**

On March 1, 1956, H. R. 3383, in the nature of a substitute with one additional amendment offered from the floor of the House, was passed by the House by a roll-call vote of 256 to 136. The amendment to which reference is made prohibits for a period of ten years the delivery of water to newly-irrigated lands of participating projects if those lands are raising basic agricultural commodities that are in surplus.

The House adopted the Senate Bill, S. 500, struck everything after the enacting clause, substituted the language of the substitute for H. R. 3383, as amended, and submitted the bill, S. 500 as amended by the House to the Senate-House Conference Committee.

The final language agreed to on March 15, 1956 in the Conference Report to accompany S. 500 is as follows:



AUTHORIZING THE SECRETARY OF THE INTERIOR TO CONSTRUCT,  
OPERATE, AND MAINTAIN THE COLORADO RIVER STORAGE PROJ-  
ECT AND PARTICIPATING PROJECTS.

CONFERENCE REPORT

(To accompany S. 500)

The committee of conference on the disagreeing votes of the two Houses on the amendments of the House to the bill (S. 500) entitled "AN ACT TO AUTHORIZE THE SECRETARY OF THE INTERIOR TO CONSTRUCT, OPERATE, AND MAINTAIN THE COLORADO RIVER STORAGE PROJECT AND PARTICIPATING PROJECTS, AND FOR OTHER PURPOSES," having met, after full and free conference, have agreed to recommend and do recommend to their respective Houses as follows:

That the Senate recede from its disagreement to the amendment of the House, and agree to the same with an amendment, as follows:

In lieu of the matter inserted by the House amendment insert the following: That, in order to initiate the comprehensive development of the water resources of the Upper Colorado River Basin, for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for the reclamation of arid and semiarid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes, the Secretary of the Interior is hereby authorized (1) to construct, operate, and maintain the following initial units of the Colorado River storage project, consisting of dams, reservoirs, powerplants, transmission facilities and appurtenant works: Curecanti, Flaming Gorge, Navajo (dam and reservoir only), and Glen Canyon: Provided, That the Curecanti Dam shall be constructed to a height which will impound not less than nine hundred and forty thousand acre-feet of water or will create a reservoir of such greater capacity as can be obtained by a high waterline located at seven thousand five hundred and twenty feet above mean sea level, and that construction thereof shall not be undertaken until the Secretary has, on the basis of further engineering and economic investigations, reexamined the economic justification of such unit and, accompanied by appropriate documentation in the form of a supplemental report, has certified to the Congress and to the President that, in his judgment, the benefits of such unit will exceed its costs; and (2) to construct, operate, and maintain the following additional reclamation projects (including power-generating and transmission facilities related thereto), hereinafter referred to as participating projects: Central Utah (initial phase); Emery County, Florida, Hammond, La Barge, Lyman, Paonia (including the Minnesota unit, a dam and reservoir on Muddy Creek just above its confluence with the North Fork of the Gunnison River, and other necessary works), Pine River Extension, Seedskaadee, Silt and Smith Fork: Provided further, That as part of the Glen Canyon Unit the Sec-



retary of the Interior shall take adequate protective measures to preclude impairment of the Rainbow Bridge National Monument.

Sec. 2. In carrying out further investigations of projects under the Federal reclamation laws in the Upper Colorado River Basin, the Secretary shall give priority to completion of planning reports on the Gooseberry, San Juan-Chama, Navajo, Parshall, Troublesome, Rabbit Ear, Eagle Divide, San Miguel, West Divide, Bluestone, Battlement Mesa, Tomichi Creek, East River, Ohio Creek, Fruitland Mesa, Bostwick Park, Grand Mesa, Dallas Creek, Savery-Pot Hook, Dolores, Fruit Growers Extension, Animas-La Plata, Yellow Jacket, and Sublette participating projects. Said reports shall be completed as expeditiously as funds are made available therefor and shall be submitted promptly to the affected States, which in the case of the San Juan-Chama project shall include the State of Texas, and thereafter to the President and the Congress: Provided, That with reference to the plans and specifications for the San Juan-Chama project, the storage for control and regulation of water imported from the San Juan River shall (1) be limited to a single offstream dam and reservoir on a tributary of the Chama River, (2) be used solely for control and regulation and no power facilities shall be established, installed or operated thereat, and (3) be operated at all times by the Bureau of Reclamation of the Department of the Interior in strict compliance with the Rio Grande Compact as administered by the Rio Grande Compact Commission. The preparation of detailed designs and specifications for the works proposed to be constructed in connection with projects shall be carried as far forward as the investigations thereof indicate is reasonable in the circumstances.

The Secretary, concurrently with the investigations directed by the preceding paragraph, shall also give priority to completion of a planning report on the Juniper project.

Sec. 3. It is not the intention of Congress, in authorizing only those projects designated in section 1 of this Act, and in authorizing priority in planning only those additional projects designated in section 2 of this Act, to limit, restrict, or otherwise interfere with such comprehensive development as will provide for the consumptive use by States of the Upper Colorado River Basin of waters, the use of which is apportioned to the Upper Colorado River Basin by the Colorado River Compact and to each State thereof by the Upper Colorado River Basin Compact, nor to preclude consideration and authorization by the Congress of additional projects under the allocations in the compacts as additional needs are indicated. It is the intention of Congress that no dam or reservoir constructed under the authorization of this Act shall be within any national park or monument.

Sec. 4. Except as otherwise provided in this Act, in constructing, operating, and maintaining the units of the Colorado River storage project and the participating projects listed in section 1 of this Act, the Secretary shall be governed by the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and Acts amendatory thereof or supplementary thereto): Provided, That (a) irrigation repayment contracts shall be entered into which, except as otherwise provided for the Paonia and Eden projects, provide for repayment of the obligation assumed thereunder with respect to any project contract unit over a period of not more than fifty years exclusive of any development period authorized by law; (b) prior to construction of irrigation distribution facilities, repayment contracts shall be made with an "organization" as defined in paragraph 2 (g) of the Reclamation Project Act of 1939 (53 Stat. 1187) which



has the capacity to levy assessments upon all taxable real property located within its boundaries to assist in making repayments, except where a substantial proportion of the lands to be served are owned by the United States; (c) contracts relating to municipal water supply may be made without regard to the limitations of the last sentence of section 9 (c) of the Reclamation Project Act of 1939; and (d), as to Indian lands within, under or served by any participating project, payment of construction costs within the capability of the land to repay shall be subject to the Act of July 1, 1932 (47 Stat. 564): Provided further, That for a period of ten years from the date of enactment of this Act, no water from any participating project authorized by this Act shall be delivered to any water user for the production on newly irrigated lands of any basic agricultural commodity, as defined in the Agricultural Act of 1949, or any amendment thereof, if the total supply of such commodity for the marketing year in which the bulk of the crop would normally be marketed is in excess of the normal supply as defined in section 301 (b) (10) of the Agricultural Adjustment Act of 1938, as amended, unless the Secretary of Agriculture calls for an increase in production of such commodity in the interest of national security. All units and participating projects shall be subject to the apportionments of the use of water between the Upper and Lower Basins of the Colorado River and among the States of the Upper Basin fixed in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, and to the terms of the treaty with the United Mexican States (Treaty Series 994).

Sec. 5. (a) There is hereby authorized a separate fund in the Treasury of the United States to be known as the Upper Colorado River Basin Fund (hereinafter referred to as the Basin Fund), which shall remain available until expended, as hereafter provided, for carrying out provisions of this Act other than section 8.

(b) All appropriations made for the purpose of carrying out the provisions of this Act, other than section 8, shall be credited to the Basin Fund as advances from the general fund of the Treasury.

(c) All revenues collected in connection with the operation of the Colorado River storage project and participating projects shall be credited to the Basin Fund, and shall be available, without further appropriation, for (1) defraying the costs of operation, maintenance, and replacements of, and emergency expenditures for, all facilities of the Colorado River storage project and participating projects, within such separate limitations as may be included in annual appropriation acts: Provided, That with respect to each participating project, such costs shall be paid from revenues received from each such project; (2) payment as required by subsection (d) of this section; and (3) payment as required by subsection (e) of this section. Revenues credited to the Basin Fund shall not be available for appropriation for construction of the units and participating projects authorized by or pursuant to this Act.

(d) Revenues in the Basin Fund in excess of operating needs shall be paid annually to the general fund of the Treasury to return—

(1) the costs of each unit, participating project, or any separable feature thereof which are allocated to power pursuant to section 6 of this Act, within a period not exceeding fifty years from the date of completion of such unit, participating project, or separable feature thereof;

(2) the costs of each unit, participating project, or any separable feature thereof which are allocated to municipal water supply pursuant to



section 6 of this Act, within a period not exceeding fifty years from the date of completion of such unit, participating project, or separable feature thereof;

(3) interest on the unamortized balance of the investment (including interest during construction) in the power and municipal water supply features of each unit, participating project, or any separable feature thereof, at a rate determined by the Secretary of the Treasury as provided in subsection (f), and interest due shall be a first charge; and

(4) the costs of each storage unit which are allocated to irrigation pursuant to section 6 of this Act within a period not exceeding fifty years.

(e) Revenues in the Basin Fund in excess of the amounts needed to meet the requirements of clause (1) of subsection (c) of this section, and to return to the general fund of the Treasury the costs set out in subsection (d) of this section, shall be apportioned among the States of the Upper Division in the following percentages: Colorado, 46 per centum; Utah, 21.5 per centum; Wyoming, 15.5 per centum; and New Mexico, 17 per centum: Provided, That prior to the application of such percentages, all revenues remaining in the Basin Fund from each participating project (or part thereof), herein or hereinafter authorized, after payments, where applicable, with respect to such projects, to the general fund of the Treasury under subparagraphs (1), (2), and (3) of subsection (d) of this section shall be apportioned to the State in which such participating project, or part thereof, is located.

Revenues so apportioned to each State shall be used only for the repayment of construction costs of participating projects or parts of such projects in the State to which such revenues are apportioned and shall not be used for such purpose in any other State without the consent, as expressed through its legally constituted authority, of the State to which such revenues are apportioned. Subject to such requirement, there shall be paid annually into the general fund of the Treasury from the revenues apportioned to each State (1) the costs of each participating project herein authorized (except Paonia) or any separable feature thereof, which are allocated to irrigation pursuant to section 6 of this Act, within a period not exceeding fifty years, in addition to any development period authorized by law, from the date of completion of such participating project or separable feature thereof, or, in the case of Indian lands, payment in accordance with section 4 of this Act; (2) costs of the Paonia project, which are beyond the ability of the water users to repay, within a period prescribed in the Act of June 25, 1947 (61 Stat. 181); and (3) costs in connection with the irrigation features of the Eden project as specified in the Act of June 28, 1949 (63 Stat. 277).

(f) The interest rate applicable to each unit of the storage project and each participating project shall be determined by the Secretary of the Treasury as of the time the first advance is made for initiating construction of said unit or project. Such interest rate shall be determined by calculating the average yield to maturity on the basis of daily closing market bid quotations during the month of June next preceding the fiscal year in which said advance is made, on all interest-bearing marketable public debt obligations of the United States having a maturity date of fifteen or more years from the first day of said month, and by adjusting such average annual yield to the nearest one-eighth of 1 per centum.

(g) Business-type budgets shall be submitted to the Congress annually for all operations financed by the Basin Fund.



Sec. 6. Upon completion of each unit, participating project or separable feature thereof, the Secretary shall allocate the total costs (excluding any expenditures authorized by section 8 of this Act) of constructing said unit, project or feature to power, irrigation, municipal water supply, flood control, navigation, or any other purposes authorized under reclamation law. Allocations of construction, operation and maintenance costs to authorized non-reimbursable purposes shall be non-returnable under the provisions of this Act. In the event that the Navajo participating project is authorized, the costs allocated to irrigation of Indian-owned tribal or restricted lands within, under, or served by such project, and beyond the capability of such lands to repay, shall be determined, and, in recognition of the fact that assistance to the Navajo Indians is the responsibility of the entire nation, such costs shall be nonreimbursable. On January 1 of each year the Secretary shall report to the Congress for the previous fiscal year, beginning with the fiscal year 1957, upon the status of the revenues from, and the cost of, constructing, operating, and maintaining the Colorado River storage project and the participating projects. The Secretary's report shall be prepared to reflect accurately the Federal investment allocated at that time to power, to irrigation, and to other purposes, the progress of return and repayment thereon, and the estimated rate of progress, year by year, in accomplishing full repayment.

Sec. 7. The hydroelectric powerplants and transmission lines authorized by this Act to be constructed, operated, and maintained by the Secretary shall be operated in conjunction with other Federal powerplants, present and potential, so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates, but in the exercise of the authority hereby granted he shall not affect or interfere with the operation of the provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, the Boulder Canyon Project Act, the Boulder Canyon Project Adjustment Act and any contract lawfully entered into under said Compacts and Acts. Subject to the provisions of the Colorado River Compact, neither the impounding nor the use of water for the generation of power and energy at the plants of the Colorado River storage project shall preclude or impair the appropriation of water for domestic or agricultural purposes pursuant to applicable State law.

Sec. 8. In connection with the development of the Colorado River storage project and of the participating projects, the Secretary is authorized and directed to investigate, plan, construct, operate, and maintain (1) public recreational facilities on lands withdrawn or acquired for the development of said project or of said participating projects, to conserve the scenery, the natural, historic, and archeologic objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects by such means as are consistent with the primary purposes of said projects; and (2) facilities to mitigate losses of, and improve conditions for, the propagation of fish and wildlife. The Secretary is authorized to acquire lands and to withdraw public lands from entry or other disposition under the public land laws necessary for the construction, operation, and maintenance of the facilities herein provided, and to dispose of them to Federal, State, and local governmental agencies by lease, transfer, exchange, or conveyance upon such terms and conditions as will best promote their development and operation in the public interest. All costs incurred pursuant to this section shall be nonreimbursable and nonreturnable.

Sec. 9. Nothing contained in this Act shall be construed to alter, amend,



repeal, construe, interpret, modify, or be in conflict with the provisions of the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774), the Colorado River Compact, the Upper Colorado River Basin Compact, the Rio Grande Compact of 1938, or the Treaty with the United Mexican States (Treaty Series 994).

Sec. 10. Expenditures for the Flaming Gorge, Glen Canyon, Curecanti, and Navajo initial units of the Colorado River storage project may be made without regard to the soil survey and land classification requirements of the Interior Department Appropriation Act, 1954.

Sec. 11. The Final Judgment, Final Decree and stipulations incorporated therein in the consolidated cases of United States of America v. Northern Colorado Water Conservancy District, et al., Civil Nos. 2782, 5016 and 5017, in the United States District Court for the District of Colorado, are approved, shall become effective immediately, and the proper agencies of the United States shall act in accordance therewith.

Sec. 12. There are hereby authorized to be appropriated, out of any moneys in the Treasury not otherwise appropriated, such sums as may be required to carry out the purposes of this Act, but not to exceed \$760,000,000.

Sec. 13. In planning the use of, and in using credits from, net power revenues available for the purpose of assisting in the pay-out of costs of participating projects herein and hereafter authorized in the States of Colorado, New Mexico, Utah, and Wyoming, the Secretary shall have regard for the achievement within each of said States of the fullest practicable use of the waters of the Upper Colorado River system, consistent with the apportionment thereof among such States.

Sec. 14. In the operation and maintenance of all facilities, authorized by Federal law and under the jurisdiction and supervision of the Secretary of the Interior, in the basin of the Colorado River, the Secretary of the Interior is directed to comply with the applicable provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, the Boulder Canyon Project Act, the Boulder Canyon Project Adjustment Act, and the Treaty with the United Mexican States, in the storage and release of water from reservoirs in the Colorado River Basin. In the event of the failure of the Secretary of the Interior to so comply, any State of the Colorado River Basin may maintain an action in the Supreme Court of the United States to enforce the provisions of this section, and consent is given to the joinder of the United States as a party in such suit or suits, as a defendant or otherwise.

Sec. 15. The Secretary of the Interior is directed to continue studies and to make a report to the Congress and to the States of the Colorado River Basin on the quality of water of the Colorado River.

Sec. 16. As used in this Act—

The terms "Colorado River Basin", "Colorado River Compact", "Colorado River System", "Lee Ferry", "States of the Upper Division", "Upper Basin", and "domestic use" shall have the meaning ascribed to them in article II of the Upper Colorado River Basin Compact;

The term "States of the Upper Colorado River Basin" shall mean the States of Arizona, Colorado, New Mexico, Utah, and Wyoming;



The term "Upper Colorado River Basin" shall have the same meaning as the term "Upper Basin";

The term "Upper Colorado River Basin Compact" shall mean that certain compact executed on October 11, 1948 by commissioners representing the States of Arizona, Colorado, New Mexico, Utah, and Wyoming, and consented to by the Congress of the United States of America by Act of April 6, 1949 (63 Stat. 31);

The term "Rio Grande Compact" shall mean that certain compact executed on March 18, 1938, by commissioners representing the States of Colorado, New Mexico, and Texas and consented to by the Congress of the United States of America by Act of May 31, 1939 (53 Stat. 785);

The term "Treaty with the United Mexican States" shall mean that certain treaty between the United States of America and the United Mexican States, signed at Washington, District of Columbia, February 3, 1944, relating to the utilization of the waters of the Colorado River and other rivers, as amended and supplemented by the protocol dated November 14, 1944, and the understandings recited in the Senate resolution of April 18, 1945, advising and consenting to ratification thereof.

And the House agree to the same.

Clair Engle,  
Wayne N. Aspinall,  
Leo W. O'Brien,  
William A. Dawson,  
John P. Saylor,

Managers on the Part of the House.

Clinton P. Anderson,  
Henry M. Jackson,  
Joseph C. O'Mahoney,  
Eugene D. Millikin,  
Arthur V. Watkins,

Managers on the Part of the Senate.

#### STATEMENT OF THE MANAGERS ON THE PART OF THE HOUSE

The managers on the part of the House at the conference on the disagreeing votes of the two Houses on the amendment of the House to the bill (S. 500) to authorize the Secretary of the Interior to construct, operate, and maintain the Colorado River storage project and participating projects, and for other purposes, submit the following statement in explanation of the effect of the language agreed upon and recommended in the accompanying conference report. The language incorporates the recommendations of the conference committee with respect to each of the differences between the Senate and House bills.

#### Scope of the Project

With respect to the scope of the project, the conference committee agreed to retain in the bill for authorization only the four storage units and eleven participating projects in the House-approved bill.

The matter of retaining intact our national park system was an important issue in the consideration by Congress of this legislation. The House-approved bill—

- (1) deleting the Echo Park storage unit;
- (2) requiring "protective measures to preclude impairment of the Rainbow Bridge National Monument"; and
- (3) expressing the "intention of Congress that no dam or reservoir constructed under the authorization of this Act shall be within any national park or monument"—

makes clear the intention of the House that there be no invasion or impairment of the national park system by the works authorized to be constructed under this legislation. The conference committee upheld the House position and adopted the House-approved language.

The Juniper project would have been authorized as a storage unit by the language in the Senate bill. The House language would have required the Secretary to give priority to completion of a planning report on the Juniper unit in the event he found the Curecanti unit infeasible. The conference committee adopted substitute language, which requires that priority be given to completion of a planning report on the Juniper project but removes the contingency in the House language and does not specify whether the Juniper project is to be a storage unit or a participating project.

The conference committee adopted House language requiring the Secretary to give priority to completion of planning reports on certain participating projects including those, except Woody Creek, which would have been conditionally authorized by the language in the Senate bill.

The sum of \$760 million remains in the bill as the amount authorized to be appropriated. However, the conference committee, in retaining this amount in the bill, agreed that it should not be earmarked project-wise and that there is no prohibition against the use of such funds for the construction of the Curecanti unit, subject to the certification by the Secretary required in section 1 of the act.

#### **Repayment Plan and Basin Fund**

With respect to the repayment plan incorporated in the legislation, the conference committee agreed to and adopted language in the Senate bill, which requires the repayment with interest of costs allocated to power in not to exceed 50 years—a requirement that is in accordance with presently established policy.

The House-approved bill contained language setting out certain accounting and funding requirements to be made applicable to the basin fund. The conference committee adopted the language of the House bill, which provides for the establishment, from surplus power revenues of the storage project, of credits, within the basin fund, to each State of the upper basin for financial assistance to irrigation development in such State. It should be understood that the revenues thus credited to the States are only for use, within the individual States, in assisting the construction of Federal reclamation projects and shall not be used for any other purpose.



## Indian Lands

The House-approved bill contained language making nonreimbursable the costs allocated to irrigation of Indian lands which are beyond the capability of such lands to repay. The conference committee agreed to and adopted substitute language limiting this provision to the Navajo participating project. This language was adopted in recognition of the fact that assistance to the Navajo Indians is the responsibility of the entire Nation and not just the upper basin States.

## Operation of Power Facilities

Section 7 of the House-approved bill, containing a grant of authority to the Secretary of the Interior relating to operation of the power facilities authorized to be constructed by S. 500, has been amended by the conference committee in two respects.

The first sentence of section 7, directing the Secretary to operate such facilities so as to produce the greatest amount of power and energy that can be sold at firm rates, has been amended through adoption of substitute language which relates to the grant of authority to the Secretary, and provides that such operation—

\* \* \* shall not affect or interfere with the operations of the provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, the Boulder Canyon Project Act, the Boulder Canyon Project Adjustment Act and any contract lawfully entered into under said Compacts and Acts.

This language has been adopted to make clear the intent that all of the instruments constituting the law of the Colorado River shall be read together by the Secretary of the Interior in the operation of the power facilities authorized to be constructed, operated, and maintained by this legislation.

In a similar vein the conference committee has adopted an amendment in the nature of a substitute for the House-approved language contained in the second sentence in section 7. The language of this sentence, which deals with the impounding and use of water for the generation of power and energy at the plants of the Colorado River storage project, has been rewritten to make clear the intent of Congress that, subject to the provisions of the Colorado River compact, such impounding and use shall be subservient to the appropriation of water for domestic or agricultural purposes.

## Approval of Final Court Decree Relating to Blue River Water

The Senate bill contained language authorizing conveyance to the city of Denver of certain water rights used for the production of power at Green Mountain Dam on the Blue River in Colorado. The conference committee adopted substitute language. These water rights have been the subject of prolonged litigation between the United States, Denver, and water users on both the eastern and western slopes of Colorado in the consolidated cases of the **United States of America v. Northern Colorado Water Conservancy District, et al.**, in the United States District Court for the District of Colorado. Since the Senate action on S. 500, agreement has been reached between representatives of the eastern slope and western slope of Colorado, and a final decree has been filed by the United States district court in this matter. Copies of the final decree and stipulations have been submitted to the Congress. The substitute language adopted by the conference committee gives immediate congress-

sional approval to the final judgment, final decree and stipulations and instructs the proper agencies of the United States to act in accordance therewith.

#### **Planning of Future Projects**

With respect to House language in section 13 of the bill, relating to the planning of future projects by the Secretary, the conference committee adopted substitute language which does not change the intended purpose of this section. The intention of the language is to require the Secretary, in planning additional developments in the upper basin, to give consideration to achievement, within each of the States, of the fullest practicable use of the water apportioned to each State. Since, under section 5, revenues to assist irrigation development are apportioned to the States on the basis of the estimated percentages of upper-basin water remaining to be developed in each such State, the intention of this section could also be stated as requiring the Secretary, in planning future projects, to give consideration to the revenues which it is anticipated will be available for repayment of such projects.

#### **Consent to Suit of United States**

Section 14 of the bill, which gives consent to joinder of the United States as a party to an action or actions by any State of the Colorado River Basin asserting noncompliance with the provisions of law made applicable by this section, has been amended to make clear the intent of Congress that the United States may be joined as a party thereto as a defendant or otherwise.

#### **Quality-of-Water Studies**

The House-approved bill included language in section 15 requiring the Secretary of the Interior to make certain quality-of-water studies. The conference committee adopted substitute language which, although not as specific, accomplishes the same purpose and recognizes that such studies are already required by law and are underway.

#### **Other Differences Between House and Senate Language**

With respect to all other major differences between the House and the Senate bills not discussed hereinbefore, the conference committee concurred in and adopted the House language.

In conclusion, one additional observation appears in order: Throughout the hearings and deliberations of the House Committee on Interior and Insular Affairs on this legislation, in floor presentation and debate, and in the several sessions of the conference committee, there has existed unity of understanding and agreement on the purpose of this legislation. That purpose is to authorize the construction of the Colorado River storage project and participating projects and to provide for the operation of the facilities thereof in accordance with the law of the Colorado River.

Clair Engle,  
Wayne N. Aspinall,  
Leo W. O'Brien,  
William A. Dawson,  
John P. Saylor,

Managers on the Part of the House.



## Legislative History

The following table consists of a series of pertinent events of recent years leading to the passage of legislation by the Congress of the United States to make possible the development of the water and power resources of the Upper Colorado River Basin:

### SUMMARY OF EVENTS IN THE LEGISLATIVE HISTORY OF THE ACT TO AUTHORIZE THE CONSTRUCTION OF THE COLORADO RIVER STORAGE PROJECT AND PARTICIPATING PROJECTS

The legislative history of the authorization of the Colorado River Storage Project by the 84th Congress might be construed as having started on December 21, 1928 when Congress passed the Boulder Canyon Project Act. This Act initially provided for \$250,000 from the Colorado River Dam Fund to be used for investigations, comprehensive surveys and reports on projects in the Colorado River Basin.

The Boulder Canyon Project Adjustment Act of July 19, 1940 provided \$500,000 in a Colorado River Development Fund for investigations, surveys and construction of projects. In recent years, all of this Fund has been used in the Upper Basin. This Fund contributed to the completion by the Department of Interior in 1946 of a comprehensive report on development of the Colorado River.

The 1946 report of the Department of Interior recommended that the Upper Basin States should enter into a compact agreement apportioning among themselves the consumptive use of waters that had been previously allocated to the Upper Basin by the Colorado River Compact of 1922.

#### EIGHTIETH CONGRESS, 1947-1948

##### HOUSE

##### SENATE

January 30, 1948, S. 2095 (Watkins) introduced to authorize the construction of the Central Utah Project.

March 18, 1948, S. 2346 (Robertson, Wyo.) introduced.

May 24, 1948, S. 2346 passed by Senate (S. Report 127).

June 1, 1948, companion bill H. R. 5901 approved (H. Report 127).

#### Public Law 570

Provided that the Colorado River Development Fund for years 1949-1955 should be divided as equally as practicable among the four Upper Division States and provided for the appropriation of additional funds for investigation and construction of projects.

EIGHTY-FIRST CONGRESS, 1949-1950

HOUSE

SENATE

**H. R. 8980** (Granger) and **H. R. 9014** (Bosone) introduced. Reports were requested from the Department of Interior but were not received. No hearings were held.

March 23, 1949, **S. 790** passed by House of Representatives (H. Report 270).

January 5, 1949, **S. 168** (Watkins) introduced to authorize construction of the Central Utah Project.

January 18, 1949, **S. 168** referred to the Department of Interior.

February 3, 1949 **S. 790** introduced to grant consent of the United States to the UPPER COLORADO RIVER BASIN COMPACT.

February 7, 1949, **S. 790** ordered reported favorably to the Senate by the Committee on Interior and Insular Affairs.

March 18, 1949, **S. 790** passed by Senate (S. Report 39).

April 6, 1949, **S. 790** approved by the President.

August 26, 1949, Report on Central Utah Project by the Regional Director of the Bureau of Reclamation.

June 28, 1950, **S. 3839** (Thomas) introduced to authorize Colorado River Storage Project.

June 29, 1950, **S. 3839** was referred to the Department of Interior and Bureau of the Budget.

July 26, 1950, Bureau of the Budget advised that **S. 3839** should be held up for further report.

December 15, 1950, Interim Report on Colorado River Storage Project made by Regional Director of the Bureau of Reclamation.

EIGHTY-SECOND CONGRESS, 1951-1952

No legislation introduced.



## HOUSE

## SENATE

February-June, 1951, States of the Colorado River Basin submitted comments on the Colorado River Storage Project to Department of Interior.

March-July, 1951, comments submitted on Project Report by Federal Security Agency, Department of Commerce, Federal Power Commission, Department of Agriculture and Department of Army.

April 16, 1952, S. 3013 (Watkins and Bennett) introduced to authorize Colorado River Storage Project.

April 17, 1952, S. 3013 referred to Department of Interior and Bureau of the Budget.

June 2, 1952, report on S. 3013 received from Bureau of the Budget.

December 4, 1952, Department of Interior submitted its report proposing a basin-wide plan of development for the Upper Colorado River Basin.

### EIGHTY-THIRD CONGRESS, 1953-1954

January 27, 1953, Bureau of the Budget requested Department of Interior to review report of previous Administration on Colorado River Storage Project.

April 2, 1953, H. R. 4443 (Aspinall) H. R. 4449 (Dawson) and H. R. 4463 (Stringfellow) introduced.

April 2, 1953, S. 1555 introduced (Millikin, Anderson, Barrett, Bennett, Chavez, Goldwater, Hayden, Hunt, Johnson, Watkins).

September 18, 1953, report requested from Department of Interior.

April 3, 1953, S. 1555 referred to Department of Interior and Bureau of the Budget.

May 29, 1953, S. 1555 referred to Federal Power Commission, Department of the Army, Department of Agriculture.

November 13, 1953, Supplemental Report on Colorado River Storage Project submitted by Commissioner of Reclamation.

December 10, 1953, Supplemental Report of Commissioner of Reclamation approved and adopted by the Secretary of the Interior.

## HOUSE

January 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, March 8, 9, 10, 22, April 7, 8, 9, 13, 14, 1954 hearings before Irrigation and Reclamation Subcommittee.

April 2, 1954, report from State Department with no objections.

May 3, 1954, Subcommittee by vote of 12 to 9 reported **H. R. 4449** to Committee on Interior and Insular Affairs with amendments.

May 18, 1954, full Committee by vote of 13 to 12 ordered **H. R. 4449** reported to House with amendments.

June 9, 1954, reported in House (H. Report 1774).

June 30, 1954, comments received from Department of Agriculture.

July 27, 1954, Rule requested. **H. R. 4449** died in Rules Committee.

## SENATE

March 18, 1954, favorable report received from Bureau of the Budget providing bill amended.

April 1, 1954, substitute bill recommended by Department of Interior.

April 8, 1954, Bureau of Budget advised that interested Federal departments will report on substitute bill recommended by Interior Department.

June 14, 1954, Department of Army recommended Interior Department substitute bill.

June 18, 1954, Federal Power Commission approved amended bill.

June 28-July 3, 1954, Senate Subcommittee on Irrigation and Reclamation conducted hearings on **S. 1555**.

June 30, 1954, Department of Agriculture reported that "... since both **S. 1555** and the Administration substitute draft bill relate primarily to Department of the Interior authority this Department takes no position regarding enactment of the bill."

July 24, 1954, **S. 1555** reported by Subcommittee with an amendment in the nature of a substitute. Ordered reported favorably by full Committee as amended.

July 26, 1954, amended **S. 1555** reported to Senate.

August 11, 1954, **S. 1555** objected to on call of the calendar by Mr. Smathers.



## HOUSE

## SENATE

August 18, 1954, S. 1555 objected to on call of the calendar by Mr. Henrickson.

August 19-20, 1954, S. 1555 debated by Senate and set aside for consideration of other measures. This and House bill were pending matters of business on adjournment of 83d Congress.

### EIGHTY-FOURTH CONGRESS 1955-1956

January 6, 1955, President Eisenhower urged passage of Colorado River Storage Project in State of Union Message.

January 17, 1955, President Eisenhower in his Annual Budget Message recommended earmarking \$5,000,000 to initiate construction contingent upon Congressional approval during fiscal year 1956.

January 5, 1955, **H. R. 270** (Dawson) introduced.

January 24, 1955, **H. R. 2836** (Fernandez) introduced.

February 2, 1955 **H. R. 3383** (Aspinall) introduced.

February 2, 1955, **H. R. 3384** (Aspinall) introduced by request.

February 3, 1955, report requested from Department of Interior.

February 28, 1955, **H. R. 4488** (Rogers) introduced.

March 8, 1955, Interior reported favorably if bill were to be amended.

March 9, 10, 11, 14, 16, 17, 18, 19, 28 and April 18, 20, and 22, 1955, hearings held by Subcommittee on Irrigation and Reclamation.

June 6, 8, 9, 10, 13, 1955, Subcommittee meetings.

January 18, 1955, **S. 500** (introduced by Anderson, Allott, Barrett, Bennett, Chavez, Goldwater, Hayden, Millikin, Watkins, O'Mahoney) to authorize the construction of Colorado River Storage Project.

January 20, 1955, **S. 500** referred to Bureau of the Budget and Department of Interior.

January 21, 1955, **S. 500** referred to Department of Agriculture, Department of Army and Federal Power Commission.

February 25, 1955, Department of Interior reported favorably on **S. 500**.

February 28-March 5, 1955, Subcommittee on Irrigation and Reclamation held hearings on **S. 500**.

March 17-28, 1955, reports on **S. 500** received from Bureau of Budget, Federal Power Commission, and Department of Agriculture.

## HOUSE

June 14, 1955, Subcommittee reported **H. R. 3383** with amendments by a vote of 18 to 6 to Committee on Interior and Insular Affairs.

June 28, 1955, Interior Committee by a vote of 20 to 6 ordered **H. R. 3383** with amendments reported favorably to House of Representatives.

July 6, 1955, Rule requested.

July 8, 1955, reported in House with amendments (Report 1087).

July 21, 1955, Rule granted by Rules Committee (H. Res. 311, Report 1332).

November 1, 1955, Conference of Senators, Congressmen and Governors of the four Upper Division States and members of Upper Colorado River Commission in Denver, Colorado, adopted resolutions concerning recommended changes in legislation pending before the Congress.

January 5, 1956, President Eisenhower recommends earmarking of \$8,000,000 in Annual Budget Message to start construction.

January 16, 1956, President Eisenhower again recommends earmarking of \$8,000,000 in Annual Budget Message to start construction.

January 23, 1956, Conservation organizations announced withdrawal of opposition to Colorado River Storage Project.

February 8, 1956, Committee on Interior and Insular Affairs by a vote of 13 to 3, amended **H. R. 3383** as a substitute bill.

February 14, 1956, Supplemental Report (Part 2, Report 1087) was filed by the Chairman of the Committee on Interior and Insular Affairs with the House of Representatives.

March 1, 1956, House passed **H. R. 3383** by a vote of 256 to 136.

## SENATE

March 29, 1955, **S. 500** reported favorably by Subcommittee and by full Senate Interior and Insular Affairs Committee to the Senate by a vote of 11 to 1 (S. Report 128).

April 6, 1955, report on **S. 500** received from Department of Army.

April 20, 1955, **S. 500** passed Senate by vote of 58 to 23.



## HOUSE

## SENATE

March 8, 1956, Joint Senate-House Conference Committee began consideration of Bills approved by House and Senate.

March 15, 1956, Joint Conference Committee agreed on final language of Conference Report.

March 27, 1956, Conference Report and the Statement of the Managers on the Part of the House filed.

March 28, 1956, Conference Report approved by the House.

March 28, 1956, Conference Report approved by Senate.

April 11, 1956, President Eisenhower signed **Conference Bill S. 500**, enacting into Law the Bill to authorize construction of the Colorado River Storage Project. Public Law No. 485, 84th Congress.

From the standpoint of legislation under which the Upper Basin States have been seeking for many years "to secure the expeditious agricultural and industrial development of the Upper Basin" the year covered by this Annual Report has been one of great accomplishment. The passage of S. 500 by the Senate and H. R. 3383 by the House of Representatives constitutes ample reason for people of this area to look to the future with renewed hopes. Each member of the Commission, members of his staff, and the citizens of his State can take great pride in what has been done.

### Acknowledgments

The Commission acknowledges with appreciation the assistance it has received from agencies of the Executive Branch of the Federal Government, particularly the staff of the White House, the Department of Interior, the Bureau of Reclamation, Office of Indian Affairs and the U. S. Geological Survey.

The Commission especially wishes to recognize the difficult and able work done by the members of the Senate and House of Representatives of the Congress from the five Upper Colorado River Basin States who devoted so much of their time and effort to fighting for the development of the water resources of the Upper Basin.

The Commission is grateful to all other individuals, organizations, businesses and associations who aided in securing the passage of legislation by the Congress to authorize the construction of the Colorado River Storage Project and participating projects. The unanimity of support of the citizens of the states of Colorado, New Mexico, Utah and Wyoming and the activities of their grass roots organizations gave added impetus to the attainment of success in the 84th Congress.



## Related Activities

Throughout the First Session and during the Second Session of the 84th Congress, so long as Upper Colorado River legislation was under consideration by the Congress, the Commission maintained a temporary office in Washington, D. C. This office served as a base for operations of the Commission in connection with the authorization of the Colorado River Storage Project and participating projects.

The Commission during the past year supervised the activities of the Grass Roots organization, which, among its educational projects, published innumerable pamphlets, brochures, leaflets and news releases in support of legislation pending in Congress.

On its own behalf the Commission published and widely distributed a factual booklet called THE COLORADO RIVER STORAGE PROJECT—TO BUILD A STRONGER AMERICA.

The Commission produced a motion picture entitled A PROJECT FOR PEOPLE which portrays the benefits to be derived from the development of water, power and other natural resources.

A relief model of the Upper Colorado River Basin and adjacent areas has recently been completed. This model is constructed to the scale of 1:250,000 (4 miles to the inch) with a vertical exaggeration of 6:1, and is approximately 13 ft. by 12 ft. overall dimensions. It is to be used for exhibit at conventions, for showing the nature of the area to Congressional Committees, etc. The model was made for the Commission from a section of the Giant Relief Model of the United States with the permission and cooperation of the Babson Institute of Business Administration of Babson Park, Massachusetts.

The headquarters office of the Upper Colorado River Commission has been moved from its former location in the City Administration Building, where, through the generous action of the City Council, it enjoyed the privileges of free office space for over five years, to leased quarters in the Monte Building at 748 North Avenue, Grand Junction, Colorado.

## B. INFLOW-OUTFLOW STUDIES—HYDROLOGY

The principal engineering work in the Grand Junction office of the Commission has been in connection with the studies of the Inflow-Outflow Method of measuring stream depletions. Engineering Report No. 21, made in August, 1955, reviewed the studies which had been made during the preceding six months. A large part of the work during that period had reference to the historic and computed virgin flow of the Colorado River at Lee Ferry. Based on the recorded flows at the three inner-rim stations located at Green River, Cisco and Bluff, in Utah, correlation equations were developed between the inflow index computed from these station records and outflow at Lee Ferry. Some of the difficulties encountered in these studies were mentioned in Engineering Report No. 21. It was pointed out that reliable answers cannot be obtained with the use of



the Inflow-Outflow Method until more complete and accurate information about irrigated areas is available. The relation between historic and virgin flows depends not only on the average acreage irrigated in the Upper Basin, but also on the way the consumptive use of water for irrigation varies with changes in the volume of stream flow.

A review was made during the summer of 1955 of the numerous methods which have been developed for the measurement of consumptive use of water for irrigation. Investigations by various authorities have been made on acreages varying in size from small experimental plots to entire river valleys. This review was given as a paper presented at the Conference of the Irrigation and Drainage Division of the American Society of Civil Engineers which was held in Denver in September, 1955. Appendix C of this report contains a reprint of this paper entitled "Methods of Determining Consumptive Use of Water in Irrigation" from the Proceedings of the American Society of Civil Engineers.

The importance of information about the yield of the Colorado River and the discussions which have developed over this subject suggested the preparation of the 22d Engineering Report last November. This report includes a hydrograph of the historic flow at Lee Ferry and estimates of virgin flows. Several curves were added to the hydrograph and the discussion in the report emphasizes the extreme variability in the annual discharge of this river. Extremes in the estimated annual virgin flow vary from the minimum of 5,640,000 acre-feet in water year 1934 to the maximum during the last thirty years of 21,430,000 acre-feet in 1929. A high estimated discharge of 24,000,000 acre-feet was shown for the year 1917. The gaging station at Lees Ferry was installed in 1921. Records of historic and virgin flows prior to that time are based on estimates and correlations, which may in some instances be of questionable accuracy. The hydrograph of Report No. 22 shows that the maximum annual flow for some years may be three or four times as great as in years of the lowest flows. An average figure for yield of the Colorado River is difficult to agree upon because it depends on the period chosen for the basis of computation. A period may be chosen for which an average virgin flow is obtained that may be either greater or less than 15,000,000 acre-feet, the approximate average for the past 60 years. The following examples illustrate these facts:

Period	Date	Acre-Feet
23 years	1931-1955	13,120,000
34 years	1922-1955	14,100,000
42 years	1914-1955	15,000,000
60 years	1896-1955	15,260,000

Evidently from the above examples the computation of a reliable average will depend upon the purpose for which it is to be used. Among other things, Engineering Report No. 22 was intended to show that a single average figure may not give the best answers to all questions which may arise pertaining to the yield of a



stream or provide the most reliable basis for every purpose that an average is intended to serve.

Under special instructions on September 19, 1955 "to summarize, index and explain all basic Inflow-Outflow studies," Engineering Report No. 23 has been prepared.

This report refers to the Inflow-Outflow Manual which was prepared by the Engineering Advisory Committee to the Compact Commission and which was adopted by the present Commission "as a basis for the commencement of the activities of the administrative commission". Difficulties encountered in Inflow-Outflow investigations are discussed in Engineering Report No. 23. Progress in these studies is outlined with references to Engineering Reports Nos. 14, 15, 16 and 20. Multiple correlation equations relating inflow-index quantities and climatic factors that influence stream depletions are discussed with reference to the manner in which they were developed for several sub-basins of the Upper Colorado River. Preliminary equations are also included for the entire basin with outflow at the compact point, Lee Ferry. The following eight recommendations conclude this report:

(1) It is recommended that the investigations of the Inflow-Outflow Method be continued to the full extent allowable with the personnel and funds available to the Commission.

In using this method, it is necessary to estimate with a high degree of accuracy the annual virgin flows during the past 20 to 25 years at Lee Ferry and at State lines. This requires the adoption of methods or formulas to account for variations in consumptive uses of water due to variations in precipitation, available water supply, possibly summer temperature and other causes. The effect of summer precipitation and temperature has been introduced in some equations listed in Appendix B of Engineering Report No. 23 and the question of accounting for the probable effect of variations in stream flow or available water supply was discussed in some detail in Engineering Report No. 20. Two different depletion formulas were given in that report and a line of investigation was suggested patterned after the routing of historic and virgin stream flows as shown in Appendices to the Final Report of the Engineering Advisory Committee to the Upper Basin Compact Commission.

(2) It is recommended that at an early date a study be made of the effect of variations in available water supply upon the consumptive uses of water in the Upper Colorado River Basin. In so doing, it is suggested that above normal and deficient stream flows with corresponding irrigation uses be routed through the Upper Basin as well as average stream flows and water uses.

Stream depletion takes place along all channels carrying water whether artificial channels, canals and ditches or along natural river and tributary stream channels. While man-made depletions by trans-mountain diversion and diversions for irrigation or municipal supplies are easily recognized and can be accounted for, depletions by natural causes are not so easily recognized or accounted for.



Only in exceptional cases or under controlled conditions can losses in stream flow due to natural causes be approximated as the net difference between the inflow and outflow of any given reach of a river channel. Natural channel losses are due to evaporation from the surface of flowing water usually at higher rates than from lakes and reservoirs. Evaporation and transpiration will also take place along the banks and flood plains of water courses, especially when the soils are saturated and to a lesser extent when the level of groundwater is below the surface of the stream.

Natural channel losses are so closely related to losses caused by man's activities that the two can well be considered and analyzed together.

(3) It is recommended that natural channel losses under varying conditions of stream flow, both historic and virgin, be investigated along with the study of man-made depletion of stream flow.

In this connection, attention should be directed to the difference in index inflows and outflows at the beginning and at the end of a long period of years during which irrigation development increased. As shown by Mr. R. J. Tipton, such variations in the inflow-outflow relationships may be used as a measure of natural channel losses and also as a possible check on other determinations of such losses.

Research under recommendations (2) and (3) above are both essential unless the Commission, on the recommendation of the Engineering Committee, should elect to adopt the formula used by the Bureau of Reclamation. The principal of the Bureau's formula is, however, open to some question and estimates of virgin flows derived through its use might be open to attack unless such estimates had been fully confirmed by additional research. This research could be even more valuable than a new formula, because the Bureau Formula might then be adopted by the Commission and Recommendation (2) omitted or postponed.

The attention of the Commission has been called to the fact that accurate estimates of virgin flows based upon estimates of man-made depletions cannot be made until more accurate estimates of present and recent irrigation acreages are made available to the engineering department.

(4) It is recommended that the Commission secure revised acreage figures where needed and confirm all other acreage figures to be used in inflow-outflow computations.

One of the most interesting and challenging problems encountered in these investigations has been that of finding an index measure of the effect of accretions to stream flow due to the discharge of water from storage in various groundwater reservoirs. The rather large measure of success in the recent solution of this problem leads to the next recommendation.

(5) It is recommended that groundwater studies simplifying the procedure for finding the parameters for the formulas be continued. It is further recommended that groundwater functions be



determined and introduced into correlation equations for the Yampa, White and San Juan Rivers and also other streams where their use may appear to be of advantage.

(6) It is recommended that selections be made with the advice and assistance of the Engineering Committee of the most pertinent independent variables to be utilized in correlation equations and of the most useful equations which have been derived to date; also, that all such equations be standardized and brought up to date for the 25-year period 1930-1954.

(7) It is recommended that multiple correlation equations be derived for the three inner-rim stations using data for the 1930-1954 period including independent variables such as functions of groundwater or base flow, summer precipitation, etc. It is further recommended that from the three computed historic inflows thus obtained, historic outflows at Lee Ferry be derived similar to equations (A) and (CC) of Table 4, Appendix B of Engineering Report No. 23.

(8) Upon satisfactory completion of the studies recommended under (5), (6) and (7) above, it is recommended that equations be determined for outflow points at or reasonably near State lines to see whether or not they can be used to compute virgin flows at those points and thereby determine acceptable values of man-made depletions within each State of the Upper Basin.

When studies covered by recommendations (5), (6), (7) and (8) are completed, the most probable virgin flow equations that can be derived at this time can be obtained by the methods described and illustrated in Engineering Report No. 23. The Commission should then be able to decide whether to continue to use the Inflow-Outflow Method or adopt some other method of determining man-made depletions of stream flow in the Upper Colorado River Basin.

Included in Engineering Report No. 23 are three appendices which contain references, selection of the best equations and a table comparing the observed and computed annual flows obtained by employing some of these equations.

### Forecasts of Stream Flow

No forecasts of water supply have been made by the Engineering Department of the Commission, nor have any findings of fact as to water deliveries or stream depletions been made. The following forecast of **April-July Inflow to Lake Mead** is quoted from the report of the Boulder City, Nevada office of the Bureau of Reclamation.

“(a) Based on the accumulated October-February precipitation reported from the 13 index stations, the forecast of the flow in the Colorado River near Grand Canyon, Arizona for the period April through July 1956 is as follows:



Maximum*	13,100,000 acre-feet
Mean	9,800,000 acre-feet
Minimum *	6,500,000 acre-feet

\*The forecast equation indicates that the probability is nine chances in ten that actual flow at Grand Canyon will fall between the above maximum and minimum amounts."

"(e) Actual runoff measured near Grand Canyon during April-July last year was 4,341,000 acre-feet. The maximum recorded April-July runoff occurred in 1952 (14,064,000 acre-feet), and the minimum recorded was 2,247,000 acre-feet in 1934."

The following forecasts are from the bulletin by the U. S. Weather Bureau, **Water Supply Forecasts for the Western United States** issued March 1, 1956:

**"Colorado River Basin above Cisco:** Precipitation during February averaged slightly above normal over the Taylor Basin and over the drainage area above Cameo, Colo. Over the lower drainages of the Gunnison and Dolores Rivers monthly amounts averaged near 50% of normal. Near 70% of normal precipitation was reported at the higher elevations of Mount Wilson.

"The water supply outlook for the basin is only slightly changed from that of a month ago except for the forecasts for the Dolores and Uncompahgre Rivers which are from 4% to 8% lower. Forecasts for the main stream and tributaries of the Colorado above Cameo range from 105% to 122% of the 1938-52 average runoff. For the Gunnison Basin near 110% of average run off is predicted for the Taylor River; near 80% for the Uncompahgre Basin; and near 90% of average for the Gunnison River near Grand Junction, Colorado. The outlook for the Dolores Basin is for runoff of 77% of average at the headwaters to near 60% of average in the lower reaches. The Colorado River at Cisco, Utah, is forecast to be 97% of the 1938-52 average stream-flow.

**"Green River Basin:** The upper Green River basin in Wyoming received amounts of precipitation during February averaging much below normal. A similar precipitation pattern occurred over the Green Basin in Utah. For the Colorado portion of the Green Basin, February precipitation was more favorable where near 150% of normal was reported for the Little Snake, Yampa and White River drainages. The current water supply outlook for the Green River in Wyoming and for the Little Snake, Yampa and White Rivers in Colorado is for above average streamflow. Forecasts vary from 110% to 124% of average. The water supply outlook for the Utah tributaries of the Green River is less promising at this time. Forecasts vary from slightly below average runoff for the Duchesne River to 74% of average for the Price River near Heiner, Utah. The Green River at Green River, Utah, is predicted to have 119% of average runoff or 4,560,000 acre-feet for the period March through September.

**"San Juan River Basin:** Much below normal precipitation, averaging near 40% of normal, was reported for the San Juan River



basin during February. However, snow cover as of March 1 was reported as above normal at the higher elevations near Wolf Creek Pass in the San Juan Mountains. Prospects of water supply for the San Juan Basin vary from 88% of average runoff forecast for the San Juan River at Rosa, New Mexico, to 75% of average for the San Juan River at Farmington, New Mexico."

This bulletin also contains tables giving detailed forecasts for discharges at Lee Ferry and 5 other stations on the Colorado River in the Upper Basin, also for some thirty other gaging stations on tributary streams.

The Report of the Federal-State Cooperative Snow Surveys and Water Supply Forecasts as of March 1, 1956, contains the following:

"Irrigation water supply outlook for most of Colorado continues to be much improved over the past two years as of March 1. In the northern mountains of the state, including the headwaters of the Platte, Upper Colorado and Yampa Rivers, the snow pack is 150 percent of normal. Measurements on most snow courses on these water sheds show a snow water content near a record high for this time of year. They are comparable to the recent high snow years of 1949 and 1952.

"Unfortunately, this favorable water supply outlook does not extend throughout the state of Colorado and to adjacent areas in northern New Mexico. To the west the snow pack decreases to 100 to 125 percent of normal on the Grand Mesa and on the Dolores and San Juan Rivers in southwestern Colorado.

"Snow cover in the Colorado River drainage in Utah ranges from well above normal on the Green River tributaries in the northern part of the state to less than normal on the Virgin River in southern Utah. The decrease in seasonal snowfall is relatively constant from north to south along the Colorado River-Great Basin divide. On the headwaters of the Green River in Wyoming the snow pack is 125 percent of normal. Other conditions favor a well above normal runoff from this stream in 1956.

BASIN AND STREAM	April-Sept., Incl.		
	Forecast 1956	% of 15 yr. Avg.	15 year Avg. 1938-52
GREEN			
Green at Linwood, Utah	1,600,000	123	1,302,000
COLORADO			
Colorado at Glenwood Springs	2,000,000**	130	1,540,000**
Gunnison at Grand Junction	1,600,000	106	1,510,000



San Juan at Rosa, N. M.	650,000	92	703,000
Animas at Durango	500,000	96	522,000
Colorado near Grand Canyon, Ariz.	11,750,000	114	10,063,000

\*\*Including Diversions and change in storage"

### Miscellaneous

No further study has been made by the Engineering Staff of the Commission of evaporation from reservoirs. It is understood that the cooperative studies of the Bureau of Reclamation and the U. S. Geological Survey which were held in abeyance for some time are again underway at a high altitude reservoir. When these studies are completed a report concerning them will be of great value to the Commission. A table of gaging stations and discharges for the water years 1954, 1955 and 1956 is included, Appendix D.

### VI. LEGAL

In April, 1955, hearings in the Arizona v. California suit over water of the Colorado River were held at Phoenix, Arizona before the Special Master appointed by the Supreme Court. These hearings were on the motion of California to implead the four Upper Division States as indispensable parties to the suit.

On July 18, 1955 the Special Master's Report on the motion of the California defendants to join as parties the States of New Mexico, Utah, Colorado and Wyoming was filed with the Supreme Court. He recommended that the four Upper Division States be not made parties to the suit as Upper Basin States and in respect to Upper Basin waters, but that Utah and New Mexico be made parties in relation to their respective Lower Basin waters only.

On December 8, 1955, the U. S. Supreme Court heard arguments on California's exception to the Special Master's Report. On December 12 the Supreme Court upheld the Master's Report and denied California's request that Colorado and Wyoming be made parties. On January 23, 1956, the Supreme Court denied the California petition for a rehearing on the question of whether the Upper Division States should all be made parties to the suit between Arizona and California.

A series of interrogatories, dated February 26, 1956, addressed to the intervener, the United States of America, have been filed with the Supreme Court by the California defendants. These questions are based on A) general claims of the United States; B) claims under the Mexican Water Treaty; C) Indian claims; D) claims for Fish and Wildlife, Bureau of Land Management, Forest Service, National Park Service, flood control and navigation; E) claims under water delivery contracts; and F) claims relating to specific reclamation projects in Arizona.

The members of the Legal Committee of the Upper Colorado River Commission have continued to keep in close touch with all as-

pects of this lawsuit and have kept the Commission fully advised.

## VII. FINDINGS OF FACT

No findings of fact pursuant to Article VIII of the Upper Colorado River Basin Compact have been made by the Commission.

## VIII. CHANGES OF STAFF PERSONNEL

Mr. Ival V. Goslin, Assistant Chief Engineer, was appointed Acting Secretary of the Commission on April 1, 1955 to succeed the former Secretary and General Counsel, resigned. On August 18, 1955, Mr. Goslin was designated Engineer-Secretary of the Commission.

Mrs. Lois Burns, Administrative Assistant, resigned June 24, 1955.

Mr. R. D. Goodrich, Chief Engineer, was made Engineering Consultant to the Commission on a part-time basis, on January 1, 1956.

Mrs. Dorothy Dye, stenographer, was appointed Administrative Assistant effective January 1, 1956.



# APPENDIX A

## BUDGET

FISCAL YEAR ENDING JUNE 30, 1957

### PERSONAL SERVICES

Engineer-Secretary	\$11,000.00	
Chief Engineer (Half time after 1-1-56)	7,500.00	
Clerical Salaries	3,500.00	\$22,000.00
	<hr/>	

TRAVEL 4,800.00

### CURRENT EXPENSE

Reporting	\$ 3,000.00	
Telephone and Telegraph	900.00	
Insurance and Bonds	850.00	
Accounting	550.00	
Miscellaneous (Incl. office help)	500.00	
Printing Office Forms	350.00	
Printing Annual Report	2,000.00	
Rent of Grand Junction office	3,200.00	11,350.00
	<hr/>	

### CAPITAL OUTLAY

Automobile	\$ -0-	
Office Equipment	1,260.00	1,260.00
	<hr/>	

INFORMATION 38,628.66

OFFICE SUPPLIES AND EXPENSES 2,250.00

State of Colorado Assessment Deficit for  
1956 (To be paid in 1957) 336.54

---

\$80,625.20

Less special appropriation from General  
Fund Balance which was for 1956 fiscal year 6,000.00

### TOTAL ESTIMATED EXPENSE

Fiscal Year July 1, 1956 through  
June 30, 1957 

---

\$74,625.20 

---

APPENDIX B  
REPORT OF EXAMINATION  
UPPER COLORADO RIVER COMMISSION  
GRAND JUNCTION, COLORADO  
June 30, 1955

DALBY & McNULTY  
Certified Public Accountants  
First National Bank Building  
Grand Junction, Colorado  
August 16, 1955

Walter E. Dalby, C.P.A.  
John E. McNulty, C.P.A.

Upper Colorado River Commission  
Grand Junction, Colorado

We have examined the balance sheets of the General Fund and the Property and Equipment Fund of the Upper Colorado River Commission as of June 30, 1955, and the related statement of revenue and expense for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheets and revenue and expense statement present fairly the financial position of the Upper Colorado River Commission at June 30, 1955, and the results of its operations for the year then ended.

/s/ DALBY & McNULTY  
Certified Public Accountants



# BALANCE SHEET—GENERAL FUND

## UPPER COLORADO RIVER COMMISSION

June 30, 1955

### ASSETS

#### CASH

Office cash fund	\$ 25.00	
Demand deposit	16,040.46	\$16,065.46

RETURNABLE DEPOSIT—United Air Lines		425.00
DEFERRED CHARGE—Prepaid office rent		300.00

\$16,790.46

### LIABILITIES, RESERVES, AND FUND BALANCE

ACCOUNTS PAYABLE—for supplies and expenses	\$ 677.31
--	-----------

RESERVE—For fiscal year 1955-1956 assessments received prior to June 30, 1955	8,395.34
--	----------

#### UNAPPROPRIATED FUND BALANCE

Balance at July 1, 1954	\$27,744.96
-------------------------	-------------

#### Add:

Excess provision for encumbrances for fiscal year ended June 30, 1954	\$ 1,460.41	
Transfer from reserve for contingencies	1,124.12	
Excess of revenues over expenditures for fiscal year ended June 30, 1955	6,888.32	9,472.85

\$37,217.81

Less—appropriation for expenses for fiscal year ended June 30, 1955	29,500.00
--	-----------

Balance at June 30, 1955	7,717.81
--------------------------	----------

\$16,790.46

# BALANCE SHEET—PROPERTY AND EQUIPMENT FUND

## UPPER COLORADO RIVER COMMISSION

June 30, 1955

### ASSETS

#### PROPERTY AND EQUIPMENT—at cost:

Furniture and fixtures	\$ 6,563.44
Automobile	2,413.61
Engineering equipment	1,533.65
Motion picture film	10,733.46
	<u>\$21,244.16</u>

### FUND BALANCE

Investment in property and equipment at July 1, 1954	\$10,523.25	
Transactions for fiscal year ended June 30, 1955:		
Additions	\$10,763.62	
Retirements	42.71	10,720.91
	<u>          </u>	<u>          </u>
Investment in property and equipment at June 30, 1955		\$21,244.16
		<u>\$21,244.16</u>



# STATEMENT OF REVENUE AND EXPENSE

## UPPER COLORADO RIVER COMMISSION

For the fiscal year ended June 30, 1955

	BUDGET AMOUNT	ACTUAL AMOUNT	ACTUAL AMOUNT OVER-UNDER*
Revenue:			
Assessments	\$ 73,975.20	\$ 73,975.20	\$ 0
Sale of reports	0	335.00	335.00
Appropriated from General Fund Balance	29,500.00	29,500.00	0
<b>TOTAL REVENUE</b>	<b>\$103,475.20</b>	<b>\$103,810.20</b>	<b>\$ 335.00</b>
Expense:			
Personal services:			
Administrative salaries	\$ 17,522.95	\$ 19,943.81	\$ 2,420.86
Engineering salaries	19,550.00	17,012.40	2,537.60*
Clerical salaries	4,940.00	2,454.88	2,485.12*
Social security tax	912.25	374.96	537.29*
	\$ 42,925.20	\$ 39,786.05	\$ 3,139.15*
Capital outlay	\$ 0	\$ 30.16	\$ 30.16
Office supplies and postage	\$ 2,000.00	\$ 1,932.14	\$ 67.86*
Information:			
Washington, D. C. office:			
Supplies	\$ 900.00	\$ 783.97	\$ 116.03*
Postage	600.00	538.60	61.40*
Secretarial service	3,450.00	3,569.99	119.99
Reporting	2,000.00	427.50	1,572.50*
Rent	2,400.00	2,319.25	80.75*
Travel	12,749.82	8,025.46	4,724.36*
Telephone and telegraph	762.38	620.17	142.21*
	\$ 22,862.20	\$ 16,284.94	\$ 6,577.26*
Publicity:			
Exhibits	\$ 50.00	\$ 15.40	\$ 34.60*
Publications	5,000.00	5,472.69	472.69
Newspaper publicity	5,000.00	5,000.00	0
Motion picture film	10,000.00	10,749.81	749.81
Public relations	1,500.00	496.50	1,003.50*
	\$ 21,550.00	\$ 21,734.40	\$ 184.40

## STATEMENT OF REVENUE AND EXPENSE (Con't.)

## UPPER COLORADO RIVER COMMISSION

For the fiscal year ended June 30, 1955

	BUDGET AMOUNT	ACTUAL AMOUNT	ACTUAL AMOUNT OVER-UNDER*
Travel	\$ 6,487.80	\$ 7,320.65	\$ 832.85
Current Expense:			
Reporting	\$ 2,500.00	\$ 1,507.20	\$ 992.80*
Telephone and telegraph	1,200.00	887.35	312.65*
Insurance and bond premiums	850.00	560.32	289.68*
Accounting	500.00	420.00	80.00*
Secretarial services	0	50.49	50.49
Computing machine services	0	4,574.86	4,574.86
Miscellaneous	250.00	20.82	229.18*
Printing	2,350.00	1,812.50	537.50*
	\$ 7,650.00	\$ 9,833.54	\$ 2,183.54
TOTAL EXPENSE	\$103,475.20	\$ 96,921.88	\$ 6,553.32*
EXCESS OF REVENUE OVER EXPENSE		\$ 6,888.32	\$ 6,888.32*



# CASH RECEIPTS AND DISBURSEMENTS

## UPPER COLORADO RIVER COMMISSION

For the fiscal year ended June 30, 1955

<hr/>		
Balance of cash and demand deposit at July 1, 1954		\$ 60,958.02
Cash receipts:		
Assessments	\$ 54,999.71	
Sale of reports	335.00	55,334.71
	<hr/>	<hr/>
		\$116,292.73
Cash disbursements:		
Personal services	\$ 39,981.19	
Travel	6,707.47	
Current expense	12,254.36	
Capital outlay	30.16	
Information	35,364.73	
Office supplies	1,910.49	
Expenses of fiscal year ended June 30, 1954, not paid until after July 1, 1954	3,978.87	100,227.27
	<hr/>	<hr/>
Balance of cash and demand deposit at June 30, 1955		\$ 16,065.46
		<hr/>

INSURANCE COVERAGE  
UPPER COLORADO RIVER COMMISSION

June 30, 1955

	TYPE OF COVERAGE	AMOUNT OF COVERAGE
Furniture and fixtures	Fire and comprehen- sive	\$7,500.00
Automobile	Comprehensive Collision or upset Bodily injury and property damage	Actual cash value \$100.00 deductible \$5/100,000.00
Treasurer	Fidelity Bond	\$40,000.00
Assistant treasurer	Fidelity Bond	\$40,000.00
Employees	Workmen's compensa- tion	Various



# APPENDIX C

## METHODS OF DETERMINING CONSUMPTIVE USE OF WATER IN IRRIGATION\*

Paper Presented on September 8, 1955 at the  
Irrigation and Drainage Conference, A.S.C.E. at Denver,  
Colorado

R. D. Goodrich

### SYNOPSIS

Attention is first called to some of the early investigations of the "duty of water" in irrigation. As knowledge was acquired in this field of research, attention became focused on the "consumptive use of water" or "evapo-transpiration." Standard methods of determination of rates of consumptive use are then very briefly described and the utilization of results thus obtained to measure farm and valley uses are then described.

### INTRODUCTION

Investigations concerning the consumptive use of water by crops grown on irrigated farms have been carried on by State and Federal agencies for well over fifty years. Due to the constantly increasing value of the water used and of the crops produced, such investigations should, and no doubt will, continue indefinitely in order to increase irrigation efficiencies with improved methods and procedures.

The early studies in this field of research had to do with the "Duty of Water" on irrigated farms and projects by such authorities as Dr. Elwood Mead, while he was in charge of Irrigation Investigations for the U. S. Department of Agriculture and Dr. John A. Wightsoe, formerly president of Utah Agriculture College. In his early practice in irrigation engineering, the speaker made considerable use of reports by Don H. Bark on cooperative investigations in Idaho, to name only three experts in this field in the early 1900's. (1) (2) (3)\*\*

Many other contributions to our knowledge of the duty and consumptive use of water, such as descriptions of original research and experimentation or explanations and discussions of the work of others, are to be found in standard text and reference books.

(4) (5) (6) (7) (8) Then, too, there are numerous papers and discussions to be found in the Proceedings, Separates and Transactions of the American Society of Civil Engineers. (9) (10) (11 a, b, c, d, e) All of these and several other sources including bulletins of the Department of Agriculture (12) (13) (14) (15) (16) (17)

\*Reprinted by permission from the Proceedings of the American Society of Civil Engineers, Paper No. 884, February, 1956.

\*\*Figures in parentheses refer to the references listed at the end of this article.

have been drawn upon liberally and due credit is intended to be given here to each and all.

This paper, therefore, is in the nature of a review and summary of the work of others, with whose books and reports or papers the writer happens to be more or less familiar and which were available for reference.

## DEFINITIONS

The term "Duty of Water" refers to the relation of the area of land that is served by a given quantity of water.

S. T. Harding (M. ASCE) has called attention to the fact that a high duty of water goes with a small amount used, while a low duty indicates a large use of water. (5) He tries to avoid the confusion which often arises from such use of terms by substituting the expression "Water Requirement" as applying to the number of acre feet of water necessary to maintain a given crop per acre of land irrigated. This expression is clear but its use has been largely superseded by the term "Consumptive Use of Water," which appears to have been introduced by John E. Field (M. ASCE) while State Engineer of Colorado.

Consumptive Use may be defined (11a), (12), (13) as:

"The sum of the volumes of water used by the vegetative growth of a given area in transpiration and building of plant tissue and that evaporated from adjacent soil, snow, or intercepted precipitation on the area in any specified time, divided by the given area." (11a)

It is usually expressed in units of acre feet per acre per year (sometimes per month) for the locality and crop or vegetation or area considered. It is measured in various ways, such as by lysimeters or tanks, on experimental plots, in selected fields, on a whole farm, an irrigation project or the farms and projects in a river valley. Its determination for the entire drainage basin of a river system, for example, that of the Upper Colorado River, is required by the terms of the Upper Colorado River Basin Compact.

It should be obvious that consumptive uses will vary for different crops and that for any given crop the use will vary from year to year and from one locality to another, with the length of the growing season, the average temperature, the precipitation and the humidity. Besides these climatic factors, there are numerous others which are important also, such as the character, condition and treatment of the soil, and the practice of the irrigator in applying the water. Since the foregoing definition includes water evaporated from the soil surrounding the plants which constitute the crop, or other vegetation, as well as that used and transpired by the plants themselves, the term "evapo-transpiration" is here considered as synonymous with the term "consumptive use."



Several methods have been used to measure consumptive uses of water, by crops and by native vegetation. Among the most useful of these are: soil moisture, lysimeter, tank, and field plot experiments, ground water fluctuations, evaporation pan records, the integration method, inflow-outflow measurements, effective heat and the correlation of water use with climatological data. Some of these measurements depend upon the use of results obtained in previous work and only a brief description of any methods can be given within the limits of this review. For more detailed information, one may consult references listed in the short bibliography at the end of this article.

## SOIL MOISTURE DETERMINATIONS

The method of applying soil moisture determinations to the measurement of evapo-transpiration is best adapted to experiments where the total amount of water made available to the plants or crops used in the investigations can be measured either as natural precipitation or as water artificially applied for irrigation. If there is a water table at a measurable distance below the surface, it should be at such depth below the root zone that the plants can not obtain water from the capillary fringe, but will use only that applied at the surface. Hence, if very heavy rains are likely to occur so that deep seepage will result after a storm or if an excessive amount of water is applied in irrigation, the amount of such seepage must be measured or estimated and proper corrections made. In localities where practically no precipitation occurs during the growing season, this method is well adapted to obtain reliable measurements of consumptive use. Soil samples are usually taken before and after each irrigation and the moisture content determined by standard laboratory procedure. One advantage of this method is that it can be used on experimental plots of any practical size and the plots can be selected so as to be surrounded by similar crops or vegetation. The experiments should then reflect the consumptive use of water under the most natural conditions for accurate results. (6) (9) (11a) (15) (17)

## TANK OR LYSIMETER EXPERIMENTS

When lysimeters were first used in experiments to determine the consumptive use of water, the results obtained were qualitative rather than quantitative by present standards. Early experimenters did not always give full details as to the conditions or procedures used so that their results could not always be properly compared. Tanks of the largest practical size should be used and they should be placed so as to be surrounded by natural conditions as to local crops and vegetation, undisturbed soil, water table, etc. Accurate observations and records should be secured as to effective precipitation, time, amount and frequency and method of irrigation, water lost by deep seepage if any, and the height and movement of ground water if the presence of such water is made a part of the program of experiments. The most accurate method of determining evapo-transpiration when this method is used, is of course by weighing, (6) (11a) (15) but with the largest tanks this is not



always practical. In some experiments by Ralph L. Parshall (M. ASCE) to determine the rates of evaporation from saturated soils and river sands, Mariotte tanks were used successfully to control water table elevations. (16)

## GROUND WATER FLUCTUATIONS

Where a considerable area of irrigated land is relatively flat and when there is an adequate water supply, it is sometimes possible to estimate the average consumptive use of water for the area by an analysis of the fluctuations in the elevation of the ground water table. After irrigation practice has become well established, the ground water table is usually somewhat higher than formerly. If there is a continuous inflow of underground water into the area and if capillary water is within reach of the root zone of the crops, recorders may be set at observation wells so as to obtain continuous records of the variations in the level of the water. Then, by making the necessary allowances for irrigation water and precipitation and knowing the specific yield of the soil, it is possible to estimate the consumptive use for the area. (6) (9) This method has been used with very satisfactory results in Arizona, California and Utah. (11a)

## EVAPORATION PAN RECORDS

Occasionally, one may need to estimate the losses of water from swamps or other low areas having vegetation known to be heavy users of water (phreatophytes). If evaporation pans are installed at such places, it may be possible to utilize the evaporation data obtained to estimate evapo-transpiration in the area. It is necessary here, as it is with all other methods, to take proper account of precipitation and irrigation water if either reaches the area, and a factor depending on judgment or experience would also have to be applied to the observations. However, helpful information may be obtained for comparison with other data from similar areas. (6)

## INTEGRATION METHOD

Consumptive use determinations for a variety of crops and native vegetation made by the above or other methods are required when the integration method is used to obtain the consumptive use of water on a farm or irrigation project. In certain cases, this method has been used with satisfactory results to obtain project and even valley rates of consumptive uses.

To apply this method in a valley for example, having previously secured the rates of consumptive use for the various crops, one must obtain the acreage of each crop and of the pastures and incidental areas together with the total area of each classification of the land use in the valley. Then the sum of the products of the total area of each type of crop or other class of land by its average rate of consumptive use will give the total consumptive use or stream depletion in the valley. This total depletion quantity divided by the total area then gives the weighted average rate of consumptive use. (9) (10) (11a) (14) (15) The above outline



of the integration method may be an over-simplification of the procedure.

When applied by different individuals on different irrigation projects, the results may not always be properly compared. In a given valley there may be several irrigation projects but annual records of the areas under cultivation may not be kept on exactly the same basis. The average in one case may be based on the acreage of the actual crops to the exclusion of such areas as are occupied by houses, barns, corrals, ditches, roads, etc., giving the evapo-transpiration rate for the net area cultivated. On another project, the total amount of depletion computed may be divided by the total area of the project, thus giving a smaller rate of use when based on this gross area.

In other words, it is very desirable that the fullest explanation be made of all details in reporting results so that they can be used to check and compare with data obtained by other methods or in other areas. For the purpose of comparison, results by the integration method have been of special value in connection with investigations in the Upper Colorado River Basin. (13) (14)

### INFLOW-OUTFLOW METHOD

In theory the Inflow-Outflow Method as applied to the determination of valley consumptive use requires the actual measurement of all water entering the area. This should include both surface and subsurface inflow and precipitation, especially that falling on the valley floor, and also quantitative data as to any material changes in the amount of storage in the ground water reservoir in the area. Then the difference between the inflow and the outflow, both surface and subsurface plus the algebraic difference between ground storage at the beginning and at the end of the period is the consumptive use in the given area.

In mathematical terms this can be shown by the following equation:

$$U = (I + R) + (G^s - G^e) - Q$$

where:

U=the consumptive use for the period selected, usually 12 months.

I=the inflow during the period.

R=the effective rainfall on the valley floor for the period.

Q=the quantity of outflow for the period.

$G^s$  and  $G^e$  are the volumes of water in ground storage at the beginning and end of the period.

All quantities are to be given in acre-feet. Harry F. Blaney (M. ASCE) notes that any change in the amount of capillary water will be so small that it can be neglected. (11a) (15)

The inflow-outflow method or some modification of it has been used by numerous engineers, among them may be mentioned



Blaney, Criddle, Erickson, Harding, Hart, Lee, Lowry, Johnson, Meeker, Morin and Tipton. In recent years it has been adopted for use in connection with the negotiation and administration of several Interstate River Compacts, one of which is the Upper Colorado River Compact of 1948. Typical results by the use of this method are shown in Table I copied by permission from Table 5 of the paper on the Consumptive Use of Water, by Harry F. Blaney (M. ASCE). (11a) (15)

## CORRELATION METHODS

The correlation of consumptive uses of water with certain climatological factors has been successfully developed by several investigators. Charles R. Hedke (M. ASCE) appears to have been one of the first to use the "effective heat" (or number of day-degrees) available to agricultural crops during the growing season or crop year. No attempt will be made here to discuss Hedke's method, but only to record that he used it as early as 1916, during investigation in the Poudre River and San Luis Valleys in Colorado and in the Rio Grande Valley in New Mexico, with "gratifying results." (9) Lowry and Johnson (M's., ASCE) also used "day degrees" of heat very effectively. (10)

The many years of constant research carried on with a somewhat similar approach to this problem by Harry F. Blaney (M. ASCE) have resulted in a very useful and reliable method which has many applications. Results by his method have been checked by other methods in several instances with very satisfactory agreement. I am more familiar with this method than with any other since Blaney and Criddle made a report on "The Consumptive Uses of Water Rates in the Upper Colorado River Basin" for the Upper Colorado River Compact Commission in the summer of 1948. It was my privilege to be one of the engineers in the party that accompanied Mr. Blaney and Mr. Criddle during the time they were in the field collecting the final data to complete their report to the Compact Commission. Quoting from this report:

"Briefly, the procedure is to correlate existing consumptive use data with mean monthly temperatures, percent of daytime hours and precipitation for the frost free period or irrigation season and for the entire year. The coefficients so developed for different crops are used to transfer consumptive use data from one section to other areas where only climatological data are available."

This method was more fully described by Harry F. Blaney and Wayne D. Criddle in a report of the Division of Irrigation, of the Soil Conservation Service, U.S.D.A., entitled "Consumptive Use of Water Rates in the Irrigated Areas of the Upper Colorado River Basin" dated April, 1949. (13) The procedure can best be described in their words.

"Neglecting the unmeasured factors, consumptive use varies with the temperature and the daytime hours, and irrigation requirement is also dependent on precipitation.



By multiplying the mean monthly temperature ( $t$ ) by the monthly percent of daytime hours of the year ( $p$ ), there is obtained a monthly consumptive use factor ( $f$ ). It is then assumed that the consumptive use varies directly as this factor, or expressed mathematically,  $U=KF$  where:  $U$ = Consumptive use of crop in inches for any period.

$F$ =Sum of the monthly consumptive use factors for the period[sum of the products of mean monthly temperature and monthly percent of annual daylight hours ( $t \times p$ )].

$K$ =An empirical coefficient.

$t$ =Mean monthly temperature in degrees Fahrenheit.

$p$ =Monthly percent of daytime hours of the year.

$f=t \times p$ =Monthly consumptive use factor.

"By knowing the consumptive requirement of water by a particular crop in some locality an estimate of the use by the same crop in some other areas may be made by application of the formula. Table 2 gives a summary of the consumptive use of water ( $U$ ) by alfalfa, cotton, etc. in various localities in the West as determined by investigators, together with the calculated consumptive use factor ( $F$ ) and the crop coefficients ( $K$ ) in the areas studied. In planning to supply the irrigation requirements of any new project it then becomes necessary to estimate the acreage to be planted to each crop, determine the unit use of water by each crop based on known use in other areas and add the products for all the crops. This calculation will indicate the total consumptive use for the project. (4) Allowance must, of course, be made for the use of water by native vegetation, water surface evaporation and other minor uses.

**"Assumptions:** In order to apply the results of any study in one area to some other area, it is usually necessary to make certain minor assumptions. If sufficient basic information is available, some of the assumptions may be replaced by actual data, but rarely are all the data known in sufficient for reliable use. In other words, the more data available, the more accurate the estimates or assumptions, but some doubts still exist. For practical use the following assumptions must be made in applying the consumptive use formula between areas:

1. The fertility and producing power of the soils are similar.
2. Sufficient water is applied and at the proper time to maintain good growing conditions.
3. The length of growing season, to a large extent, determines the production and annual consumptive use of continuous growing crops such as alfalfa and pasture.



4. Consumptive use of water varies directly with the consumptive use factor." (F)

The Blaney-Criddle method has certain advantages since the percentage of daylight hours in any month for various latitudes is given in published tables. (11a) With these quantities taken for the months and fractions during the growing season and the mean monthly temperatures from Weather Bureau Reports consumptive use factors can be computed for almost any crop in any western location since reliable records of experimental determinations of rates of consumptive uses for many crops and vegetative types are also available. The necessary coefficient (K) can therefore be computed as the ratio of each observed value of consumptive use (U) by its corresponding factor (F). Typical rates of consumptive use for various crops are given in Tables 2 and 3. (15)

It is assumed by Blaney and Criddle, as stated above in assumption 4, that consumptive use rates vary directly with the consumptive use factor. The data on alfalfa given in Table 2 was used to test the validity of this assumption, by computing the mean (M), standard variation (SV) and the coefficient of variation (CV), for each of the three quantities, consumptive use (U), consumptive use factor (F), and the crop coefficient (K). The seven records shown in the table are of experiments made in seven different states with consumptive uses varying from less than 20 acre-inches per acre in California to more than 40 acre-inches for one year in Texas. Yet the coefficients of variation (CV) of the consumptive uses (U) and of the consumptive use factor (F) are respectively 34.5% and 30.0%. That these two quantities are directly proportional for all practical purposes is also shown by the further fact that the crop coefficient (K) has a variation indicated by its coefficient of 11.1%. Results for a similar table of nine observations are also published. This shows extremely high correlation between consumptive use for this crop and the index of the heat available during the growing period. Once the coefficient (K) has been determined for any crop or type of vegetation, its use with reasonable judgment is certainly justified on other areas. In Table 3 there are given values of (K) suggested by Blaney for a number of the common crops grown by irrigation in Western United States. These two tables are taken by permission from the paper by Mr. Blaney on "Evapo-Transpiration in Western United States." (15) In using consumptive use coefficients given in Table 3, one should note that the lower values of (K) are for areas along the coast while the higher values are for more arid climates.

#### NATIVE VEGETATION AND MUNICIPAL AREAS

Some of the methods that have already been mentioned are available for the determination of evapo-transpiration rates from incidental areas such as natural grass land and pasture and also for large plants or shrubs, orchards and wooded areas. Consumptive use rates for these areas are contained in several of the references listed. (13) (14) (15) (18) In addition an excellent report on the "Consumptive Use of Water by Forest and Range Vegetation" by L. R. Rich, Hydrologist with the Southwestern Forest and Range



Experiment Station at Tucson, Arizona, is available as one section of the Symposium in the ASCE Transactions for 1952, Vol. 117. (11b)

Municipal areas are often considered as taking approximately the same evapo-transpiration rates per acre as the surrounding cultivated or native vegetation. Another section of the above mentioned Symposium is devoted to a rather detailed and very valuable report on the investigations on the "Consumptive Use in Municipal and Industrial Areas," "to determine a fair distribution of water rights in the Raymond Basin Area, of Pasadena, Calif.," by George B. Gleason (Assoc. M. ASCE). (11d) The limited scope of this paper precludes discussion of these papers which, however, should be called to the attention of those who may be interested.

## DISCUSSION

The Upper Colorado River Commission was organized under authority of the Upper Colorado River Basin Compact of 1948. There are five Commissioners, one each from the four states of Colorado, New Mexico, Utah and Wyoming, with the chairman appointed by the President of the United States. The Commission is empowered, among other things, to make findings as to the consumptive use, or more specifically, the man-made stream depletion in each of these states and in the Upper Basin as a whole each year "by the inflow-outflow method." Hence the engineering department of this Commission has spent much time and effort in the study of methods for the determination of the consumptive use of water in irrigation and of how best to apply appropriate methods in the determination of man-made depletions of stream flow in the Upper Basin of this very important river.

The area of the Upper Colorado River Basin is about 110,000 square miles or 70,400,000 acres. This is 70,000,000 acres more than the area of the San Luis Valley of Colorado which is the largest area reported by Blaney and Rohwer as having determined valley consumptive uses by the inflow-outflow method. (15) The irrigated area in this basin, however, is something on the order of 3% of the total and it is divided into numerous sub-basins, both large and small, separated by long, deep and magnificent canyons on tributaries as well as on the main stem of the river. There are nearly 300 streams of varying size upon which about twice that number of gaging stations have been operated by the U. S. Geological Survey for periods varying from only two or three years up to as many as fifty years. This does not include the very large number of streams from which many ditches take water but on which the U. S. Geological Survey has never installed a gaging station. Recently it has been estimated that there are between 15,000 and 20,000 canals and ditches diverting water for use on an equivalent area of the order of 2,000,000 acres in this basin. This may give a little idea of the magnitude of the task undertaken in these studies. With only two or three ground water observation wells in the Upper Colorado Basin, information on this source of inflow and storage is difficult to obtain to say the least. The records of annual

discharge of the Colorado River at Lees Ferry, which is near the outflow point of the Upper Basin, are good since 1922 when the recording gage was installed. But with a limited number of rim stations, most of which have much shorter periods of continuous operation, it has only been possible to use indirect methods to obtain data which can be used in applying the inflow-outflow method in the valleys of this river system. The attack on this problem has therefore been to develop inflow indexes which are used with pertinent climatological factors in multiple correlation relationships. These studies are not complete and in fact they may continue indefinitely as additional years of records become available and new facts are learned which tend to increase the accuracy of such inflow-outflow relationships as are being developed. Several problems are still to be investigated and questions continue to arise which will require answers as the investigation continues.

Because interest in this problem, among others before the Upper Colorado River Commission, seems to be rather widespread, this review of some of the methods of determining the consumptive uses of water in the West and of the rather special conditions governing the application of the inflow-outflow method to the measurement of man-made stream depletions on a basin-wide basis is offered for your information at this time.

## CONCLUSION

Up to the present time, the Upper Colorado River Commission has not adopted any regulation or procedure by which to "make findings of fact" as to the amounts of man-made depletions either at Lee Ferry or at State Lines. Progress Reports are made from time to time (this paper may be considered as in that category) which are reviewed by the committee of engineering advisors to the Commission. When this committee makes recommendations to the Commission which can be adopted for the application of the inflow-outflow method to its purposes, it is hoped that it will also authorize a technical paper on that subject.



## APPENDIX

### METHODS OF DETERMINING CONSUMPTIVE USE OF WATER IN IRRIGATION

#### REFERENCES

- (1) The Use of Water in Irrigation, by Elwood Mead, with Computations of Records, etc. by C. T. Johnston. (Reprint Bulletin 86, USDA). Annual Report of Irrigation and Drainage Investigation, 1904.
- (2) The Production of Dry Matter with Different Quantities of Irrigation Water by John A. Widtsoe, Utah College of Agriculture, Experiment Station Bulletin 116, 1912.
- (3) Experiments on the Economical Use of Irrigation Water in Idaho by Don H. Bark, U.S.D.A., Bulletin 339, April 1916. Also a more detailed report by the State Engineer of Idaho of the same experiments, the State cooperating with the U. S. Department of Agriculture.
- (4) Irrigation Engineering, Ch. X, Duty of Water by Davis and Wilson, 7th Ed.
- (5) Irrigation Practice and Engineering by Etcheverry and Harding, Vol. I, 2nd Ed., Chs. IV and V, 1933.
- (6) Hydrology Handbook, ASCE, Manual of Engineering Practice, No. 28, Evapo-Transpiration or Consumptive, Ch. 4, Art. 10, page 136.
- (7) Irrigation Principles and Practice, by O. W. Israelsen, 1st Ed. Ch. XIV, 1932.
- (8) Hydrology, Physics of the Earth—IX, Edited by Oscar E. Meinzer, Ch. VIII by Charles H. Lee, 1st Ed. 1949.
- (9) Consumptive Use of Water in Irrigation. Progress Report of the Duty of Water Committee. Trans. ASCE. Vol. 94 (1930) 1340.
- (10) Consumptive Use of Water for Agriculture by Robert L. Lowry and Arthur F. Johnson. Trans. ASCE. Vol. 107 (1942) 1243.
- (11) Consumptive Use of Water, A Symposium, by Harry F. Blaney and others. Trans. ASCE. Vol. 117 (1952).
  - a) Consumptive Use of Water by Harry F. Blaney, page 949.
  - b) Consumptive Use of Water by Forest and Range Vegetation by L. R. Rich, page 974.
  - c) Consumptive Use of Water on Irrigated Lands by Wayne D. Criddle, page 991.

- d) Consumptive Use in Municipal and Industrial Areas, by George B. Gleason, page 1004.
  - e) Consumptive Use in the Rio Grande Basin, by Robert S. Lowry, page 1014.
- (12) A Method of Estimating Water Requirements in Irrigated Areas from Climatological Data by Harry F. Blaney and Wayne D. Criddle, U.S.D.A., S.C.S. Dec. 1947. (Mimeographed Report).
  - (13) Consumptive Use of Water Rates in the Upper Colorado River Basin by Harry F. Blaney and Wayne D. Criddle, U. S. D. A., S. C. S. April 1949.
  - (14) Consumptive Water Use and Requirements in the Colorado River Area of Utah, by Willis C. Barrett and Cleve H. Milligan, Special Report No. 8, Utah State Agricultural College Experiment Station, S. C. S., U. S. D. A., and State Engineer of Utah, March, 1953.
  - (15) Evapo-Transpiration Measurements in Western United States, by Harry F. Blaney. Paper given at the Tenth General Assembly of the International Union of Geodesy and Geophysics at Rome, Italy, September, 1954.
  - (16) Experiments to Determine Rate of Evaporation from Saturated Soils and Riverbed Sands, by Ralph L. Parshall, Trans. ASCE. Vol. 94 (1930) 961.
  - (17) Irrigation Requirements of California Crops, Bulletin No. 51, November 1945, Department of Public Works, Division of Water Resources, State of California.
  - (18) Consumptive Use Requirements for Water, by Harry F. Blaney, Agricultural Engineering, Vol. 35, December, 1954.



TABLE 1. Examples of Valley Consumptive Use of Water Determinations by Inflow-Outflow Method.

Location	Year	Area (acres)	Annual Consumptive Use		Authority
			Total (acre-ft.)	Average (feet)	
San Luis Valley, Colo.	1925-1935	400,000	664,900	1.66	Blaney-Rohwer
San Luis Valley, Colo.	1936	400,000	685,423	1.71	Blaney-Rohwer
San Luis Valley, Colo.	1930-1932	17,300	26,215	1.52	Tipton-Hart
Isleta-Belen, N. M.	1936	17,500	38,700	2.28	Blaney-Morin
Mesilla Valley, N. M.	1919-1935	109,000	297,756	2.73	Blaney-Israelsen
Mesilla Valley, N. M.	1936	110,418	303,683	2.75	Blaney-Israelsen
Carlsbad, N. M.	1921-1939	51,700	129,752	2.51	Blaney-Morin- Criddle
Carlsbad, N. M.	1940	51,700	119,898	2.33	Blaney-Morin- Criddle
New Fork, Wyo.	1939-1940	25,000		1.59	Lowry-Johnson
Michigan-Ill.-Colo.	1938-1940	43,000		1.50	Lowry-Johnson
Uncompahgre, Colo.	1938-1940	137,700		2.28	Lowry-Johnson

TABLE 2

Examples of Coefficients (K) for Irrigated Crops Developed From Measurements of Consumptive Use and Climatological Data\*

Location and crop	Year	Growing Season or Period	Consumptive Use Rate (U)	Factor (F)	Coefficient (K)**
		DATES	INCHES		
ALFALFA					
Carlsbad, N. M.	1940	4/18-11/10	38.6	43.59	0.88
Ft. Stockton, Tex.	1940	4/13-11/11	40.5	46.28	.88
San Fernando, Calif	1939	2/26 - 9/9	19.3	23.35	.88
Ferron, Utah	1948	5/9-10/6	24.2	30.23	.84
Mesa, Ariz.	1948	2/10-12/3	52.5	57.51	.91
Ontario, Ore.	1941-42	5/1-10/5	29.4	35.50	.83
Gooding, Idaho		5/23- 9/24	21.6	26.18	.83
COTTON					
Mesa, Ariz.	1935	4/1 - 10/31	30.9	49.08	.63
Bakersfield, California	1927-30	4/1 - 10/31	29.2	47.14	.62
Carlsbad, N.M.	Normal	3/28-11/3	28.7	47.39	.61
Ft. Stockton, Tex.	1940	4/13-11/11	28.9	46.28	.62
SMALL GRAINS					
Scottsbluff, Neb.	1932-35	4/20-7/25	14.72	20.02	.74
Prosser, Wash.	1944	3/20-7/16	18.00	23.32	.77
Ferron, Utah	1948	5/13-8/21	17.8	20.86	.85
Davis, Calif.		3/1-6/7	12.0	17.73	.68
ORCHARD-ORANGES					
Mesa, Ariz.	1931-34	3/1 - 10/31	32.4	58.26	.56
Azuso, Calif.	1929	4/1 - 10/31	21.8	43.19	.50
San Fernando, Calif.	1940	4/1-10/31	22.1	43.73	.51
ORCHARD—DECIDUOUS					
Ontario, Cal.	1928	4/1-9/30	28.4	37.73	.75
Wenatchee, Washington	1908	4/15-10/22	23.0	38.15	.60
Albuquerque, New Mexico	1936	5/1-9/31	19.5	33.94	.58
PASTURE					
Vernal, Utah	1948	5/17-10/6	25.0	27.42	.91
Murietta, Calif.	1953	4/1 - 10/31	35.04	42.04	.84



# POTATOES

Bonnors Ferry, Idaho	1947	5/8-9/27	22.95	29.35	.78
Utah County, Utah	1938	5/15-9/15	22.50	27.23	.83
Prosser, Wash.	1945	4/20-8/4	16.65	22.81	.83
Davis, Calif.		3/1-6/30	16.8	22.93	.73
Logan, Utah	1902-29	5/20-9/15	15.0	25.27	.60

# VEGETABLES

Stockton, Cal.	1925-28	5/1-9/30	21.4	33.91	.63
Stockton, Cal.	1925-28	4/1-10/31	24.6	44.18	.56

\*Table 6 of "Evapo-Transpiration Measurements in Western United States" by Harry F. Blaney.

$$**K = \frac{U = \text{Consumptive Use}}{\text{Use Factor}} = \text{Empirical coefficient}$$

TABLE 3

Consumptive-use Coefficients (K) for Irrigated Crops  
in Western United States\*

Crop	Length of growing season or period	Consumptive-use Coefficient <sub>1</sub> (K)
Alfalfa	Between frosts	0.80 to 0.85
Beans	3 months	.60 to .70
Corn	4 months	.75 to .85
Cotton	7 months	.60 to .65
Flax	7 to 8 months	.80
Grains, small	3 months	.75 to .85
Grain sorghums	4 to 5 months	.70
Orchard, citrus	7 months	.50 to .65
Orchard, walnuts	Between frosts	.70
Orchard deciduous	Between frosts	.60 to .70
Pasture, grass	Between frosts	.75
Pasture, Ladino clover	Between frosts	.80 to .85
Potatoes	3½ months	.65 to .75
Rice	3 to 5 months	1.00 to 1.20
Sugar beets	6 months	.65 to .75
Tomatoes	4 months	.70
Vegetables—small	3 months	.60

\*Table 7 of "Evapo-Transpiration Measurements in Western United States" by Harry F. Blaney.

<sub>1</sub>The lower values of (K) are for coastal areas, the higher values for areas with an arid climate.



## APPENDIX D

### UPPER COLORADO RIVER COMMISSION

#### Key Gaging Stations

Derived from reports of U.S. Geological Survey and others.

Not to be construed as findings.

Unit of flow—1000 acre-feet

Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
1.	Animas River near Cedar Hill, N. M.	1,092	442.3	426.8	464.0
2.	Animas River at Durango, Colorado	692	391.9	364.0	409.7
3.	Animas River at Farmington, N. M.	1,360	373.6	376.5	412.6
4.	Arapaho Creek at Monarch Lake Outlet, Colorado	47.1	53.2	37.4	50.5
5.	Ashley Creek near Jensen, Utah	386	27.9	16.0	15.6
6.	Ashley Creek at Sign of the Main, near Vernal, Utah	241	65.1	58.6	52.4
7.	Ashley Creek near Vernal, Utah	101	58.1	53.4	49.5
8.	Big Sandy Creek at Leckie Ranch, Wyo.	94	48.0	54.7	
9.	Blacks Fork near Milburne, Wyo.	156	114.8	71.5	
10.	Blacks Fork near Green River, Wyo.	3,670	177.4	67.5	
11.	Blue River at Dillon, Colorado	129	78.6	36.0	54.5
12.	Boulder Creek below Boulder Lake, Wyo.	130	117.9	147.9	
13.	Bloomfield Canal (See Citizens Ditch)				

Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
14.	Brush Creek near Jensen, Utah	255	7.6	5.1	4.7
15.	Brush Creek near Vernal, Utah	82	19.7	16.4	14.4
16.	Burnt Fork near Burnt Fork, Wyo.	53	19.8	12.4	
17.	Carter Creek near Manila, Utah		5.2	3.0	
18.	Carter Creek at mouth near Manila, Utah	110	33.6	22.3	18.2
19.	Citizens Ditch (Bloom- field Canal) near Tur- ley, N. M. Diverting water around Blanco gage		72.2	79.1	74.2
20.*	Colorado River near Cameo, Colorado	8,055	2,572.8	1,552.0	1,976.0
21.	Colorado River near Cisco, Utah	24,100	4,037.0	2,329.0	3,241.0
22.	Colo. River near Colo.- Utah State line	20,680	3,773.0	2,086.0	2,903.0
23.*	Colo. River at Glen- wood Springs, Colorado	4,560	1,589.0	885.9	1,026.0
24.	Colorado River near Grand Lake, Colorado	103	44.0	23.8	33.3
25.	Colorado River at Hite, Utah	76,600	7,767.0	5,015.0	6,238.0
26.	Colo. River at Hot Sul- phur Springs, Colorado	782	164.2	80.4	103.1
27.	(A) Colo. River at Lee Ferry, Arizona	@109,889	8,822.4	6,119.2	7,300.0
28.	Colorado River at Lees Ferry, Arizona	@108,335	8,804.6	6,101.1	7,283.0
29.	Cottonwood Creek near Orangeville, Utah	200	62.1	41.2	43.2



Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
30.	Crystal River near Redstone, Colorado	225	211.3	142.5	213.2
31.	Dirty Devil River near Hite, Utah				53.0
32.	Dolores River near Cisco, Utah		290.8	208.5	360.0
33.	Dolores River at Dolores, Colorado	556	195.1	155.6	
34.	(D) Dolores River at Gateway, Colorado	4,350	293.4	203.2	
35.	Duchesne River at Myton, Utah	2,705	272.0	148.3	185.4
36.	Duchesne River near Randlett, Utah	3,820	354.9	191.4	247.6
37.	Duchesne River near Tabiona, Utah	352	140.3	77.7	92.2
38.	Eagle River below Gypsum, Colo.	957	402.9	221.1	292.3
39.	Eagle River at Redcliff, Colorado	72	28.8	14.8	16.7
40.	East River at Almont, Colorado	295	200.8	126.3	175.8
41.	East Fork of Smith Fork near Robertson, Wyoming	53	30.2	18.4	
42.	East Fork of Beaver Creek near Lonetree, Wyoming		6.7	4.2	4.4
43.	Elk River at Clark, Colorado	206	178.1	135.1	186.8
44.	Escalante River near Escalante, Utah	315	4.4	2.2	2.4
45.	Escalante River near mouth, Utah		60.8	49.6	64.5
46.	Florida River near Durango, Colorado	96	37.3	43.8	42.4

Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
47.	(D) Fontenelle Creek near Fontenelle, Wyo.	224	33.5		
48.	Fontenelle Creek near Herschler Ranch	152	40.3	39.8	
49.	Fraser River near Winter Park, Colorado	27.6	6.36	4.3	21.1
50.	Green River near Greendale, Utah		1,288.0	1,251.0	1,002.0
51.	Green River at Green River, Utah	40,920	3,395.0	2,618.0	2,839.0
52.	Green River near Green River, Wyoming	7,670	1,086.8	1,189.0	
53.	Green River near Jensen, Utah	**	2,492.0	2,056.0	2,074.0
54.	Green River near Linwood, Utah	14,300	1,205.0	1,227.0	932.5
55.	Green River near Ouray, Utah	**	3,399.0	2,665.0	2,818.0
56.	Green River at Warren Bridge, Wyoming	468	358.7	394.1	
57.	Gunnison River and Redlands Power Canal near Grand Junction, Colorado	8,020	1,331.0	663.5	1,032.0
58.	Gunnison River near Gunnison, Colorado	1,010	480.8	283.8	362.6
59.	Gunnison River below Gunnison Tunnel, Colorado	3,980	668.8		401.4
60.	Hams Fork near Frontier, Wyo.		74.0	61.6	
61.	Henrys Fork at Linwood, Utah	530	58.1	15.6	



Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
62.	Henrys Fork near Lonetree, Wyoming	55	28.4	14.7	
63.	LaPlata River at Colorado-New Mexico State line	331	11.4	6.7	9.35
64.	LaPlata River at Hesperus, Colorado	37	22.3	18.6	20.3
65.	Little Snake River near Dixon, Wyoming	988	258.8	157.2	215.7
66.	Little Snake River near Lily, Colorado	3,730	268.7	178.3	233.2
67.	Little Snake River near Slater, Colorado	285	113.0	76.2	114.6
68.	Los Pinos River near Bayfield, Colorado	284	175.9	176.7	192.2
69.	(C) Los Pinos River at LaBoca, Colorado		64.1	64.1	80.4
70.	Los Pinos River at Ignacio, Colorado	448	43.9	43.9	57.8
71.	Mancos River near Towoac, Colorado	550	11.8	10.0	14.2
72.	McElmo Creek near Colorado-Utah state line		20.0	20.8	26.5
73.	McElmo Creek near Cortez, Colorado	233	21.3	22.1	
74.	Middle Fork Beaver Creek near Lonetree, Wyoming		14.2	8.6	11.1
75.	Minnie Maud Creek near Myton, Utah		0.9	1.1	
76.	Navajo River at Edith, Colorado	165	65.2	62.5	
77.	North Fork Gunnison River near Somerset, Colorado	521	248.0	142.3	239.8

Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
78.	North Piney Creek near Mason, Wyoming	58	38.8	40.4	
79.	(A) Paria River at Lees Ferry, Arizona	1,550	17.8	15.7	17.7
80.	#Pine Creek near Fremont Lake, Wyo.				
81.	Pine Creek at Pinedale, Wyo.	118	87.2	90.1	
82.	Plateau Creek near Cameo, Colorado	604	103.0	72.3	93.0
83.	Price River near Heiner, Utah	455	79.9	63.4	59.0
84.	Price River at Woodside, Utah	1,500	60.1	52.4	44.4
85.	Ranch Creek near Fraser, Colo.	19.9	8.61	2.9	2.9
86.	Rio Blanco River near Pagosa Springs, Colorado	58	44.4	40.0	
87.	Roaring Fork at Aspen, Colorado	109	59.4	32.6	43.5
88.	Roaring Fork at Glenwood Springs, Colorado	1,460	800.1	477.9	660.8
89.	(D) San Juan River near Blanco, N. M.	3,558	509.9	514.2	
90.	San Juan River near Bluff, Utah	23,010	934.7	984.9	988.5
91.	San Juan River at Farmington, New Mexico	7,240	841.7	896.9	915.7
92.	San Juan River at Pagosa Springs, Colorado	298	183.7	150.7	153.3
93.	San Juan River at Rosa, N. M.	1,990	459.7	433.4	434.5



Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
94.	San Juan River at Shiprock, New Mexico	12,900	873.4	943.4	956.4
95.	San Miguel River near Placerville, Colorado	308	138.8	103.0	
96.	San Rafael River near Green River, Utah	1,690	80.9	39.1	31.8
97.	Savery Creek near Savery, Wyoming	330	59.0	39.4	42.5
98.	Sheep Creek near Manila, Utah	46	7.0	1.5	2.0
99.	Sheep Creek at mouth near Manila, Utah	111	14.8	8.3	8.3
100.	(B) Sheep Creek Upper Canal, near Manila, Utah		3.1	2.8	4.0
101.	(B) Sheep Creek Lower Canal, near Manila, Utah		8.8	8.8	12.4
102.	Slater Fork near Slater, Colorado	161	42.0	29.9	40.2
103.	Snake River near Montezuma, Colorado	59	44.9	25.4	36.3
104.	South Fork White River at Buford, Colorado	170	188.6	130.4	153.8
105.	(C) Spring Creek at LaBoca, Colorado near Colo.-N. Mex. State Line	58	21.5	24.3	
106.	St. Louis Creek near Fraser, Colorado	33	26.0	13.5	19.0
107.	Strawberry River at Duchesne, Utah	1,040	89.9	64.6	72.2
108.	Taylor River at Almont, Colorado	440	245.3	166.6	177.4
109.	Tenmile Creek at Dillon, Colorado	113	90.5	44.0	56.6

Ref. (1)	Stream (2)	Drainage Area Sq. Miles (3)	Flows in Water Years (Provisional)		
			1953 (4)	1954 (5)	1955 (6)
110.	Tomichi Creek at Gunnison, Colorado	1,020	124.6	50.3	58.6
111.	Troublesome Creek near Troublesome, Colorado	178	28.7	13.5	18.5
112.	Uinta River near Neola, Utah	181	105.7	95.1	96.6
113.	Uncompahgre River at Colona, Colorado	437	144.1	87.6	
114.	Vasquez Creek near Winter Park, Colorado	27.8	4.8	2.5	3.1
115.	West Fork Beaver Creek near Lonetree, Wyoming		12.6	6.8	8.0
116.	West Fork Smith Fork near Robertson, Wyoming	37	14.2	6.4	
117.	White River at Buford, Colorado	240	208.6	160.0	174.7
118.	White River near Meeker, Colorado	762	455.4	301.1	344.5
119.	White River near Watson, Utah	4,020	475.9	340.6	
120.	Whiterocks River near Whiterocks, Utah	115	63.4	57.9	60.3
121.	Williams River near Leal, Colorado	89.5	65.3	32.9	44.3
122.	Willow Creek near Ouray, Utah	967	13.6	12.6	
123.	Yampa River near Maybell, Colorado	3,410	829.2	522.2	772.6
124.	Yampa River at Steamboat Springs, Colorado	604	285.3	156.2	241.6



Ref.	Stream	Drainage	Flows in Water Years		
		Area	(Provisional)		
		Sq. Miles	1953	1954	1955
(1)	(2)	(3)	(4)	(5)	(6)

\* This is a U. S. G. S. station but is not required at the present time for administration by the Upper Colorado River Commission.

\*\* Drainage area not shown in latest U. S. G. S. water supply paper available.

# This station is to be installed or reestablished and operated by the U.S.G.S.

(A) Lee Ferry one mile down stream from the mouth of the Paria River is the 1922 "Compact Point," and the discharge at this point is taken as the sum of Nos. 28 and 79.

(B) Discharge measurements reported in U. S. G. S. Water Supply Paper 1059 (1946) p. 384.

(C) Add Spring Creek to Los Pinos River at LaBoca to give flow at Colorado-Utah state line.

(D) Discontinued.

@ Area from Final Report of Engineering Advisory Committee to Upper Colorado River Compact Commission, November, 1948.

# TRANSMOUNTAIN DIVERSIONS IN UTAH

Not to be construed as findings.

Ditch or Tunnel	Location	Acre-feet	
		1954	1955
Ephraim Tunnel	Near Ephraim	2,480	
Reeder Ditch	Near Spring City	75	
Twin Creek Tunnel	Near Mt. Pleasant	144	
Horseshoe Tunnel	Near Ephraim	362	
Cedar Creek Tunnel	Near Spring City	191	
Spring City Tunnel	Near Spring City	1,430	
Fairview Ditch	Near Fairview		
Candland Ditch	Near Mt. Pleasant		
Black Canyon Ditch	Near Spring City	218	
Larsen Tunnel	Near Ephraim	705	
Madsen Ditch	Near Ephraim	4	
John August Ditch	Near Ephraim	224	
Coal Fork Ditch	Near Mt. Pleasant	167	
Hobble Creek Ditch	Near Heber	995	1,160
Strawberry River and Willow Creek Ditches	Strawberry River, Willow Creek	1,290	2,610
Strawberry Tunnel	Strawberry River	78,910	71,450
Tropic and East Fork Canal	Near Tropic	2,180	
Duchesne Tunnel near Kamas, Utah	North Fork Duchesne River	26,350	32,060



## TRANSMOUNTAIN DIVERSIONS IN COLORADO

Not to be construed as findings.

Ditch or Tunnel	Location	Acre-feet Year	
		1954	1955
Alva B. Adams Tunnel (East Portal)	Shadow Mountain Reservoir	302,070	256,600
Berthoud Pass Ditch	Fraser River Tributaries	212	458
Eureka Ditch	Tonahutu Creek	27	125
Grand River Ditch	Colorado River Tribs.	12,740	16,150
Moffat Tunnel (East Portal)		19,540	37,020
Independence Pass Tunnel (Twin Lakes Tunnel)	Roaring Fork Tribs.	27,470	35,260
Williams Fork Tunnel (Jones Pass)	Williams River	5,420	10,300
Boreas Pass Ditch	Blue River	136	268
Hoosier Pass Tunnel	Blue River	3,550	6,060
Columbine Ditch	Tenmile Creek Tribs.	844	1,160
Fremont Pass Ditch	Tenmile Creek	none	none
Ewing Ditch	Eagle River	498	415
Wurtz Ditch	Eagle River	905	1,350
Busk-Ivanhoe Tunnel	Fryingpan River	3,200	5,270
Larkspur Ditch	Tomichi Creek	none	16
Tabor Ditch	Gunnison River	174	31
Fuchs Ditch	N. Fork Los Pinos River	1,186	696
Raber-Lohr Ditch	Los Pinos River	3,650	3,490

## TRANSMOUNTAIN DIVERSIONS IN COLORADO

Not to be construed as findings.

Ditch or Tunnel	Location	Acre-feet	
		1954	1955
Treasure Pass Ditch	San Juan River	60	90
Squaw Pass Ditch	San Juan River	211	71
Piedra Ditch	San Juan River	none	



## APPENDIX E

### RESOLUTION OF THANKS TO JOHN GEOFFREY WILL

WHEAREAS, John Geoffrey Will has acted as Secretary and General Counsel of the Commission for the past five years, and Mr. Will has given his best efforts to further the objectives and interests of the Commission:

The Commission therefore extends Mr. Will its thanks for his services and best wishes for his future success.

RECEIVED

DEC 14 1898

STATE PUBLICATIONS  
Colorado State Library